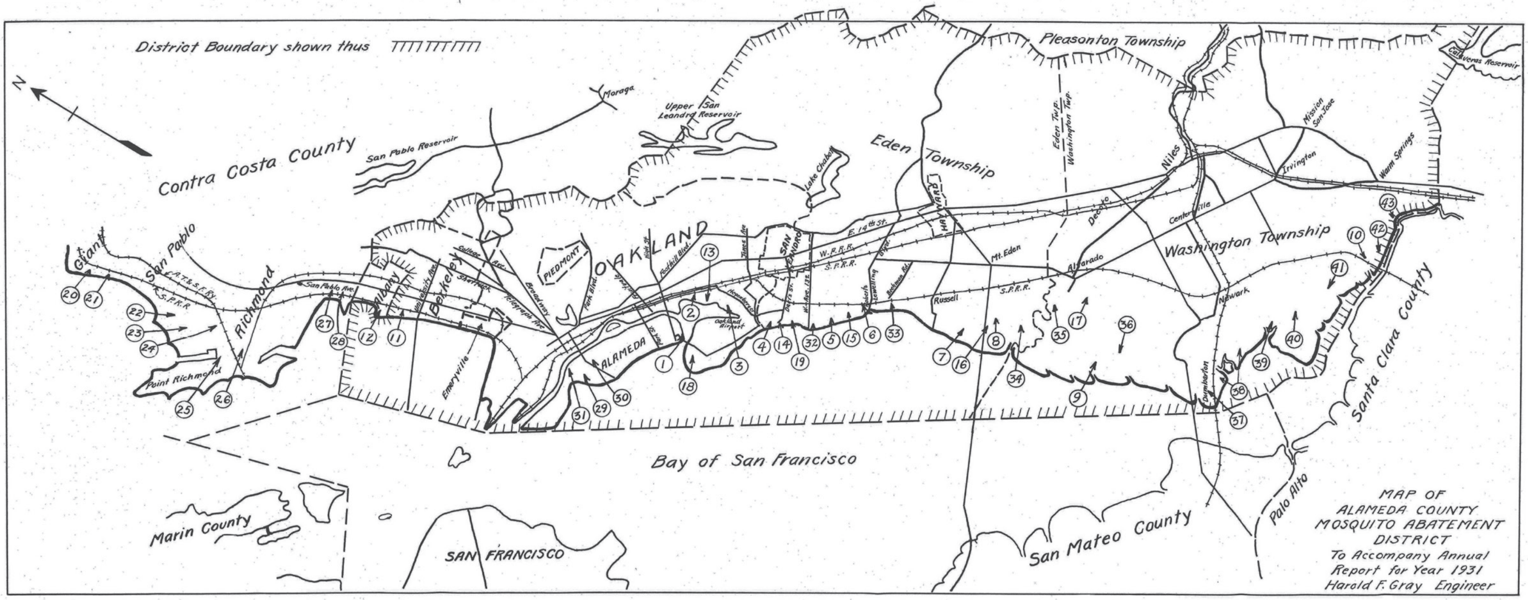
ALAMEDA COUNTY
MOSQUITO ABATEMENT DISTRICT



87th and 88th Annual Report
2018 – 2019

Dedicated to the Memory of

Denny McLeod

City of Piedmont Board Member
1997-2014

Died January 14, 2019

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THE NEXT 90 YEARS

On May 28th, 1930, the Alameda County Mosquito Abatement District (ACMAD) held its first meeting in the office of the Oakland Chamber of Commerce at 14th & Franklin Streets. The founding Trustees represented the seven cities within the District and a county-at-large member:

C.G. Hyde, At-Large, County of Alameda

C.E. Hickok, Alameda

W.B. Herms, Berkeley

W.H Christie, Emeryville

M.J. Madison, Hayward

M.L. Emerson, Oakland

L.G. Wolfe, Piedmont

L.F. Sterner, San Leandro

The group elected L.F. Sterner as its President and C.E. Hickok as Secretary. This was not the first attempt at a meeting though. An earlier attempt was on April 14th, 1930, but unfortunately a quorum was not present. It is amusing that Mr. Hickok was elected Secretary while absent—apparently it has always been difficult to find someone to take the meeting minutes. It is comforting, and useful, to reflect on how we began and where we have come since.

