ALAMEDA COUNTY
MOSQUITO ABATEMENT DISTRICT

89th and 90th Annual Report
2020–2021

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HOW TO CONTROL MOSQUITOES DURING A PANDEMIC

Many of us have a story from the winter of 2019/2020 of how that cold or flu we had was an early indicator of what was to come. I attended the 88th annual Mosquito and Vector Control Association Conference in San Diego on January 26th-28th of 2020 while feeling a bit under the weather. As I apologized to Alameda County Mosquito Abatement District (ACMAD, or District) staff for coming to work ill, colleagues from other districts admired my dedication while adding that I may "have that virus from the other side of the world." A month later, on February 27th, a colleague from Fresno County was the first person I heard use the term "COVID-19" at our annual Vector Control Joint Powers Authority Workshop in Santa Cruz. Two and a half weeks later, on March 16th, the District followed the Health Officers' Shelter-in-Place orders for essential workers sending office staff to work from home, asking our governing board to meet remotely, and providing guidance on how field employees can safely adjust their mosquito control and surveillance activities to be at less risk for infection. Those 50 days are like a prologue to a science fiction disaster story in hindsight. Thankfully, the story at ACMAD that followed those 50 days was not a disaster, rather, it was a testament to the professionalism found in every facet of our organization. I am proud to introduce the accomplishments made by our board and staff during the very surreal years of 2020 and 2021.

Staff made an agreement that we would not use certain cliches, or even mention the pandemic for the reader's sake. But, it would be a disservice to our organization if we did not acknowledge that we never used the situation as a crutch. Instead, these past two years showed how we can leverage the situation to improve our services to Alameda County residents. In 2020 and 2021, we never missed a day responding to mosquito requests for service within 24 hours, we continued to publish in peer-reviewed academic journals, we engaged directly with our residents via social media, we operated our equipment and facilities without delay, and we accessed District databases safely and securely while working remotely through cloud-based computing.

A strategic plan approved by our fifteen-member Board of Trustees every three years guides the District. ACMAD staff and the board renewed the 2021-2024 plan during a remote strategic planning workshop in December of 2020 which included the following goals:

- Ensure ACMAD has the training, equipment, personnel, partnerships, and financial support to limit the introduction of invasive *Aedes* mosquitoes.
- Leverage ACMAD assets towards efficient approaches to mosquito control.
- Employ the best practices for mosquito control districts and local governments.

Our strategic planning goals are the template for all District actions which you will see reflected in this report.

Our 2021-24 strategic plan also added a core value: accountability. The prior strategic plan should have included accountability, as this value is at the root of our District and our relationship with the community. Efficient and effective mosquito control requires us all to be transparent while communicating any obstacles. This starts at the top by ensuring our trustees have the information they need to make an informed decision, our audit is clean and publicly available, and our website is easy to navigate for the public. Because of these efforts and for the 6th year in a row, our District obtained the District Transparency Certificate of Excellence from the Special District Leadership Academy. For the first time, the Government Finance Officers Association awarded our District the Certificate of Achievement for Excellence in Financial Reporting. These achievements require a strong foundation which our updated District policies help provide. The Board of Trustees completed this review over several months in the fall of 2021.

In early 2020, the District hired a consultant, Emily Estus, to review our operations, surveillance, and outreach programs for any health equity deficiencies. This proactive measure led the District to improvements such as creating a new position in community outreach. This is an important investment the District made in one of three “legs” of Integrated Vector Management. The community outreach section of this report will detail some of the projects in this category.

The other program evaluated in Emily's report was mosquito surveillance, the results of which led to adjustments in our mosquito trapping locations. Besides mosquito trapping and disease testing, the District lab also leads our quality control and research and innovations such as work in drones and 3D printing.

Our mosquito surveillance program evaluates work done by our operations program. Mosquito operations is the “abatement” in ACMAD. Remarkably, you would not know that we were in the midst of an international crisis by the results of our mosquito control program. Operations staff performed their jobs uninterrupted while facing a hold on seasonal employment, disruptions to our partner agencies, record use of parks by residents, and an increase in unsafe driving.

Operations and lab staff were able to continually execute their work safety because of the dedication of our facility, safety, and equipment led by employee, Mark Wieland. As a member of Alameda County's Emergency Manager's Association, Mark's updates from the daily, weekly, and later bi-monthly calls hosted through the Alameda County Sheriff and Public Health Department allowed our District to keep abreast of all developments and available resources while acquiring hard-to-find essential safety equipment.

Our seamless technological transition to remote collaborations allowed communication throughout the organization without delay. Thankfully, our IT Director, Robert Ferdan, made these improvements prior to 2020 so the District was easily able to adapt to working in these conditions.

Without stealing any more of our staff's thunder, I am pleased to present the District's 89th and 90th reports — covering January of 2020 to December of 2021.

Ryan Clausnitzer
General Manager

GOVERNING BOARD

The fourteen city councils within Alameda County plus the Alameda County Board of Supervisors each appoint one trustee to represent its constituency on the fifteen-member governing board of the Alameda County Mosquito Abatement District for a fixed term of two or four years. The principal acts granting District authority are found in section 2000 of the California Health and Safety Code. The Board of Trustees possess a variety of skills and expertise in academia, agriculture, business, education, electrical engineering, entomology, environmental health, geology, insurance, government, human resources, legal, mechanical engineering, parks and recreation, pharmaceuticals, politics, and scientific research.

Trustees serve without compensation, rather, they receive a maximum stipend of $100 per month for attending business meetings of the board. The regular board meetings are held on the second Wednesday of each month at the District office, 23187 Connecticut Street, Hayward at 5:00 p.m. and the meetings are open to the public. Because of a public health emergency, all but four meetings in 2020 and 2021 were held remotely via Zoom.

TRUSTEES FOR THE YEARS 2020 & 2021

Trustee	Representing	Years of Service
Cathy Roache	County-at-large	3
Wendi Poulson	Alameda	6.5
Peggy McQuaid	Albany (2020)	.5
Preston Jordan	Albany (2021)	1
Robert Beatty	Berkeley	5.5
Shawn Kumagai	Dublin	2
Betsy Cooley	Emeryville	4.5
George Young	Fremont	9
Elisa Marquez	Hayward	7
James N. Doggett	Livermore (2020)	44
Steve Cox	Livermore (2021)	1
Jan O. Washburn	Oakland (Berkeley)	6.5 (21)
Eric Hentschke	Newark	6
Andrew Mingst	Piedmont	2
Julie Testa	Pleasanton	2
Victor Aguilar	San Leandro	3
Subru Bhat	Union City	4

DISTRICT PERSONNEL

Alameda County Mosquito Abatement District staff

Lab staff

Office staff

Operations staff

Name of Employee	Position	Years of Service
SUPPORT STAFF		
Ryan Clausnitzer	General Manager	6.5
Erika Castillo	Regulatory & Public Affairs Director	19.5
Robert Ferdan	Information Technology Director	6.5
Judith Pierce Davison	Public Outreach Coordinator	1.5
Michelle Robles	Accounting Associate	5.5
Mark Wieland	Mechanical Specialist	6.5
OPERATIONS STAFF		
Joseph Huston	Field Operations Supervisor	30.5
Nick Appice	Vector Biologist	7.5
John Busam	Vector Biologist	19.5
Cornelius Campbell	Vector Biologist	18
Erick Gaona	Mosquito Control Technician	2
Sarah Lawton	Vector Biologist	6
Tom McMahon	Vector Biologist	20
Ben Rusmisel	Vector Biologist	6
Jeremy Sette	Vector Biologist	6.5
LABORATORY STAFF		
Eric Haas-Stapleton	Laboratory Director	6.5
Dereje Alemayehu	Vector Scientist	22.5
Miguel Barretto	Associate Vector Scientist	3.5

Seasonal Employees

2020—none

2021—Allison Bates, Brenna Hentschke, Kelly Plant

REPRESENTATION ACTIVITIES

The District is one of over 60 agencies that conduct mosquito control and one of over 2,000 special districts, in California. The District participates in the activities of the California Special Districts Association (CSDA), the Mosquito and Vector Control Association of California (MVCAC), and the American Mosquito Control Association (AMCA). There, we promote the innovative work of our District, coordinate common activities, and increase the knowledge and abilities of staff and trustees. The following is a list of District employees who have participated in regional, statewide, or national activities either by committee, have spoken or presented, or are an officer chosen by their peers:

MEMBERSHIPS

Ryan Clausnitzer
Vice-President and President (2020 and 2021), CSDA

Ex officio Member, CSDA Audit, Bylaws, Fiscal, Member Services, Legislative, Professional Development Committees

Member at-large, Alameda County Special District Association Executive Committee

Member, MVCAC Legislative Committee

Executive Committee Member, East Bay Economic Development Agency

Member, California's Secretary of State Election 2020 Task Force

Erika Castillo
Member, MVCAC Regulatory Affairs Committee

Member (2020), MVCAC Public Education Committee

Member, San Francisco Bay Restoration Authority Advisory Committee

Board Member, San Francisco Bay Joint Venture

Member, AMCA Endangered Species Subcommittee

Member and Vice Chair (2021), Wetlands Regional Monitoring Program Steering Committee

Sarah Lawton
Member and Co-Chair (2021), AMCA Young Professionals

Robert Ferdan
Member, MVCAC Information Technologies Committee
Member (2021), MVCAC Training and Certification Committee
Member (2021), Municipal Information Systems Association of California Security Committee

Eric Haas-Stapleton, PhD
Chair, MVCAC Laboratory Technologies Committee

Chair, MVCAC ad hoc Drone Committee

Member, MVCAC Vector Control Research Committee

Member, MVCAC CalSurv Steering Committee

Member, MVCAC Information Technologies Committee

Joseph Huston
Member, MVCAC Trash Capture Subcommittee

Mark Wieland
Member, Alameda County Emergency Managers Association

MVCAC Mosquito and Vector Control Association of California

AMCA THE AMERICAN MOSQUITO CONTROL ASSOCIATION

CSDA California Special Districts Association Districts Stronger Together

MOSQUITO ASSOCIATION PRESENTATIONS

PUBLICATIONS

Esterly AT, Alemayehu D, Rusmisel B, Busam J, Shelton T, Sebay T, Zahiri N, Haas-Stapleton EJ, 2020. *Culex erythrothorax (Diptera: Culicidae)*: Activity periods, insecticide susceptibility, and control in California (USA). *PLOS ONE,* doi.org/10.1371/journal.pone.0228835.

Ary F, Haas-Stapleton EJ, Sorensen B, Scholl M, Goodman G, Buettner J, Schon S, Lefkow N, Lewis C, Fritz B, Hoffman C, Williams G, 2021. Toys or Tools? Utilization of Unmanned Aerial Systems in Mosquito and Vector Control Programs. *Journal of Economic Entomology, 114(5) 1896-1909.*

Batson J, Dudas G, Haas-Stapleton EJ, Kistler AL, Li LM, Logan P, Ratnasiri K, Retallack H, 2021. Single mosquito metatranscriptomics identifies vectors, emerging pathogens and reservoirs in one assay. *eLife*, 10:e68353 doi: 10.7554/eLife.68353

Castillo EB, Clausnitzer RJ, Haas-Stapleton EJ, 2021. Mosquito control opportunities amid regulations within the tidal marshes of the San Francisco Bay Area. *Wetlands Ecology and Management*, https://doi.org/10.1007/s11273-021-09832-6

2020 MVCAC

Alemayehu D, Barretto M, Busam J, Sette J, Wieland M, Haas-Stapleton EJ, 2020. Evaluating mosquito abundance using a New Jersey Light Trap fitted with an LED light bulb and BG Lure. Presented at the 2020 Annual Meeting of the American Mosquito Control Association. San Diego, CA.

Alemayehu D, Barretto M, Haas-Stapleton EJ, 2020. Use of a pop-up garden waste bag as a resting mosquito trap for mosquito surveillance. Presented at the 2020 Annual Meeting of the American Mosquito Control Association. San Diego, CA.

Barretto M, Ferdan R, Haas-Stapleton EJ, 2020. Design, manufacture, and construction of an inexpensive 3D-printed CO_2-baited EVS trap. Presented at the 2020 Annual Meeting of the American Mosquito Control Association. San Diego, CA.