One of my favorite editorials from that era comes from a publication located in Hayward:

> **In spite of the fact that it does cost real money to rid a community of these pests, and particularly a community fringed about with as many breeding places as are to be found in this section, we would recommend that other counties which have no such work under way could well afford to undertake the project. The work here stands out as an example of what can be done under capable management.**
>
> — September 1st, 1931 *Hayward Review*

This article addresses issues still present to this day. Mosquito habitats remain throughout the District, and successful control of these pests requires dedicated funding and competent planning.

Digging through historical documents used to require carefully paging through nearly-century old bound packets. Today, this research takes only a few minutes because of completing our goal of digitizing and protecting our records. This project, among others mentioned in the IT section of this report, not only saves time, it also allows current District personnel to learn from the past in preparation for the future. The District has historically invested in innovations that lead to improved operations through efficiencies and quality control, and we continue this legacy today by utilizing artificial intelligence (AI), unmanned aircraft systems (UAS), and business intelligence (BI) when appropriate.

Our Laboratory began using UAS technologies in 2018 for several applications that will be detailed later in this report. This program supplements the Lab's robust program for detecting and quantifying adult populations of native and invasive *Aedes* mosquitoes. Notably, our laboratory staff has developed new and better trapping methods. ACMAD's Lab is one of the national leaders in using 3D printing technologies to improve trap design and efficiencies while saving on expenses. The Lab is also the research branch of the District (the R&D equivalent), always encouraging discourse on "is this working", "will this work", or "how can we make it better". Our Lab shares these research projects at presentations and publishes the results in peer-reviewed journals (listed later in this report).

The Lab would not exist without its counterpart, Operations. These two branches work together in reducing mosquito populations in the District. Collaborative research projects between these groups has focused on evaluating trapping methods and control products, leading to more effective and efficient operational strategies. Operations also worked with IT on improving the unmaintained swimming pool inspection process using aerial imagery, AI, and mailed notices to homeowners. Operations staff worked twice a week for almost 5 months each year on cleaning drainage ditches in the salt marshes of the San Francisco Bay using hand tools to improve tidal flow action. This program restarted after a six year hiatus due to regulatory clearances and the certification of our Programmatic Environmental Impact Report in 2016. Improvements like these are useful in preparing for additional threats such as the eventual introduction of non-native mosquitoes, *Aedes aegypti* and *Aedes albopictus*, and sea-level rise.

Another area where ACMAD is looking towards the next 90 years is regarding how climate change and sea level rise will impact our work in controlling mosquitoes. Since the passage of measure AA by the San Francisco Bay Restoration Authority in 2016, through an unprecedented 9-county parcel tax, marsh restoration projects have begun throughout the Bay Area, including in Alameda County. Thankfully, our Regulatory & Public Affairs Director, Erika Castillo, sits on the Advisory Committee and is able to voice mosquito-related concerns in the early stages of project design. ACMAD also sponsored and attended many events centered around the future of the San Francisco Bay where we represent mosquito-related concerns on behalf of the industry.

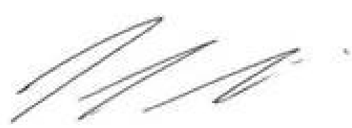
Addressing climate change in our own way, the District installed solar panels in 2019 at the facility, including electric car chargers. This project coincided with interior remodeling that adapted our existing facility to more modern uses. The expanded Board room can now be used for training, shared offices are available for seasonal and laboratory staff, and our reception area was reconfigured for improved interactions with visitors. ACMAD also worked with a consultant in creating a 20-year capital asset replacement plan. This will allow the District to maintain and fund our capital assets separately from our working capital accounts.

This type of financial planning fits with our overall goal of financial stability and transparency. In 2018 the District achieved a Transparency Certificate of Excellence from the Special District Leadership Foundation for the second time. This is a voluntary program that requires ACMAD to follow best practices that are above and beyond those required by state law. The District provides monthly financial reports to our Board of Trustees, including an income statement, balance sheet, investment and cash reserve report, and check registry. This improves the ability of our 14-member Board of Trustees to perform their fiduciary responsibility to the constituents that they serve.