Buettner J and Haas-Stapleton EJ, 2020. First live-action drone workshop at MVCAC 2020 Annual Conference. Presented at the 2020 Annual Meeting of the American Mosquito Control Association. San Diego, CA.

Hager KM, Gaona E, Kistler AL, Ratnasiri K, Retallack H, Barretto M, Wheeler SS, Haas-Stapleton EJ, 2020. Development of a *Culex* kdr assay for the detection of pyrethroid resistance. Presented at the 2020 Annual Meeting of the American Mosquito Control Association. San Diego, CA

PRESENTATIONS TO PARTNERS

ACSDA Chapter Meeting (host)
January 8, 2020
Partner presentations by:
Chan Zuckerberg Biohub collaboration project—Amy Kisler, South Bay Salt Pond Restoration Project update—Dave Halsing

UC Berkeley: Introduction to Comparative Virology (2020 and 2021)
Guest Lecture: West Nile and Zika viruses
Eric Haas-Stapleton

UC Berkeley: Zoonotic Diseases (2020 and 2021)
Guest Lecture: Tabletop Project: Dengue virus outbreak in Alameda County
Eric Haas-Stapleton

Sierra Club Northern Alameda County Group: Chapter Meeting
August 23, 2021
Sterile insect technique for controlling mosquitoes
Eric Haas-Stapleton

Alameda Rotary
October 19, 2021
Ryan Clausnitzer

Hosted Assemblymember Quirk
November 8, 2021
CalSurv presentation and District tour
Ryan Clausnitzer and Eric Haas-Stapleton

MVCAC Coastal Region Continuing Education
November 9, 2021
The varied use of 3D printing for mosquito abatement
Miguel Barretto

Berkeley City Council Meeting
November 9, 2021
Sterile insect technique overview
Judith Pierce Davison and Eric Haas-Stapleton

ACSDA Chapter Meeting
November 10, 2021
Special district partner update
Ryan Clausnitzer

Alameda County Public Health Department
November 16, 2021
Partner update
Ryan Clausnitzer and Eric Haas-Stapleton

Annual Conference of the Utah Mosquito Abatement Association (2021)
Mr. Mister rockin' salt marsh *Aedes*.
Eric Haas-Stapleton

OPERATIONAL DATA

	2017	2018	2019	2020	2021
PHYSICAL CONTROL OPERATIONS					
Maintenance of ditches (lineal feet)	0	13,491	15,752	24,798	4,834
MOSQUITOFISH OPERATIONS					
Total number of sites stocked with *Gambusia*	762	558	610	598	554
Total number of fish planted	11,656	7,370	7,612	6,752	6,087
CHEMICAL CONTROL OPERATIONS					
Pyrenone 25-5 adulticide (oz)	0	0.77	0	0	0
SURFACE AGENTS					
BVA 2 larvicidal oil (gallons)	638	425	462	347	510
BIORATIONAL LARVICIDES					
***Bacillus thuringiensis israelensis* (Bti)**					
FourStar Bti Briquets 45 Day (pounds)	0	0	0.4	0	0
FourStar Bti Briquets 150 Day (pounds)	0	1.4	0.4	2.7	3.15
FourStar Bti CRG (pounds)	0	0	17	55	0
Vectobac 12AS liquid concentrate (gallons)	243	161	211	276	411
Vectobac G granular (pounds)	5,493	6,867	5,953	5,283	7,919
Vectobac GS (pounds)	0	0	0	140	351
***Bacillus sphaericus* (Bs)**					
Vectolex FG (formerly CG) (pounds)	868	2,061	352	251.5	118
Vectolex WDG (pounds)	1	0	30	0	0
Bacillus thuringiensis israelensis* and *Bacillus sphaericus					
FourStar 180 day Briquets (pounds)	0	1.4	0	0	0.07
Vectomax FG (pounds)	2,496	1,000	2,082	1,574	1,465
Vectomax WSP (pounds)	2	3	4.4	6.4	0.92
Spinosad					
Natular G30 (pounds)	80	29	53.25	774	565
Natular G30 WSP (pounds)	0	0	2.2	0.22	0
Natular XRT (pounds)	833	1,195	999	694	548
Methoprene					
Altosid Briquets (each)	1,566	1,631	1,131	825	897
Altosid Liquid Larvicide 20% (ounces)	9	6.1	10.2	6.4	7
Altosid Pellets (ounces)	357	348	761	916	1,011
Altosid WSP (pounds)	2	0	0	0	0
Altosid XR Briquets (each)	3,535	2,325	3,576	3,998	1,380
Pyriproxyfen					
SumiLarv .05G (pounds)	0	0	0	0	697

OPERATIONS REPORT

OPERATIONS OVERVIEW

ACMAD has been actively engaged in its mission to control both disease-transmitting and nuisance species of mosquitoes for over 90 years. Some of the control methods and mosquito sources have remained surprisingly similar throughout that time, however, others have evolved and continue to evolve dramatically. We have 22 mosquito species native to Alameda County that we are familiar with, and we have also spent a significant amount of time preparing for at least three potential invasive mosquito species. While we consistently strive to be prepared to adapt, innovate, and pivot in District operations, these last two years put that skill set to the test. As a new virus dominated the world in 2020 and 2021, operations staff ensured mosquitoes did not have a chance to reach the adult stage and potentially hinder our mission.

The core of the District's control program is a focus on Integrated Vector Management (IVM) and a steadfast philosophy of controlling mosquito larvae in the aquatic sources they inhabit. IVM utilizes physical, biological, biorational, and chemical control strategies. Mosquito species, disease vectoring potential, and habitat are all assessed to determine the most effective strategy or combination of strategies. Our most used control strategy is biorational materials. These materials are designed to treat mosquito larvae in aquatic sources. Most are very mosquito specific and have no adverse effects on other insects, aquatic arthropods, fish, amphibians, birds, or mammals. There are several benefits that arise out of this focus. Primarily, controlling larvae in the water allows for an extremely focused and precise effort. Once larvae emerge as adult mosquitoes, they can fly for many miles, are more difficult to control, and require the use of materials that are not as mosquito specific. Also, leaving other aquatic organisms unaffected results in competition and predator pressure on future generations of larvae and extends the control period. ACMAD operations staff work in many unique and special habitats. Many of these habitats are home to endangered and threatened plant, insect, and animal species. Operations staff deeply understand these unique habitats and species and strive to be good stewards in these environments, while fulfilling our mission to protect public health and safety.

MOSQUITO CONTROL TREATMENTS

Having a strategy is always a good plan, however, the day-to-day and year-to-year execution is what really counts. **Figure 1** clearly demonstrates the ACMAD operations philosophy of a biorational dominated, larval control-based program. During 2020 and 2021, operations staff treated a total of 10,226 acres of aquatic habitat for larval mosquitoes. Ninety-eight percent of the acres treated, 10,001 acres (about half the area of Manhattan) received bacterial products and insect growth regulators, both of which are biorational materials. The remaining 2% of treatments utilized the surfactant BVA 2. This oil coats the water surface and suffocates the mosquito larvae that must breathe air. Operations staff primarily use this surfactant in areas with extremely high organic material content or when mosquito larvae are in their

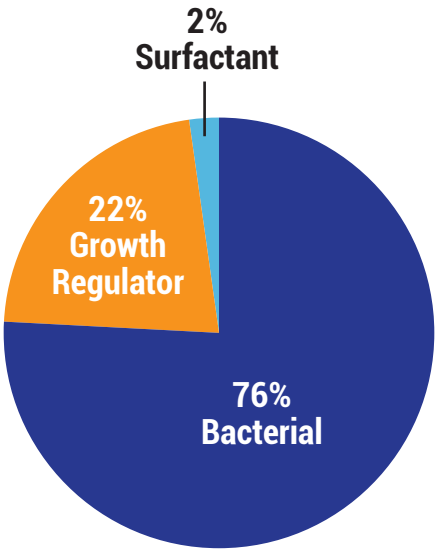


Figure 1. Acres Treated by Product.

latest stages of development and are no longer susceptible to biorational materials. These environments often include foul water sites such as sewer plants and underground infrastructure such as catch basins, sumps, and storm drains. It is also worth noting that ACMAD did not apply mosquito adulticides in 2020 or 2021. Adulticides are a valuable tool in an IVM program, especially in controlling disease vectoring adult mosquitoes, but we know that fewer larvae in the water equals fewer adults in the environment. With extra precautions in place at our District office and in the field, ACMAD operations helped keep our public safe from mosquito-borne disease during these two pandemic years.

NEW EQUIPMENT

Two new pieces of equipment joined the ACMAD operations toolbox. The first is an A1 Super Duty Mister and the second is a treatment UAS (unmanned aircraft systems or drone). The District purchased the A1 Mister prior to 2020. However, with help from our lab and the Mechanical Specialist, operations tested and utilized it for treatments in 2020 and 2021. Many mosquito control districts nationwide use the A1 Mister for Wide Area Larvicide Spray (WALS™) treatments of cryptic backyard sources in residential neighborhoods for invasive *Aedes* mosquitoes. ACMAD purchased this device in a proactive effort to respond to the arrival of invasive mosquitoes. As opposed to it sitting in our shed awaiting that fateful day, operations decided to assess its effectiveness for other applications. The District conducted tests in tidal salt marshes to treat larvae of one of our native species, *Aedes dorsalis*. This species is an extremely aggressive day-biter that can fly upwards of 15 miles from its emergence location. Many of our tidal marsh sources fall under the jurisdiction of the U.S. Fish and Wildlife Service which limits the equipment and materials we can use to treat mosquito larvae. Prior to the A1 Mister, operations staff treated these marshes in teams solely by hand. This species develops rapidly from egg to adult after high tide events, so the control window is very narrow. The A1 Mister trials were highly successful, and this piece of equipment came into regular use, allowing for larvicide treatments of hundreds of acres in a fraction of the time it took to do by hand. **Figure 2** illustrates the 400% increase in acreage treated in these areas from previous years. This project also led to a substantial reduction of larvae collected in these sources post-treatment (**Figure 3**). At the same time, the lab collected fewer adult mosquitoes in traps set in these areas (**Figure 4**). Overall, there was a 65% reduction in service requests received by the public relating to this species in areas surrounding these tidal marshes (**Figure 5**). The positive results led to greater usage of the A1 Mister and allowed operations staff to become familiar with its use, better preparing them for the arrival of invasive *Aedes* mosquitoes.

The operations treatment UAS is also showing a great deal of promise for future mosquito control applications. ACMAD has been an early adapter of this tool. To date, four operations staff have passed their FAA Part 107 Remote Pilot certification test allowing them to fly the UAS, and two have passed their California Department of Pesticide Regulation Vector Control Technician Unmanned Aircraft Pest Control Pilot certification exam, which allows them to treat. There are many areas in our county with dense vegetation, poison oak, and thick stands of tule that are exceedingly difficult, if not impossible, to fully access by our conventional means. The UAS allows for more thorough and contiguous treatments in these areas otherwise only achievable by helicopter. Operations conducted several trials and treatments in 2020 and 2021 and from all indications, the treatment UAS will become an increasingly valuable tool in the years ahead.

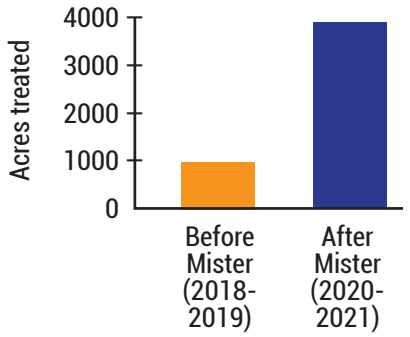


Figure 2. The A1 Mister led to a 4x increase in salt marsh acres treated.

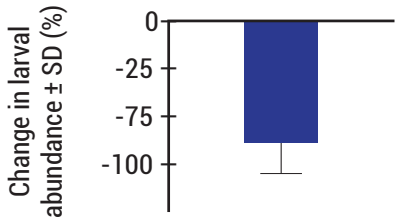


Figure 3. An 83 % reduction in salt marsh larva abundance was recorded in sites dipped pre- & post-treatment with the A1 Mister.

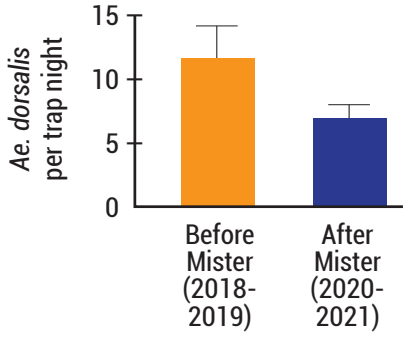


Figure 4. Reduced adult female salt marsh mosquito abundance was detected with CO2-baited EVS traps collecting half as many salt marsh mosquitoes after A1 Mister treatments.

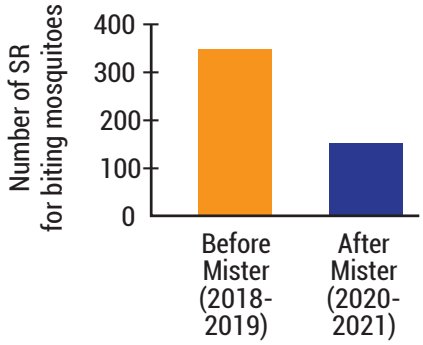


Figure 5. A 56% reduction in Service Requests for biting mosquitoes was achieved in areas near A1 Mister treatments.

PHYSICAL CONTROL

When ACMAD formed in 1930 and for many years thereafter, much of the work centered around physical modifications to control mosquito larvae, like adding circulation ditches in diked and tidal marshes. Physical control is still an important part of our IVM program to this day and will continue to be in the future. Nowadays, ditch work in marshes is more complicated and ACMAD must obtain several permits to maintain existing circulation ditches. This permit process requires the Regulatory and Public Affairs Director and operations to work with the U.S. Army Corps of Engineers, the San Francisco Bay Regional Water Quality Control Board, the U.S. Fish and Wildlife Service, and the San Francisco Bay Conservation and Development Commission. 2021 was the end of our current five-year permit and the renewal process is currently underway. When permits are in place, operations staff conduct ditch maintenance work solely with hand tools from September to January. The goal is to clear debris, silt, and vegetation from existing ditches to enhance water circulation and reduce areas conducive to mosquito reproduction. Though difficult, dirty, and labor-intensive, the work continues to have a positive impact on these areas in terms of reduced mosquito production. During the 2020 and 2021 ditching seasons, operations staff cleared close to 30,000 linear feet of ditches in several different marsh sites. Working closely together while still maintaining "social distance" made the work even more complicated.

Another physical control project began in 2021 involving flower vases in cemeteries because they are significant sources for mosquito reproduction. Several of our native species, including some with the potential to vector West Nile virus, utilize this habitat on a regular basis. In other counties, flower vases in cemeteries are also known habitat for invasive *Aedes* mosquitoes. Dumping, draining, or treating vases by hand is a very time-consuming task for operations in the best of times. Doing so in the much shorter reproduction window needed for invasive species is not sustainable. As a proactive measure and to further prepare for the arrival of these mosquitoes, operations staff began comprehensive research into state and national responses in locations that are currently dealing with invasive *Aedes* mosquitoes. Based on the findings, staff designed a pamphlet to illustrate some effective and viable options for cemeteries to undertake and a poster to educate the public on the importance and necessity of the program. ACMAD provided these educational tools to cemeteries countywide. As we work with our cemeteries to address the tens of thousands of vases throughout our county, we are asking that they too adapt, innovate, and pivot to aid our preparation for invasive mosquitoes and to protect the people of our county from mosquito-borne diseases.

SERVICE REQUESTS

As alluded to earlier, one of the services ACMAD provides is responding to calls from the public, typically on the next business day. Operations staff responded to 1,983 requests for service in 2020 and 2021 (**Figure 6**). These requests come in five main types: requests for mosquito fish, reports of a mosquito problem, reports of standing water, requests for insect identification, and reports of a dead bird. Fish requests usually amount to half of our total service requests. These fish offer great control of mosquito larvae in backyard ponds, livestock watering troughs, and unmaintained swimming pools. They are a form of biological control and fit well into our IVM program. However, they are non-native so ACMAD does not place them in natural sources. Reports of a mosquito problem, a distant second most common type of service request, can be time consuming and require a fair amount of detective work. With 22 native mosquito species, each with its own preferred habitat and widely variable flight range, any given area has

many potential mosquito reproduction sites. We ask for an insect sample to help determine the species and potential source. Occasionally, other "mosquito-like" non-biting insects are the reason for the call. The next most common service request is to report standing water. This is an alert from the public that they would like an area of standing water checked to ensure it is not a mosquito reproduction site. The final types of requests are for insect identifications and picking up dead birds. ACMAD provides insect identification services because many staff members have extensive education and training on insects and spiders. Dead birds are PCR tested by the ACMAD lab to look for West Nile virus infection. This is an important indicator of virus activity and allows for focused efforts in controlling potential vector mosquito species in specific regions of the county.

An additional program that ACMAD conducts to protect the public from mosquitoes and the threat of mosquito-borne disease is surveillance for unmaintained swimming pools. In just the last two years, the program identified 1,080 unmaintained swimming pools, which can be a significant source of mosquito reproduction. ACMAD identifies and responds to mosquito breeding sources from all corners of the county. **Figure 7** depicts the combined service requests and outreach for unmaintained swimming pools in 2020 and 2021 by city with relation to the population. These responses commonly involve a high level of public contact as staff often enters yards, properties, homes, and businesses. It is a fantastic opportunity to educate the public on mosquito prevention, habitat, and disease transmission. These one-on-one interactions have always been the most significant point of contact between the District and the public we serve. This dynamic became extraordinarily complex beginning in March of 2020 and continuing through 2021. However, ACMAD operations was determined to continue the level of service our public is accustomed to, including responding to requests for service in person, contingent on the caller's comfort level. We masked up, maintained distances, and sanitized but did not limit or shut down any of our operations.

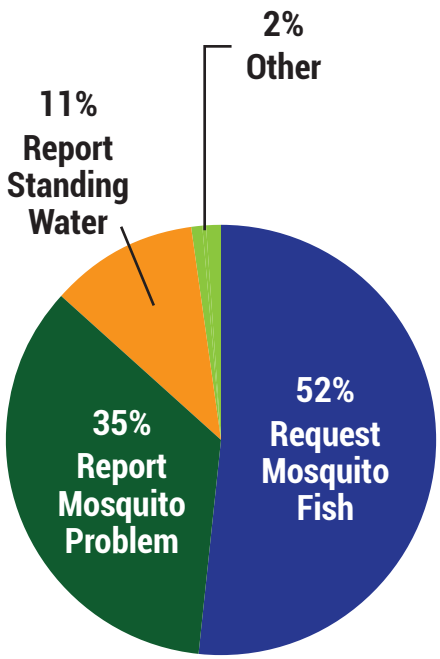


Figure 6. Distribution of service requests during 2020 and 2021. Other represents requests for insect identifications, reports of dead birds, and miscellaneous calls like requests for picking up mosquitofish from a pond that is being removed. Dead bird reports started counting as service requests in September of 2021, so the number is disproportionately low.

CONCLUSION

Operations at ACMAD has and will continue to focus on larval mosquito control, maintain a biorational dominant IVM program, investigate, test, and employ novel equipment and techniques, promote physical control, and respond to requests for service from the public. All while monitoring mosquito sources countywide, controlling native mosquito species, and preparing for the arrival of invasive mosquito species. Pandemic or not, we will continue to adapt, innovate, and pivot to meet whatever challenges we face to achieve our mission.

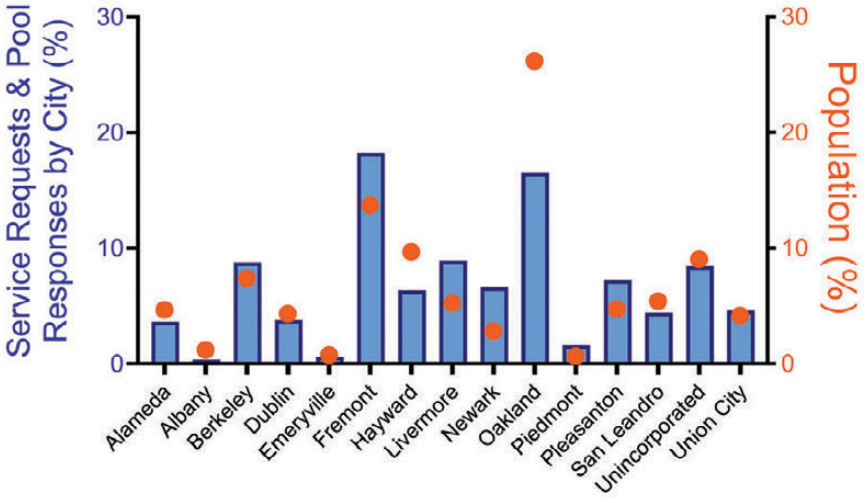


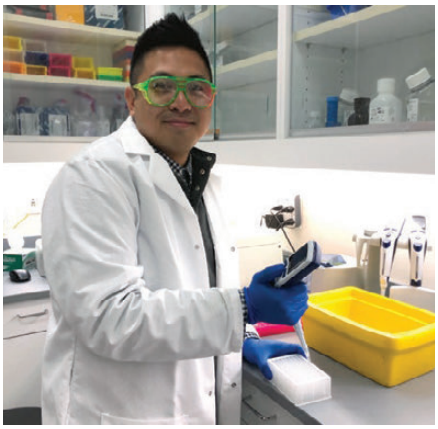
Figure 7. The percentage of ACMAD's direct service (service requests and unmaintained swimming pool outreach) to Alameda County residents in 2020 and 2021 by city relative to each city's population.

LABORATORY REPORT

OVERVIEW OF ACMAD LAB ACTIVITIES

The ACMAD lab focuses on providing and interpreting the data that enable District staff to make knowledge-based decisions that improve mosquito control in Alameda County and beyond. The principal responsibilities of the lab are to: (1) monitor the abundance of adult mosquitoes throughout the county, (2) test for the presence of arboviruses (arthropod-borne viruses) in mosquitoes that are trapped by District staff and dead birds reported by the public, (3) assess insecticides, application equipment and resistance in mosquitoes, (4) provide regulatory and administrative support to the District drone program, and (5) conduct applied and basic research that support mosquito control efforts and train the next generations of mosquito control workers.

Adult mosquito abundance and the presence of arboviruses in birds and mosquitoes was monitored throughout the entirety of Alameda County starting in 2020, the year that the annexation of Albany was formally completed. Several species of mosquito belonging to the *Culex* genus are native to Alameda County and can transmit arboviruses to people (West Nile virus (WNV) and Saint Louis Encephalitis virus (SLEV)). Another arbovirus, Western equine encephalitis virus (WEEV), is also transmitted by native mosquitoes but has not been detected in California for over a decade. The ACMAD lab uses reverse transcription quantitative PCR to test *Culex* species of mosquito that can transmit WNV, WEEV, or SLEV (e.g., *Culex pipiens*, *Culex tarsalis*, and *Culex erythrothorax*) for the presence of those viruses. Two sentinel chicken flocks are maintained in the county as an additional assessment of arbovirus risk. Dead birds that are reported by the public and collected by ACMAD staff are also tested for those arboviruses as their presence in birds indicate that infected mosquitoes may be nearby. *Aedes aegypti*, also known as the yellow fever mosquito, was detected in 2019 in San Joaquin County, which adjoins Alameda County to the east. This mosquito, along with several other species of so-called "invasive *Aedes* mosquitoes" can transmit dengue, chikungunya, Zika, and yellow fever viruses to people. Consequently, the lab expanded its mosquito monitoring programs for invasive *Aedes* to detect them before becoming widely established in the county.



Research during 2020 and 2021 included: (1) developing and evaluating 3D printed mosquito traps that are more cost-effective than commercially available alternatives, (2) utilizing aerial drones to assess water circulation channels in tidal salt marshes that limit mosquito reproduction, and (3) assessing the efficacy of our new mister equipment for applying larvicide and controlling mosquitoes in a salt marsh.