Besides reflecting on our prior 90 years in preparations for the next 90, we also adopted our first 3-year strategic plan in 2018. Our Vector Biologist, Miguel Cardenas, coordinated this effort between Staff and the Board. The process included a SWOT (strengths, weaknesses, opportunities, threats) analysis, elucidating all individual goals from performance evaluations, revising our mission and vision statements, and adding core values. This plan will guide District efforts until its update by the conclusion of 2020.

The challenges faced by ACMAD between 1930 and 2019 are similar to those we are facing in 2020. Mosquito-related illnesses still occur, salt marsh mosquitoes can still disrupt lives if left unchecked, and good government practices are needed to efficiently and effectively deliver our services. The Board of Trustees has grown from eight to 14 and soon will be 15 with the completion of the annexation of the City of Albany to the District. For the first time in the District's 90-year history our service area will cover the entire County. While our borders have changed over time, the foundations of this District remain the same:

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



Ryan Clausnitzer
General Manager

GOVERNING BOARD

The Alameda County Board of Supervisors and each of the elected councils of the 13 cities within the District appoint one trustee to represent its constituency on the governing board of the Alameda County Mosquito Abatement District. The Board of Trustees consists of individuals dedicated to community service and willing to accrue the knowledge required to govern a mosquito abatement district effectively. The District board members possess a variety of skills and expertise in academia, agriculture, business, chemical engineering, education, electrical engineering, emergency planning and safety, entomology, environmental health, insurance, government, human resources, legal, mechanical engineering, pharmacy, and scientific research.

The diversity of knowledge possessed by the trustees provides a broad conceptual framework within which the Board's decision-making process occurs. This knowledge base provided by the trustees is an invaluable resource.

Trustees serve two or four-year terms without compensation; however, they do receive allowances for expenses incurred in 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.

TRUSTEES FOR THE YEARS 2018 & 2019

Trustee	Representing	Years of Service
Humberto Izquierdo	County-at-large (2018)	2.5
Cathy Roache	County-at-large (2019)	1
Wendi Poulson	Alameda	4.5
Robert Beatty	Berkeley	3.5
Alan Brown	Dublin	2
Betsy Cooley	Emeryville	3
George Young	Fremont	7
Elisa Marquez	Hayward	5
James N. Doggett	Livermore	43
Jan O. Washburn	Oakland (Berkeley)	4.5 (21)
Eric Hentschke	Newark	4
Robert Dickinson	Piedmont	6
Kathy Narum	Pleasanton	6.5
Ed Hernandez	San Leandro (2018)	1
Victor Aguilar	San Leandro (2019)	1
Subru Bhat	Union City	2

COMMITTEE ASSIGNMENTS AS OF DECEMBER 2019

FINANCIAL COMMITTEE

Purpose: The Finance Committee is a standing committee tasked with reviewing the annual budget, assessing the District's long-term capital needs, making recommendations for designating reserves, and evaluating the allocation of the Other Post-Employment Benefits (OPEB) Trust.

Membership: Bhat, Cooley, Dickinson, Hernandez, Narum, Young

POLICY COMMITTEE

Purpose: The Policy Committee evaluates the District's Policies and updates and adds policies as needed. All changes and additions to District policies must be approved by a majority of the Board.

Membership: Bhat, Doggett, Hernandez, Marquez

MANAGER EVALUATION COMMITTEE

Purpose: The primary task of this committee is to review the performance of the District Manager, annually by the June board meeting. Compensation changes and contract adjustments are based on this evaluation.

Membership: Past, present, and future Board Presidents: Marquez, Hentschke, Poulson

PUBLIC HEALTH EMERGENCY COMMITTEE

Purpose: To meet with the District Manager and/or Staff to review District surveillance and treatment information pertaining to current or emerging public health threats and to make recommendations to the board if necessary.

Membership: Washburn, Doggett, Poulson

Status: This committee only meets on an as needed basis.