New Jersey Light Trap

MOSQUITO AND ENVIRONMENTAL ARBOVIRUS MONITORING PROGRAM

PROGRAM OVERVIEW

The lab uses a variety of traps to assess adult mosquito abundance, primarily so that operations can make informed decisions for when and where to apply insecticides. Abundance data is also used by ACMAD management to allocate resources and the state of California for developing mathematical models that aim to predict the risk of arbovirus statewide.

ASSESSING ADULT MOSQUITO ABUNDANCE

Mosquito Abundance Monitoring Using Encephalitis Virus Survey Traps

Of greatest public health concern are female mosquitoes that are seeking animals to bite as this is how arboviruses are transmitted to people. Thus, the primary adult mosquito monitoring approach used by the lab is to place encephalitis virus survey (EVS) traps that are baited with dry ice and a scent lure. Adult female mosquitoes are attracted to the CO_2 that emanates from the dry ice and the human odor mimics that are released from the scent lure. EVS traps are placed throughout the county in natural habitats where mosquitoes reproduce and urban areas where risk of arbovirus transmission to people is greatest. Seasonal difference in mosquito species composition and geographic distribution prompts us to place traps at different sites and intervals during the summer–fall (**Figure 8A**; N = 141 trap sites) and winter–spring seasons (**Figure 8B**; N = 79 EVS trap sites). The quantity, species, and location of adult mosquitoes that are collected in EVS traps are reported to ACMAD staff using MapVision, Power BI software, and printed tables, and to the California Department of Public Health via the VectorSurv website (https://gateway.vectorsurv.org/).

Our EVS trapping program was substantially improved in 2021 from an analysis of public services that we provide to county residents by a Master of Public Policy intern from UC Berkeley Goldman School of Public Policy. She found that people in low socioeconomic neighborhoods, newly immigrated communities, and those experiencing homelessness were underserved relative to other demographics. Her work pointed to several underserved communities where there was a dearth of mosquito monitoring. Consequently, we added 22 EVS trap sites to the summer–fall program for 2021, a 12% increase, to improve service to underserved communities (**Figure 8A**). We seek to continuously improve equity in our services to the public by routinely examining our efforts in underserved communities. To improve the safety and economy of the EVS-based trapping program, we retrofitted the standard D-size battery compartments

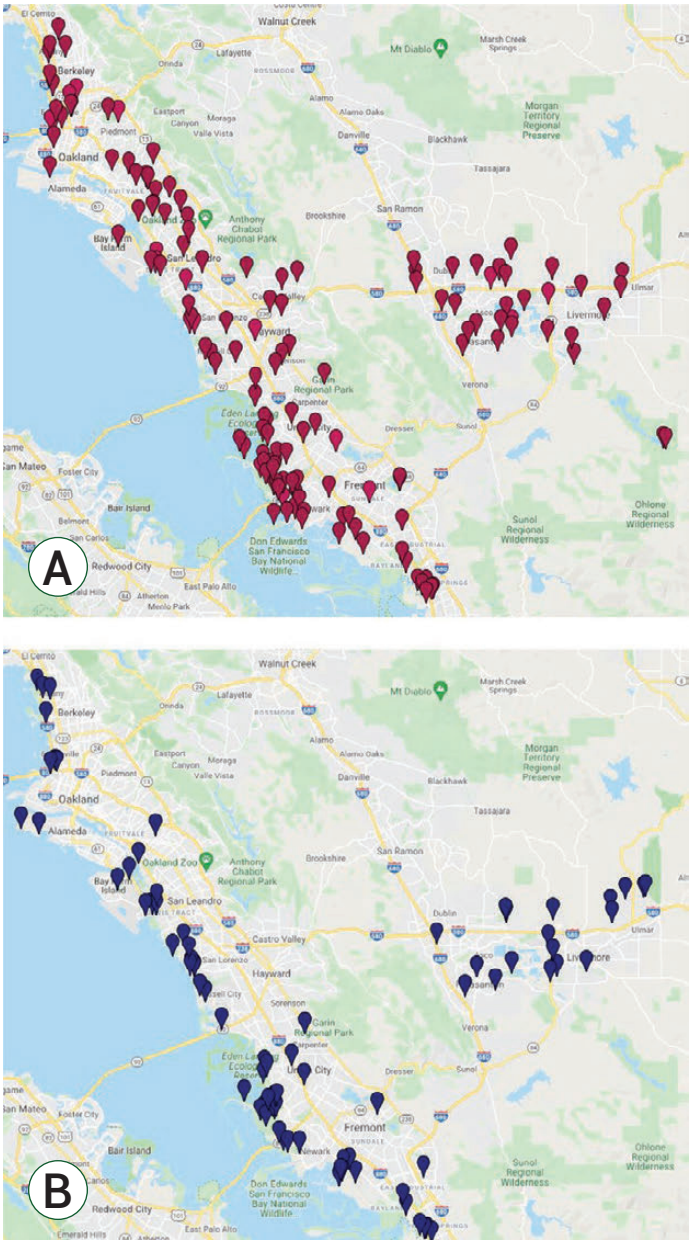


Figure 8. EVS trap sites during 2020–2021 for (A) summer–fall and (B) winter–spring.

(which were prone to sparking) to accept USB-rechargeable power banks.

Although the COVID pandemic constrained research collaborations and external training plans, adult mosquito monitoring efforts were not substantially impacted. The quantity of EVS traps placed during 2020 and 2021 were within or less than one standard deviation of the 7-year average (**Figure 9**). The lower number of traps placed during 2020 was due to uncertainties regarding health safety that came with that first year of the COVID pandemic and the decision to not hire seasonal staff support. Adapting lab workflow efficiencies to the new circumstances enabled us to increase our EVS trapping effort in 2021 by 52% over the 7-year average (**Figure 9**).

During 2020, EVS traps were placed from February through December, and for 2021, EVS traps were placed year-round (**Figure 10A**). EVS traps were placed at sites for one day to attract biting female mosquitoes. There were 12% more mosquitoes captured in each EVS trap during 2020 relative to 2021 (average = 26.1 and 23.2 mosquitoes per EVS trap for 2020 and 2021, respectively). However, because more traps were placed in 2021, nearly 2-fold more mosquitoes were trapped and identified to species compared to 2020 (50,822 vs 27,588 mosquitoes). Monthly trend lines of mosquitoes captured per EVS trap show that there were overall fewer mosquitoes for each month of 2021 relative to 2020, except for June (**Figure 10A**). During June 2021, the water level in the reservoir at Del Valle Regional Park (Livermore, CA) was raised to its highest since 2017 (704 feet), which allowed water to flood into vegetation. That combined with maximum daily temperatures above 90°F provided a habitat for rapid growth of *Aedes vexans*, a mosquito that bites voraciously during the daytime and crepuscular hours. Nearly 19,000 adult female *Ae. vexans* were caught in EVS traps during June 2021, making it the most abundant species collected in EVS traps that year (**Figure 10B**). Effective control efforts coupled with reductions in water elevation at the reservoir reduced *Ae. vexans* abundance to less than a total of 100 for the remainder of the year. We detected a few *Ae. vexans* in the city of Livermore that were aged and may have originated from Del Valle Regional Park. *Culex erythrothorax* was the most abundant species collected during 2020 and third-most abundant during 2021 (**Figure 10B**). Notably, it is difficult to collect larval *Cx. erythrothorax* in the field, so adult abundance it the best metric for assessing the impact of control efforts on this species.

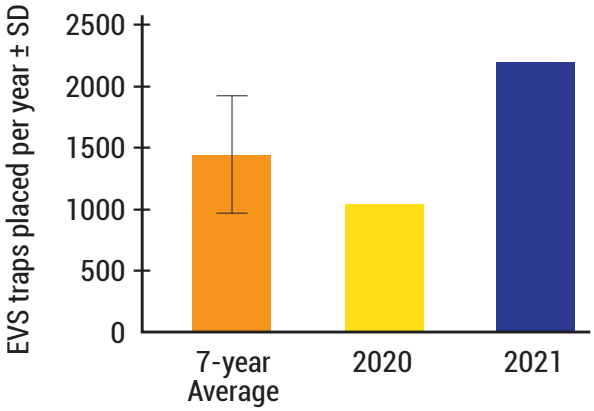


Figure 9. Number of EVS traps placed during 2020 and 2021 relative to the 7-year average of 2015–2021. The number of EVS traps placed were: 7-year average = 1434 ± 470; 2020 = 1057; 2021 = 2185.

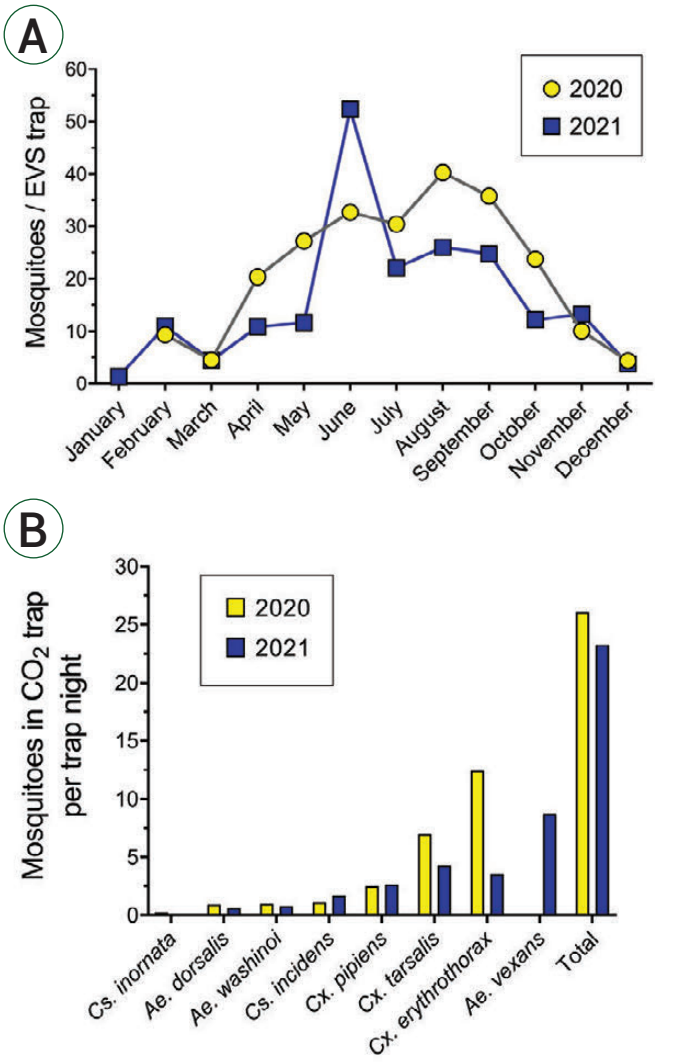


Figure 10. Summary of adult mosquito abundance for 2020 (yellow) and 2021 (dark blue) measured using EVS traps. (A) Number of adult mosquitoes collected each trap night by month. (B) Six most abundant species collected in EVS traps each year.

Mosquito Abundance Monitoring with Light Traps

Light Traps (LT) attract mosquitoes and other flying insects using a light that we set to turn on prior to sunset and off after sunrise. LT were developed in 1927 when only incandescent lights were available. Substantial heat is released from an incandescent lamp, which damages the insect specimens. We sought to determine if a LED light in the LT would be as effective for collecting mosquitoes while improving the quality of the specimens. Paired tests of LT fitted with incandescent or LED lights showed no significant difference in the quantity of male or female mosquitoes that were collected (**Figure 11**; unpaired t-tests, $P > 0.7329$). Consequently, we replaced the incandescent lights with LEDs in the LT. We had hoped that LT fitted with LED lights might reduce the quantity of non-mosquito insects that were collected in the trap, but no difference was observed (not shown). Because we aim for precision in our mosquito monitoring efforts, we began in 2020 to use EVS traps instead of LT at those monitoring sites and in 2021 had only three LT sites in Alameda County (there were 16 LT sites during 2019). Similar to the monthly trends of mosquito abundance seen with EVS traps (**Figure 12A**), fewer mosquitoes were captured in LT during 2021 relative to 2020 (**Figure 12B**; 168 and 1,934 mosquitoes, respectively). The most prevalent mosquito captured in LT during 2020 and 2021 was *Culiseta incidens* (**Figure 12B**), a species that is not known to transmit pathogens of relevance to public health.