PERSONNEL COMMITTEE

Purpose: To meet as needed if personnel issues rise to the level of an appeal to the Board.

Membership: Marquez, Poulson, Hentschke, Beatty

Status: This committee only meets on an as needed basis.

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	4.5
Erika Castillo	Regulatory & Public Affairs Director	17.5
Robert Ferdan	Information Technology Director	4.5
Michelle Matthes	Accounting Associate	3.5
Mark Wieland	Mechanical Specialist	4.5
OPERATIONAL STAFF		
Joseph Huston	Field Operations Supervisor	28.5
Nick Appice	Vector Biologist	5.5
John Busam	Vector Biologist	17.5
Cornelius Campbell	Vector Biologist	16
Miguel Cardenas	Vector Biologist	8
Sarah Erspamer	Vector Biologist	4
Erick Gaona	Assistant Mosquito Technician	0.1
Tom McMahon	Vector Biologist	18
Ben Rusmisel	Vector Biologist	4
Jeremy Sette	Vector Biologist	4.5
LABORATORY STAFF:		
Eric Haas-Stapleton	Laboratory Director	4.5
Dereje Alemayehu	Vector Scientist	20.5
Miguel Barretto	Associate Vector Scientist	1.5

Seasonal Employees

2018 – Annika Avery, Miguel Barretto, Jacob Ferdan, Gael Garcia, Starla House, Kathleen Lew, Alejandro Maestas, Emily Beth Rodriguez

2019 - Michael Clem, Erick Gaona, Kelli Hager, Starla House, Andrea Lee, Robert Pelc, Gaurav Sharma, Miranda Strapson, John Yue

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). Through these organizations we promote the innovative work of our District, coordinate common activities, and increase the knowledge and abilities of our staff and trustees. The following is a list of District employees who have participated in regional, statewide or national activities either by serving on committees, by presenting research results at meetings, or by serving as an officer chosen by their peers:

MEMBERSHIPS

Ryan Clausnitzer
Board Member and Treasurer (2019), CSDA
Chair, CSDA Fiscal Committee
Member, CSDA Audit Committee
Member at-large, Alameda County Special District Association Executive Committee

Erika Castillo
Member, MVCAC Regulatory Affairs Committee and Public Education Committee
Member, San Francisco Bay Restoration Authority Advisory Committee
Board Member, San Francisco Bay Joint Venture
Member, AMCA Endangered Species Subcommittee
Member, Wetlands Regional Monitoring Program Steering Committee

Sarah Erspamer
Member, AMCA Young Professionals
Member, Alameda County Emergency Managers Association

Robert Ferdan
Member and Chair (2019), MVCAC IT Committee

Eric Haas-Stapleton
Chair, MVCAC Laboratory Technologies Committee
Member, MVCAC Vector Control Research Committee
Member, MVCAC CalSurv Committee

Joseph Huston
Member, MVCAC Trash Capture Sub-Committee

Mark Wieland
Member, Alameda County Emergency Managers Association

PUBLICATIONS

Dereje Alemayehu, Trinidad Reyes and Eric J. Haas-Stapleton. (2018). Field Evaluation of a Redesigned Oviposition Trap to Monitor Gravid Invasive *Aedes* Mosquitoes in a Suburban Environment. *Journal of the American Mosquito Control Association, 34(1)*, 67-69. doi.org/10.2987/17-6647.1

Eric J. Haas-Stapleton, Miguel C. Barretto, Erika B. Castillo, Ryan J. Clausnitzer and Robert L. Ferdan. (2019). Assessing Mosquito Breeding Sites and Abundance Using an Unmanned Aircraft. *Journal of the American Mosquito Control Association, 35(3)*, 228-232. doi.org/10.2987/19-6835.1

Huston, Joseph. (2019, July/August). Mosquito Abatement and Trash Capture Devices. *Stormwater*, 20(5), 6.

Huston, Joseph. (2019, Spring). Trash Capture Devices and Mosquito Abatement: An Odyssey. *Wing Beats*, 30(1), 5-13.