SENTINEL CHICKEN PROGRAM

Sentinel chicken flocks are recommended by the California Department of Public Health (CDPH) for environmental arbovirus monitoring. We maintain two such flocks, one in Livermore and another in Newark. Every two weeks from May to early November we collect blood samples from each chicken and send them to CDPH where they get tested for the presence of antibodies that indicate arbovirus infection. None of the samples showed that any of the chickens had been infected with WNV, WEEV, or SLEV during 2020 or 2021.

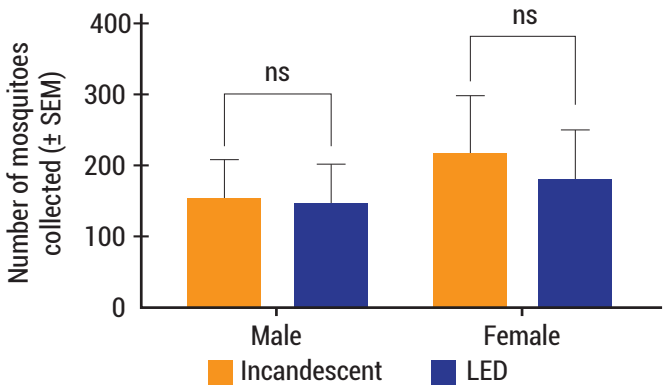


Figure 11. Number of female or male mosquitoes collected in LT fitted with incandescent or LED lights (ns indicates there was no significant difference between the two groups).

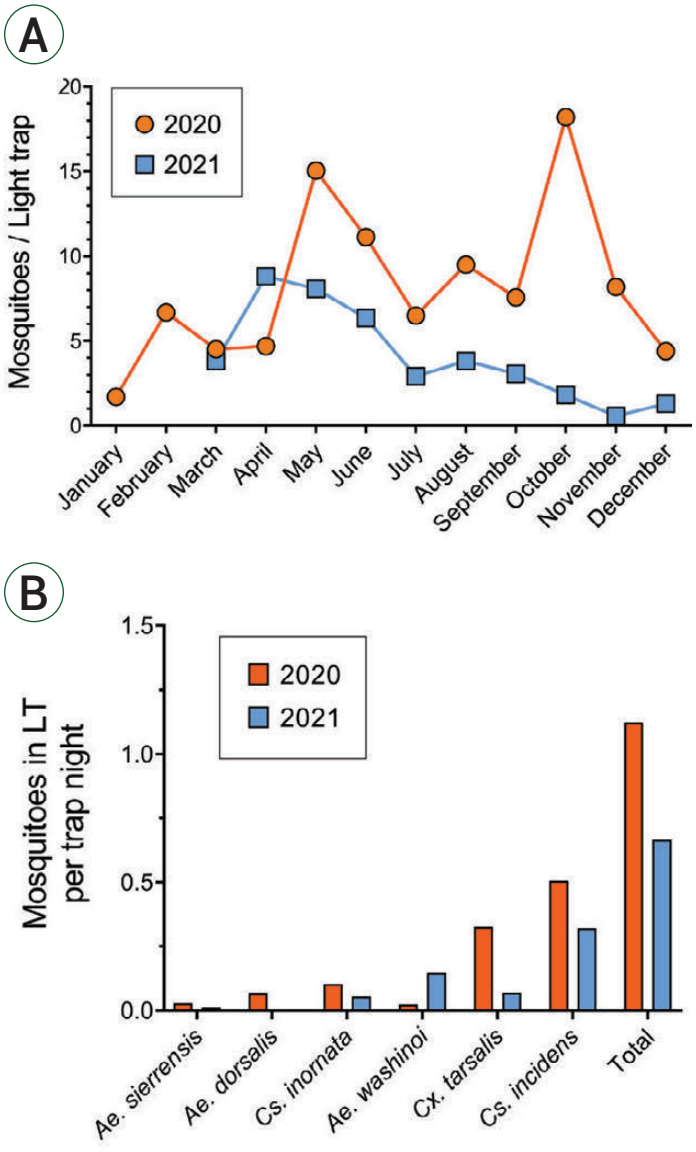


Figure 12. Summary of adult mosquito abundance for 2020 (orange) and 2021 (light blue) measured using EVS traps. (A) Number of adult mosquitoes collected each trap night by month. (B) Six most abundant species collected in LT each year.

FIRST ADULT *CULEX RESTUANS* DETECTION IN ALAMEDA COUNTY

Adult female *Culex restuans* were collected in an EVS trap from Pleasanton during September and August of 2021 (**Figure 13**). This is the first of this species recorded in our database, which begins in 2001. This species is often mistaken for *Cx. pipiens* due to similarities in size and color. Distinctive morphological characteristics include a very narrow band of pale scales that overlap the joints of the hind tarsi and a patch of pale scales under the proboscis. *Culex tarsalis* also have pale scales on the proboscis, but they form a complete ring and are brighter (closer to white). *Culex restuans* are typically rare and sporadically distributed from central California and south, occurring near foul or heavily organic water. Adult females are considered a vector of WNV and SLEV but are not thought to be vectors of high importance.

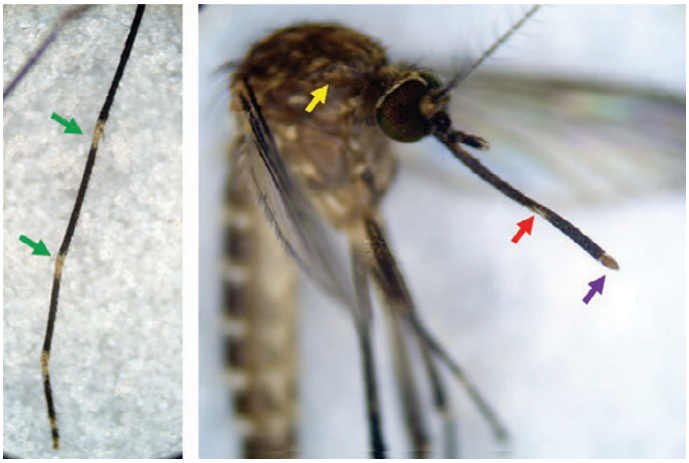


Figure 13. Adult female *Cx. restuans* collected from Pleasanton in an EVS trap. This is the first adult *Cx. restuans* that has been recorded for Alameda County since at least 2001. (Left) Hind tarsus with narrow bands of pale scales (green arrows). (Right) Proboscis without a median ring of bright pale scales, but the underside with a broad patch of dull pale scales (red arrow). Bright tip of proboscis (purple arrow). Scutum with mediolateral spots of pale scales (yellow arrow).

ARBOVIRUS PREVALENCE

Prior to the arrival of the COVID pandemic, we tested each of the mosquitoes that were collected in EVS traps that could transmit WNV, SLEV, and WEEV using reverse transcription quantitative PCR (e.g., *Cx. pipiens*, *Cx. tarsalis*, and *Cx. erythrothorax*). Supplies used to test mosquitoes for the presence of arboviruses are the same as what is used to test human specimens for COVID. The surge in COVID testing needs in the absence of adequate supply limited our capacity to test mosquito specimens for arboviruses. As a result, we tested when vector species abundance was greater than 6 mosquitoes per EVS trap during 2020 and 2021. In contrast to 2019, during which we did not detect arboviruses in birds or mosquitoes, during 2020 we found 7 birds positive for WNV (5 in Livermore and 1 each in Dublin and Oakland) and 2 positive birds in 2021 (Livermore and Pleasanton; **Figure 14**). Although the lab conducted enhanced adult mosquito surveillance in response to each WNV-positive dead bird and tested 17,824 mosquitoes during 2020 and 2021 as part of our regular monitoring programs, we did not detect WNV, SLEV, or WEEV in any mosquitoes during that period (**Figure 14**).

Alameda County Public Health Department routinely reports human cases of diseases that are transmitted by mosquitoes to ACMAD. A few human cases of dengue, chikungunya, and malaria were reported during 2020 and 2021. The Health Department notified us that each case had traveled internationally, so likely acquired the infection abroad. Our enhanced trapping efforts in response to the cases and historical mosquito abundance records did not find relevant vectors that could have acquired and then spread the pathogens to others in the county.

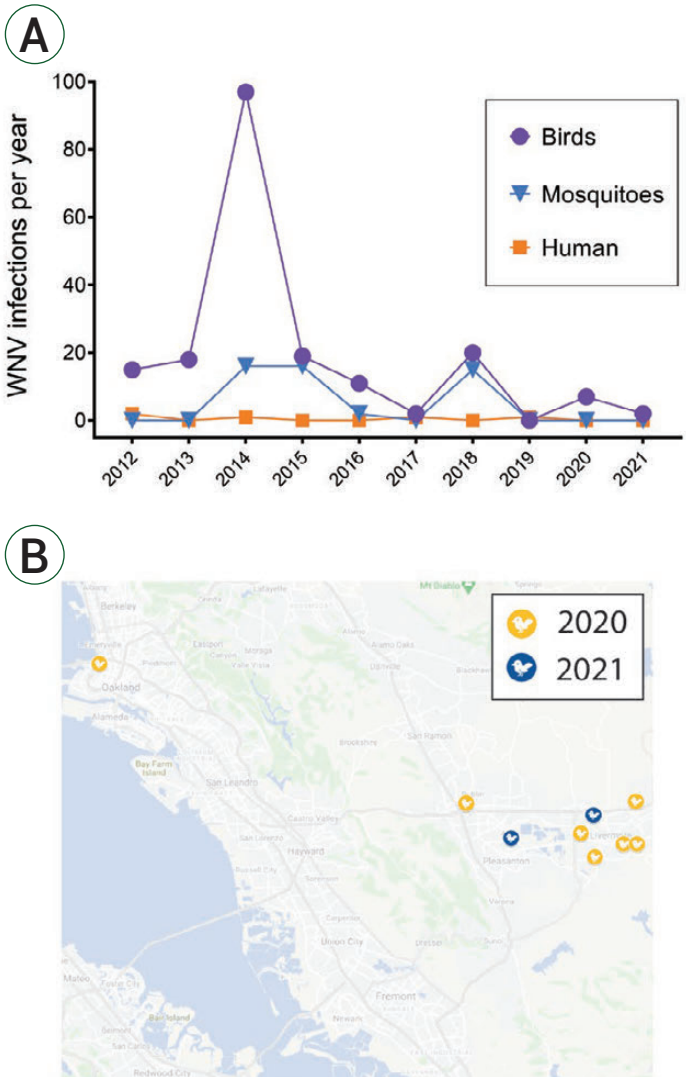


Figure 14. Arbovirus monitoring. (A) Number of birds, mosquitoes, or people infected with WNV in Alameda County from 2012–2021. (B) Geographic distribution of WNV in birds during 2020 and 2021. WNV was not detected in mosquitoes during 2020 or 2021.

INVASIVE *AEDES* MONITORING PROGRAM

While EVS and LT contents are inspected for the presence of invasive *Aedes* species (e.g., *Ae. aegypti*), we also have a network of oviposition traps (OT) in the county. These traps are designed to collect the eggs of *Aedes* mosquitoes, and if found, indicate that invasive *Aedes* may be near to the OT site. When eggs are collected, we test them using PCR and sequencing to determine if they were from invasive or native *Aedes* mosquitoes. During 2019, we had over 500 OT sites in the county. However, we found that quantity of OTs to be unmanageable in the absence of sufficient seasonal staff support, which was absent during 2020 due to the COVID pandemic. To reduce the quantity of OT, we assessed each trap site for overlap with others, habitat suitability for invasive *Aedes* mosquitoes, and excluded sites that routinely captured native *Aedes* mosquito eggs. That analysis allowed us to focus our OT efforts on approximately 200 sites in the county, none of which detected invasive *Aedes* mosquito eggs. Moreover, we did not detect invasive *Aedes* mosquitoes in any other trap type during 2020 or 2021.

APPLIED RESEARCH

3D PRINTED EVS TRAPS

The efficacy of the 3D printed EVS traps that were designed and printed at ACMAD (**Figure 15A**) was compared to a commercially available Heavy Duty EVS (HD EVS) Trap (BioQuip Products, Rancho Dominguez, CA USA). One of each trap type (baited with dry ice) was placed overnight within 5 meters of each other at various sites throughout Alameda County. The number and species of mosquitoes collected in each trap was subsequently determined using a dissection microscope. Although the 3D printed EVS trap typically caught slightly more mosquitoes in each paired trial, there was no significant difference in the number of mosquitoes captured in 3D printed or the HD EVS trap (**Figure 15B**; paired t-test, P = 0.8866; N = 26 paired comparisons). There was also no significant difference in the number of mosquito species collected in each type of trap for the paired trials (paired t-test, P = 0.1343). The results demonstrate that the 3D printed EVS trap is as effective as the more costly HD EVS trap that is commercially available. Consequently, the lab will have the opportunity to integrate the 3D printed EVS traps into routine surveillance efforts. Additionally, the Associate Vector Scientist in the lab delivered a continuing education presentation on 3D printing that was viewed by 100s of vector control technicians across the state and assisted several vector control districts with their 3D printing programs.

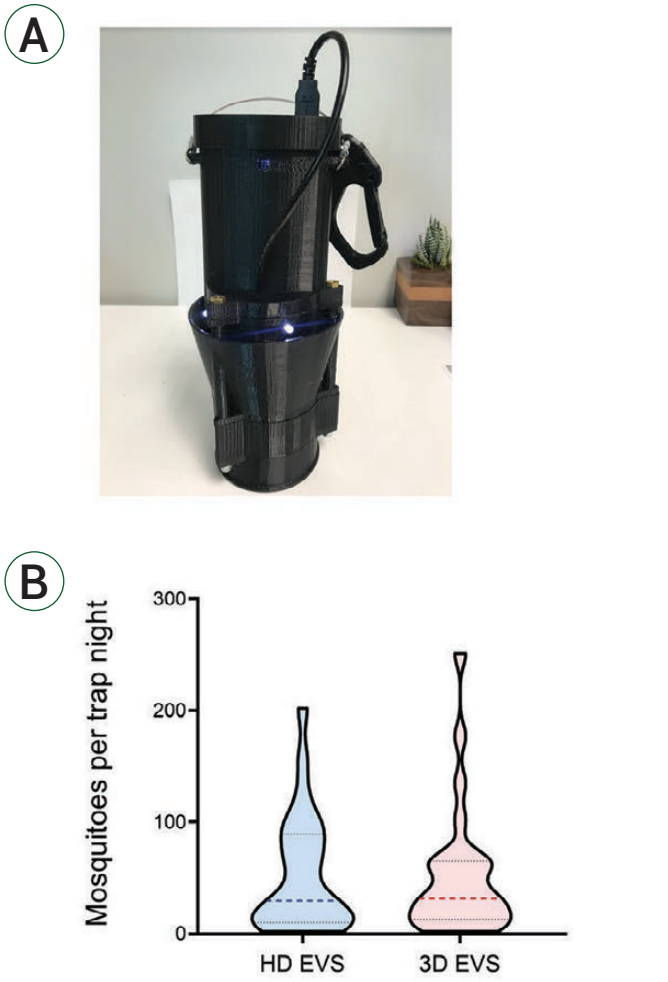


Figure 15. Mosquitoes captured in commercially available Heavy Duty EVS and 3D printed EVS trap designed by ACMAD. (A) 3D Printed EVS Trap, designed and printed by ACMAD lab staff. (B) Commercially available Heavy Duty EVS and 3D printed EVS traps were placed overnight within 5 meters of each other at various sites throughout Alameda County. The number and species of mosquitoes collected in each was determined. There was no significant difference in the number of mosquitoes captured by each trap type (paired t-test, P = 0.8866; N = 26 paired comparisons).

DRONES TO ASSESS WATER CIRCULATION DITCHES

Functional water circulation channels in tidal salt marshes are essential for limiting the reproduction of mosquitoes in that habitat, yet they often become filled with silt, thereby limiting their capacity for allowing water to ebb and flow in the marsh. It is crucial for ACMAD to easily locate poorly functioning water circulation channels so they can be repaired and to identify other areas where water could accumulate in the marsh to support mosquito growth. Measuring elevation differences in a salt marsh is one key way to assess both, and can be accomplished using aerial drones (i.e. unmanned aircraft systems (UAS)).

The ACMAD Mavic 2 Zoom drone was used to assess elevation changes in the ditch system at Patterson Hill Marsh (Union City, CA). The mission was flown during a period of low tide so that the lowest possible regions of the ditches were exposed. The drone was programmed for autonomous flights above the site where it captured imagery from perpendicular and oblique angles. Over 1,100 images were combined using DroneDeploy software to produce a single orthomosaic map (**Figure 16**). The resulting map was analyzed using DroneDeploy software to quantify differences in elevation. The most prominent ditches were apparent from Google Maps imagery (**Figure 16A**). However, the smaller overgrown ditches were better visualized using the drone imagery (**Figure 16B**, orange arrowheads). In the computed elevation map, low areas are shown as dark blue and the highest elevations in red (**Figure 16C**). Potholes that could accumulate water and support mosquito reproduction are obvious in the elevation map (**Figure 16C**, white arrowheads), but are not visible in the Google Maps image (**Figures 16A**). The ditches in the red box of **Figure 16C** show low areas that would not drain properly and are not obvious in the Google Maps image or the photographs captured by the drone (**Figures 16D**, **16E**), but can be easily seen as regions of dark blue in the elevation map (**Figure 16F**, pink arrowheads).

ACMAD can now utilize its aerial drones to produce orthomosaic elevation maps that show if water circulation channels are functioning properly. However, the drone that was utilized has limited flight capabilities and is not practical for large-scale wetlands imaging projects, such as those being constructed along the San Francisco Bay using the Measure AA parcel tax. A drone such as the ACMAD DJI 210 RTK fitted with a high-resolution camera would be better suited as it could image from the higher altitudes. To accomplish that goal, ACMAD acquired a DJI Zenmuse X5S camera with a 15mm DJI lens an additional 45mm Olympus lens that was fitted to the ACMAD DJI 210 RTK drone. Images captured using the 15mm lens at 75, 100,

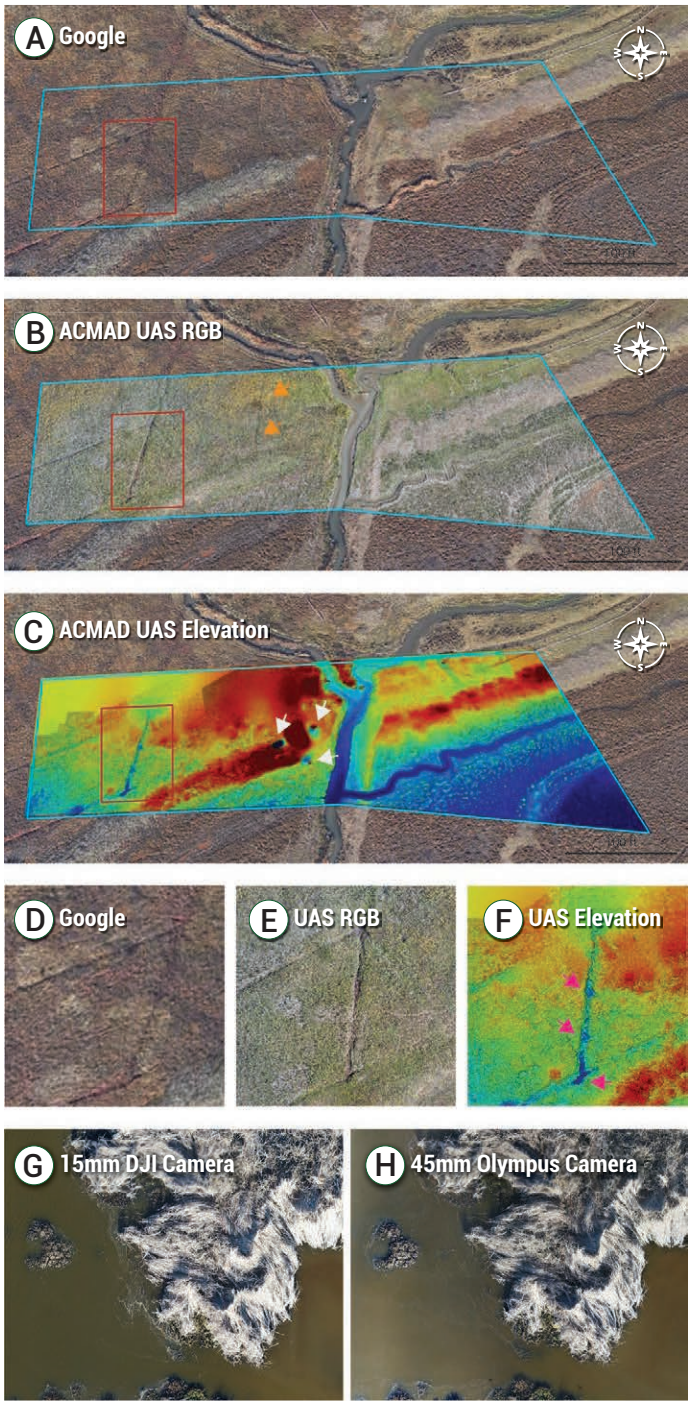


Figure 16. Orthomosaic mapping drones. (A–F) The ACMAD Mavic 2 Zoom drone was piloted autonomously above Patterson Hill Marsh in the area shown in the blue polygon to collect imagery that was orthogonal and perpendicular to the drone. (A) Google Map image of the site that was assessed with the drone. (B) Orthomosaic image captured using the drone shows much higher resolution relative to the Google Maps image (orange arrowheads show a ditch that is not obvious in the Google Map image). (C) Computed orthomosaic elevation map captured using the drone shows areas with low elevation in dark blue and high elevation in red. White arrowheads denote potholes that could support mosquito breeding and are not apparent in 16A or 16B. (D) Google Maps image, (E) orthomosaic drone image, and (F) computed orthomosaic elevation image of the area shown in the red box of Figure 16C (pink arrowheads show low elevation areas that may not drain properly). (G–H) Wetlands imaged using ACMAD 210 RTK drone with X5S camera. (G) Image using 15 mm DJI Camera and (H) 45 mm Olympus Camera.

120 and 150 feet above the surface did not differ substantially in their resolution (not shown). Tests of the 15 mm and 45 mm cameras at 150 feet above the marsh surface showed the 45 mm camera produced higher resolution images (**Figures 16G**, **16E**). As U.S. Fish and Wildlife Service currently requires a minimum flight elevation of 150 feet above the surface, ACMAD can now comply with that limit to image marsh landscapes on the properties they manage.

DROPLET ANALYSIS OF A LARVICIDE MISTER

Turbine mist sprayers such as the A1 Super Duty Mister (hereafter, A1 Mister) that was acquired by ACMAD are being rapidly utilized nationwide to apply larvicide for controlling peridomestic *Ae. aegypti*. Because the A1 Mister can loft large quantities of larvicide over relatively long distances, we examined its efficacy in a tidal salt marsh for controlling *Aedes dorsalis*. Liquid Vectobac 12AS larvicide mixed with a red dye (FD&C Red #40) was applied at 1 pint/acre by the A1 Mister with the output nozzle directed 5–15 degrees below horizontal at a ground speed of 15 mph from a levee that was elevated 3–6 feet above the tidal marsh (**Figure 17A**). The A1 Mister wind that propels the larvicide mist was 98.3 mph at the mister output atomizer (not shown). Cards that change color when exposed to liquid or that showed the red-dyed droplets were placed perpendicular to the path of the A1 Mister to capture the larvicide mist, imaged using a DSLR camera fitted with a macro lens, and the droplets analyzed using ImageJ software (**Figure 17B**). The mist traveled up to 60 meters from the A1 Mister but did not extend substantially beyond 30 meters (**Figure 17C**; 1 meter is approximately 1 yard). Droplet density was highest 7 meters from the A1 Mister with a higher density observed using the water sensitive cards relative to those that captured the red dye droplets (27.9 and 16.0 droplets/cm2, respectively; **Figure 17C**). Average droplet diameter measurements were highest on the red dye cards at 15 meters from the mister (123.8 microns (µm)), and at 30 meters for the water sensitive cards (118.1 µm; **Figure 17D**). The higher droplet diameter on the red dye cards may have resulted from the red-dyed Vectobac 12AS becoming flattened when the cards were collected. Many vector control labs report mean droplet diameter as mean droplet volume (DV 0.5). However, it may be of greater value to report the distribution of droplet diameters using a violin plot (**Figure 17E**). The application rate of the Vectobac 12AS was calculated using the formula of a sphere (volume = (4/3) * (radius)3 * π) and was optimal at 7–15 meters from the A1 Mister (1.1 ± 0.4 pints/acre; **Figure 17F**). Turbine misters such as the A1 offer an attractive alternative to hand treatments in tidal marshes.

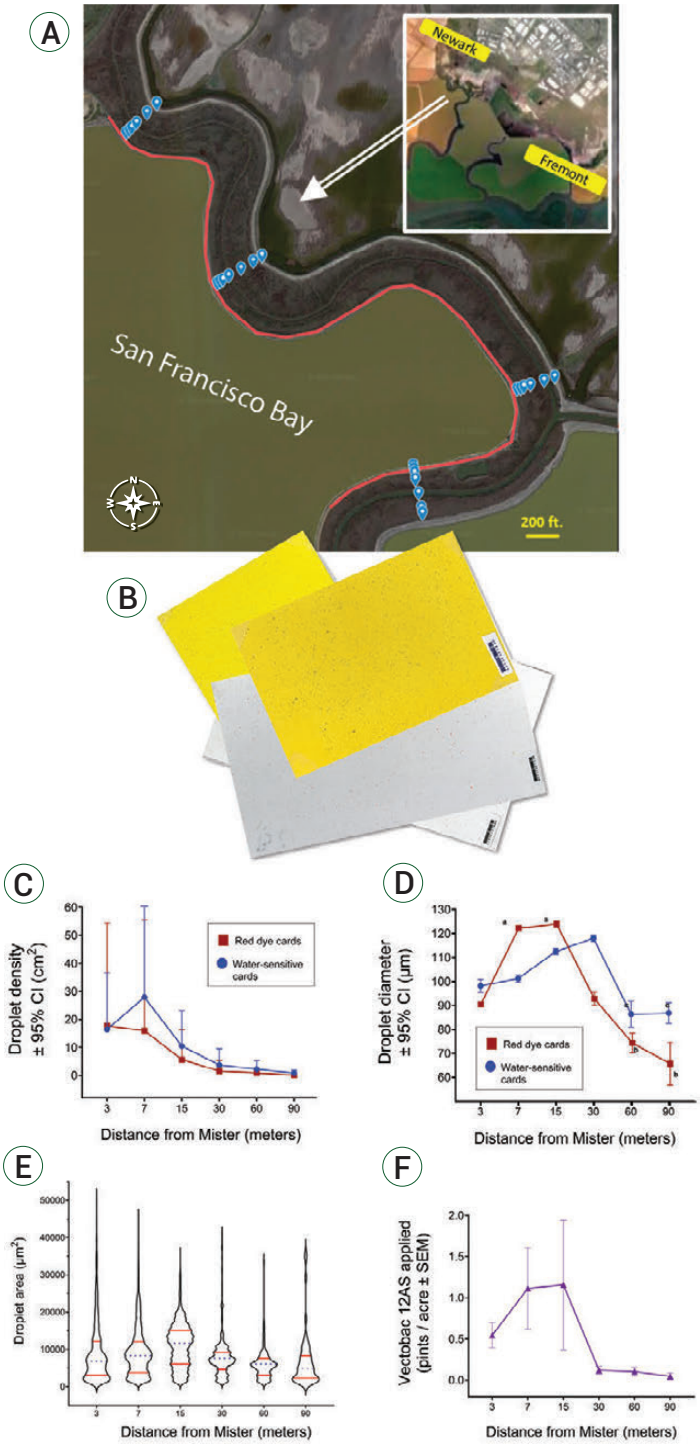


Figure 17. Droplet analysis of A1 Super Duty Mister trial in a tidal salt marsh that abuts San Francisco Bay. (A) Vectobac 12AS mixed with red dye (FD&C Red #40) was applied at 1 pint/acre (the label rate). Red line indicates the driving path of the A1 Mister truck and blue pins show location of droplet assessment cards that were placed at 3, 7, 15, 30, 60, and 90 meters perpendicular to the path of the A1 Mister. Surface wind speed was 10.7 mph to the northwest (toward the upper right corner of Figure 17A). The map insert shows the location of the treatment site in relation to the cities of Newark and Fremont. (B) Yellow water sensitive assessment cards that turn blue when the contact water and assessment cards which show the red dye that was mixed with the Vectobac 12AS larvicide. Droplet density (C) and diameter (D) on the water sensitive and red dye cards at multiple distances from the A1 Mister. (E) Violin plot showing the distribution of droplet areas on the water sensitive cards. (F) Vectobac 12AS application rate as measured using the water sensitive cards.

PUBLIC OUTREACH

Public education and outreach efforts aid the District's Integrated Vector Management program by encouraging the reduction and prevention of mosquito habitats on private and public property. The District had many plans for 2020 including an open house to celebrate our 90th year anniversary, greater public events presence, and a new classroom-based education program for 3rd graders. Unfortunately, COVID-19 disrupted all these plans.

When the governor issued a Shelter-in-Place order, schools began the complicated process of shifting entirely to remote learning, cities canceled public events, and no one was sure how long Alameda County would suffer the acute effects of the pandemic. Unfortunately, much of 2020 and 2021 was spent between surges and plateaus of cases. Nonetheless, the District hired its first Public Outreach Coordinator in July 2020, enhanced social media presence, attended virtual events, and planned for a post COVID world.

EVENTS

Typically the District participates in large events, such as Día de los Muertos, Newark Days, and the Solano Stroll to name a few. In 2020, all events were canceled, and in 2021 most events did not occur or purposefully limited the number of vendors. Completed events included a mosquito education presentation to 4-H of Bayside (10-16 year-old students), virtual Día de los Muertos (2020), virtual Newark Days (2020), Downtown Hayward Street Party (2021), and a San Leandro Creek clean-up (2021).

SOCIAL MEDIA

FACEBOOK AND TWITTER

Both social media giants receive the same messages and memes resulting in a similar number of posts (**Figures 18**, **19**). However, Twitter has a far larger audience (**Figure 19**), owing to the larger numbers of "entomology Twitter" followers and ease of sharing. The District has had an even number of shares and likes over the years.

NEXTDOOR

This outlet allows the District to distribute messages to the entire county, or key neighborhoods (**Figure 20**). This tool is especially helpful when certain neighborhoods are experiencing mosquitoes. We do not have access to communications that happen among neighbors so it is important that residents reach out to us directly if they would like us to respond. Nextdoor will continue to be an invaluable tool, especially in case of an invasive *Aedes* threat.

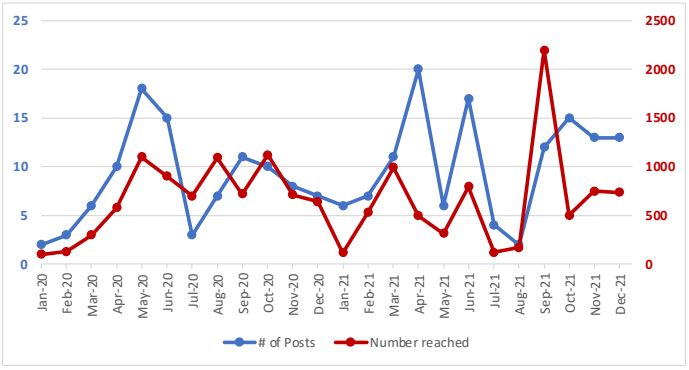


Figure 18. ACMAD Facebook account activity.

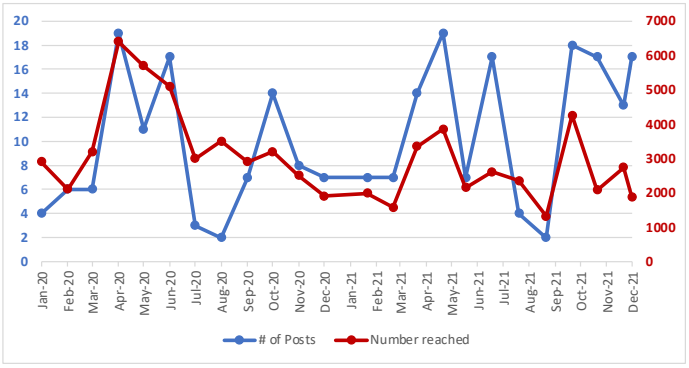


Figure 19. ACMAD Twitter account activity.

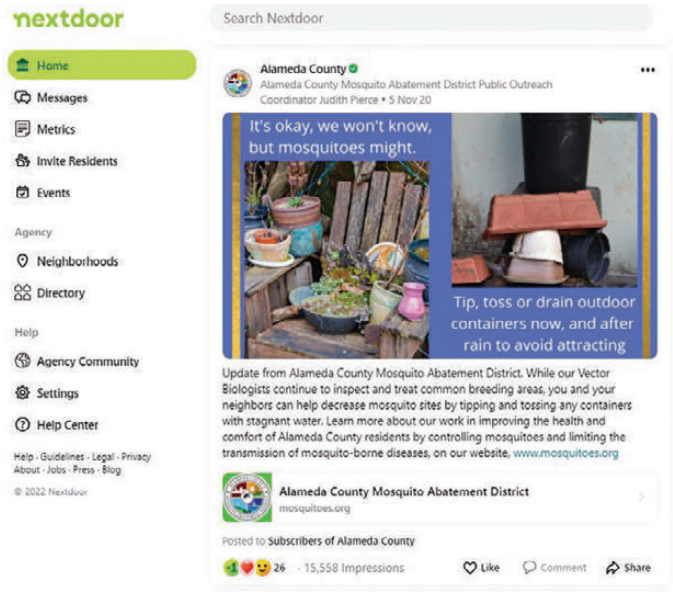


Figure 20. A sample post from the ACMAD Nextdoor account.

PRESS

WEST NILE VIRUS

The District detected West Nile virus in birds but not mosquitoes in 2020 and 2021. The first indication of West Nile virus in Alameda County triggers the District to send a press release to major news outlets in the area, including print and television media. In 2021 three different newspapers printed articles about the West Nile virus positive birds.

STERILE INSECT TECHNIQUE

In November 2021, the Berkeley City Council considered sending a letter to government officials opposing the release of genetically modified mosquitoes in California. As the local experts on mosquito control in the county, the District used the opportunity to educate the council and the public on current sterile insect techniques. Our Berkeley trustee, the Laboratory Director, and the Public Outreach Coordinator all spoke at the Berkeley City Council meeting (**Figure 21**). After an hour-long discussion, the city council voted against sending the letter. Berkeleyside.org featured a story about the meeting and there were a few comments on the website along with comments on the District's social media pages.

Figure 21. A screenshot from the Berkeley City Council meeting where the ACMAD Board President (2021), Robert Beatty PhD, and ACMAD staff, Eric Haas-Stapleton PhD, and Judith Pierce Davison MPH, presented.

PUBLIC ENGAGEMENT

INVASIVE *AEDES* TRAINING AND HELP

As a part of the District's emergency response coordination, the Public Outreach Coordinator worked with the Mechanical Specialist to organize a meeting and initial training with the heads of local Community Emergency Response Team (CERT) groups (**Figure 22**). The training yielded many questions along with verbal confirmations from CERT leaders that volunteers would be prepared to mobilize if ACMAD needs help for an invasive *Aedes aegpyti* response. Following the initial training, the Public Outreach Coordinator sent additional training materials to selected cities at their request.

Figure 22. An example of the training CERT Coordinators received.

HOMEOWNER ASSOCIATIONS IN SOUTH COUNTY

After a fly-off of adult mosquitoes in 2020 yielded many complaints from the same neighborhood, the Public Outreach Coordinator worked to gain contact information for 12 homeowner association (HOA) managers along the marsh. The goal of this effort was for the HOA managers to consolidate mosquito concerns rather than every member of a community calling and overloading our service request system. HOA's are also a useful way to disseminate information quickly among a community.

LOCAL GOVERNMENT

After a number of city governments sent residents to other organizations for mosquito control concerns, ACMAD launched an email and presentation campaign to inform cities of our services. The Public Outreach Coordinator reached out to multiple offices within every city's public works and code enforcement departments with an introduction email and option to present at future department meetings. Cities were grateful to learn about the resources we offer and the District plans to send out periodic reminders about our services.

In November of 2021 the District was invited to host Assemblymember Bill Quirk as he presented a check to CalSurv, the California statewide vector surveillance website (**Figure 23**). The presentation included a demonstration of the CalSurv website by our Laboratory Director and a tour of the District facility. Assemblymember Quirk sponsored bill AB 320 which codified CalSurv in state statute in 2019 and was instrumental in getting CalSurv into the state budget.

Figure 23. The CalSurv check presentation by Assemblymember Bill Quirk.

EDUCATION

Since winter of 2020, the Public Outreach Coordinator compiled lesson plans from multiple mosquito control districts, including Marin-Sonoma, Lee County in Florida, and Greater Los Angeles. These plans were then adapted specifically for Alameda County. Unfortunately, most Alameda County students were not back in class full time during the spring semester of 2021 and the fall 2021 school year remained complicated given new COVID-19 protocols. The Public Outreach Coordinator is working to roll out initial testing of the District-created curriculum (**Figure 24**) to gain insight into which lessons can work, and how to improve or modify them for teachers. The official rollout to all schools is planned for the fall of 2022.

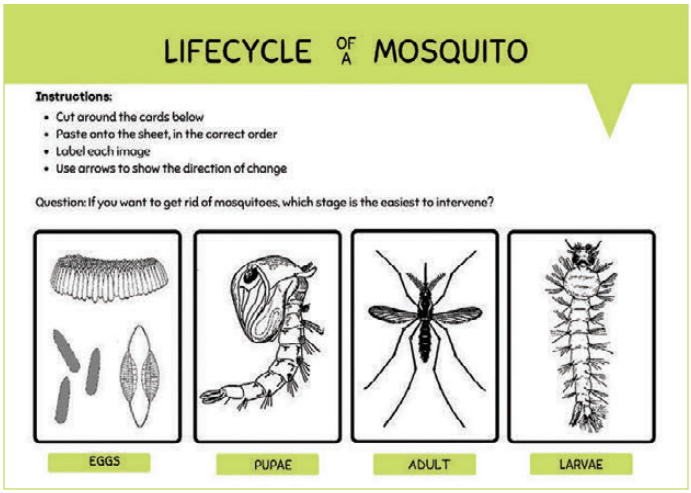


Figure 24. A sample of the school program worksheets.

INFORMATION TECHNOLOGY UPDATE

Over the last two years, ACMAD had to quickly shift to operating in a decentralized environment by adopting remote work technologies. While this was not something new to the District, it had only been done previously for short periods of time. With the extended need for remote work to comply with public health orders, each department evaluated its readiness to work remotely without compromising cybersecurity.

A REMOTE WORKFORCE

To produce a mobile and remote workforce, each facet of our District business model was migrated to the cloud (e.g., computing, communication, access functions). Our cloud-based telephone system allowed office staff to route calls to a home office or cellular phone. District staff already periodically used virtual meetings, but we needed to scale up the technology for holding meetings from any location. Teleconferencing was deployed to give staff, management, and the Board of Trustees the ability to attend meetings and communicate from the field or their home office. Our geospatial database enabled operations and lab staff to work remotely in the field using tablets that were connected by cellular technology. Operations staff returned to the District office only when they needed to replenish supplies. All data entry was performed in the field.

District documents were converted to digital files in Office 365 and SharePoint, a cloud-based file repository. Employees now had access to District documents from any computer or tablet from any location that had cellular data. Remote timekeeping was mandatory. OnePoint, our HR solution, allowed employees to clock in and out, along with all other HR functions, using their cell phones or tablets remotely. ACMAD participation in committees and meeting of the Municipal Information Systems Association of California helped the District stay updated on potential security threats.

ARCHIVING RECORDS

The digital transformation at ACMAD continued with the archiving of all historical media to the cloud. Earlier work resulted in the digitizing of every board packet dating back to 1930 and moving all working documents to SharePoint, however, we knew it was only a matter of time before all archival data would need to be clouded for safety and security. Over the last two years, efforts focused on archiving and restoring photos, videotapes, wire recordings, and movie reels to prevent further degradation. The District office housed media dating back to the early 1900s. Old movie reels had short videos like Disney's "The Winged Scourge" and educational public service features that were shown in silent movie houses around Alameda County. Using today's technology, we were able to restore 16 mm and 35 mm film from as far back as the 1930s and videotape interviews from the 1970s through the 2000s into Ultra High Definition 4K video. All old plate photography and slides have also been persevered and converted into high-resolution digital files. ACMAD used these mediums to document the history of the District's dedication to serving the citizens of Alameda County.

By peeking into history through photos and films and listening to wire recordings of District founders William Herms and Harold Grey, we learn that ACMAD has always changed with the times by using the best that technology has to offer. The District has a steadfast history of education and documentation through the technology of the time. In continuance of that tradition, the upgrade of our media library to cloud-based storage was the next logical step to preserve these records for future generations.

FACILITY AND EQUIPMENT

COMPLETION OF REMODEL

The District completed the interior remodel (**Figure 25**) in the first few months of 2020 before COVID restrictions limited outsourced projects. Final touches to the project included standing desks with appropriate computer and monitor mounting. A slight change in the office floorplan required new evacuation maps and room signage for safety and aesthetics. The District also included some privacy features to accommodate the needs of some new members of the ACMAD family...congratulations to Ben, Judith, Jeremy, and Sarah.

Figure 25. Remodel project completion.

SAFETY

In 2020, as COVID played a heavier hand in our daily lives, requirements and restrictions regarding safety were constantly changing. Routine safety equipment such as masks and gloves became increasingly difficult to source. In addition to COVID, 2020 was the worst fire season in California history, producing poor air quality. With a little strategic planning and cooperation with the Alameda County Emergency Managers Association, the District was never without proper personal protective equipment (**Figure 26**). ACMAD established and followed safety plans and protocols accordingly.

EXTERIOR PAINT

As COVID surges came and went, the District managed to squeeze in an exterior paint project (**Figure 27**). Everything but the main office/lab stucco building was due for a wash and a fresh coat of paint, so the bids went out and paint began in April of 2021. Prior to painting the buildings, some additional parking lines were added throughout the facility to provide extra identified parking spaces.

NURSE TANK & TRAILER MODIFICATIONS

Some areas within Alameda County do not have a convenient water source for operations staff to refill the treatment tanks on the Argos. Hauling a separate trailer with a nurse tank is just as inconvenient. As a solution, low-profile aluminum tanks were constructed to fit between the tracks of the Argo (**Figure 28**). By utilizing the unused space on the trailer under the Argo, an additional 100 gallons of water can now be

Figure 26. COVID protocols in place at the District.

Figure 27. Before, after, and during the exterior paint project.

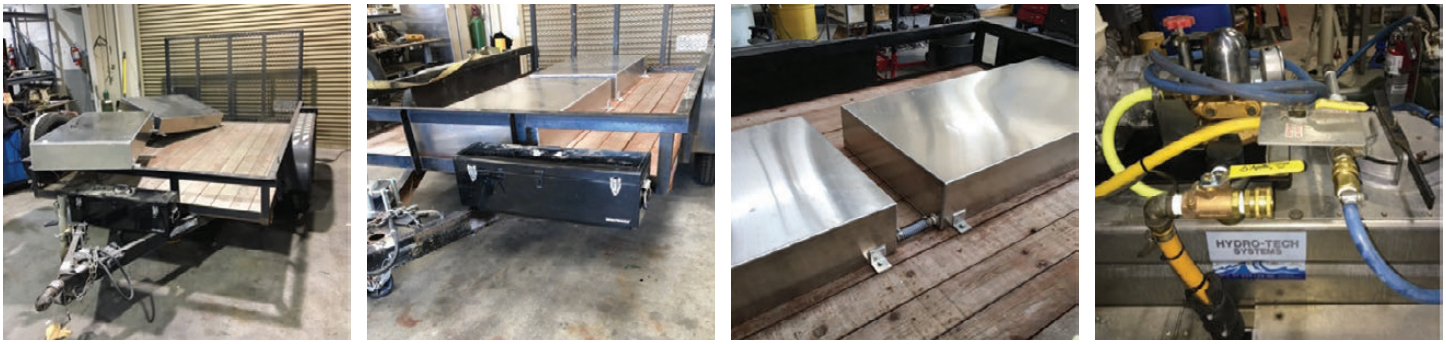


Figure 28. Nurse tank and utility box additions to the Argo trailers.

carried. This gives operations staff enough water for two more treatment loads. Modifications to the suction and discharge of the sprayer make for an easy transfer of water. Additional modifications included a utility box mounted to the front of the trailer.

EV STATIONS

February of 2020 marked the completion of the final steps of the 2019 Solar Project. Two dual plug EV towers were installed near the front of the District parking lot, allowing charging for four electric vehicles (**Figure 29**). Parking safety features were also added for additional protection.

Figure 29. EV station intallations.

GENERAL FUND STATEMENT

FOR FISCAL YEARS ENDING JUNE 30, 2020 AND JUNE 30, 2021

	2020	2021
REVENUES :		
Property taxes	$ 2,502,132	$ 2,624,188
Redevelopment distribution	$ 297,598	$ 364,485
Special Assessments	$ 1,951,959	$ 1,962,192
Homeowners Property Tax Relief, State Subvention	$ 16,055	$ 15,854
Interest	$ 176,499	$ 236,567
Other Revenue	$ 202,459	$ 203,268
TOTAL REVENUES	**$ 5,146,702**	**$ 5,406,554**
EXPENDITURES :		
Salaries and fringe benefits	$ 2,854,468	$ 2,990,918
Materials, supplies, and services	$ 867,982	$ 817,384
Capital outlay	$ 464,392	$ 36,964
TOTAL EXPENDITURES	**$ 4,186,842**	**$ 3,845,266**
NET CHANGE IN FUND BALANCES	$ 959,860	$ 1,561,288
FUND BALANCES, BEGINNING OF PERIOD	$ 7,991,796	$ 8,951,656
FUND BALANCES, END OF PERIOD	**$ 8,951,656**	**$ 10,512,944**

COMBINED BALANCE SHEET

FOR FISCAL YEARS ENDING JUNE 30, 2020 AND JUNE 30, 2021

	JUNE 30, 2020	JUNE 30, 2021
ASSETS		
Current and Investments	$ 9,107,233	$ 10,699,709
Capital Assets (Net)		
Non-depreciable assets	$ 61,406	$ 61,406
Depreciable assets, net	$ 2,548,142	$ 2,331,620
Net OPEB asset	$ 1,823,556	$ 2,522,763
TOTAL ASSETS	**$ 13,540,337**	**$ 15,615,498**
Deferred Outflow	$ 1,056,534	$ 936,411
LIABILITIES		
Account Payable	$ 155,577	$ 186,765
Compensated Absences	$ 200,290	$ 208,229
Net Pension Liability	$ 3,277,554	$ 3,603,091
TOTAL LIABILITIES	**$ 3,633,421**	**$ 3,998,085**
NET ASSETS		
Invested in Capital Assets	$ 2,609,548	$ 2,393,026
Unrestricted	$ 7,132,452	$ 8,697,501
TOTAL NET ASSETS	**$ 9,742,000**	**$ 11,090,527**

ALAMEDA COUNTY
MOSQUITO ABATEMENT DISTRICT

Our Mission

Alameda County Mosquito Abatement District is committed to improving the health and comfort of Alameda County residents by controlling mosquitoes and limiting the transmission of mosquito-borne diseases.

Our Vision

To serve all residents of Alameda County in a transparent and equitable manner by providing knowledge-driven and environmentally-conscious mosquito control. We strive to provide an exemplary model of good government through fiscal transparency and accountability.

510-783-7744

www.mosquitoes.org

Alameda County Mosquito Abatement District

@AlamedaMosquito

www.mosquitoes.org