MVCAC
Mosquito and Vector Control Association of California

AMCA
THE AMERICAN MOSQUITO CONTROL ASSOCIATION

CSDA
California Special Districts Association
Districts Stronger Together

SAN FRANCISCO BAY
RESTORATION AUTHORITY

MOSQUITO ASSOCIATION PRESENTATIONS

2018 MVCAC

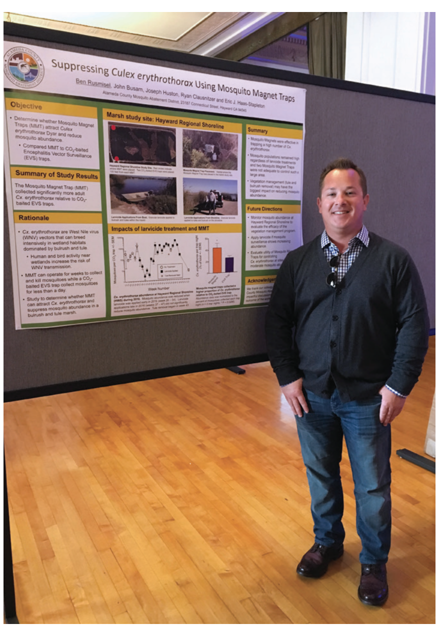
Modernizing a mosquito district through process discovery and technological innovations
Robert Ferdan

Metagenomic sequencing of *Culex tarsalis* from the field
Hanna Retallack[1], Leslie Goo[2], Amy Kistler[2], **Eric Haas-Stapleton**[3], Joseph DeRisi[1,2]
1 University of California, San Francisco, San Francisco, CA
2 Chan Zuckerberg, Biohub, San Francisco, CA
3 Alameda County Mosquito Abatement District, Hayward, CA

Invasive *Aedes* surveillance network in Alameda County
Eric Haas-Stapleton, Dereje Alemayehu

Reducing *Culex erythrothorax* at a freshwater marsh using larvicide, physical control, and traps
Ben Rusmisel, John Busam, Dereje Alemayehu, Joseph Huston, Ryan Clausnitzer, Eric Haas-Stapleton

Mosquito magnet and BG-Sentinel traps baited with BG-Lure for collecting *Aedes aegypti*
Dereje Alemayehu[1], **John Busam**[1], Trinidad Reyes[2], **Eric Haas-Stapleton**[1]
1 Alameda County Mosquito Abatement District, Hayward, CA
2 Madera County Mosquito & Vector Control District, Madera, CA



Saving resources by utilizing a novel reel dipper to inspect out-of-reach sources
Sarah Erspamer, Mark Wieland, Joseph Huston, Eric Haas-Stapleton

Permethrin resistance in *Culex pipiens*
Danny Avila, Eric Haas-Stapleton

Insecticide resistance in *Culex tarsalis*
Miguel Barretto, Rajni Lakha, Eric Haas-Stapleton

Blood-meal analysis of *Culex erythrothorax* collected in a marsh habitat
Joanne Roacho, Allen Esterly, Eric Haas-Stapleton

2019 MVCAC

Opportunities with the advancement of tidal marsh restoration in the San Francisco Bay Area
Erika Castillo, Ryan Clausnitzer

Mosquito and vector control as special districts: opportunities and challenges
Ryan Clausnitzer, Kyle Packham

Assessing mosquito breeding sites and abundance from above
Eric Haas-Stapleton, Ryan Clausnitzer

Unexpected observations in catch basins treated with extended release briquettes
Sarah Erspamer, Annika Avery, Joseph Huston, Eric Haas-Stapleton

Mapping the *kdr* mutation in *Culex pipiens* throughout Alameda County
Miguel Barretto, Dereje Alemayehu, Eric Haas-Stapleton

Determining the effectiveness of a sticky light trap in trapping and testing mosquitoes for insecticide resistance
Annika Avery[1], **Miguel Barretto**[1], **John Busam**[1], Babak Ebrahimi[2], Noor Tietze[2], **Eric Haas-Stapleton**[1]
1 Alameda County Mosquito Abatement District, Hayward, CA
2 Santa Clara County Vector Control District, San Jose, CA

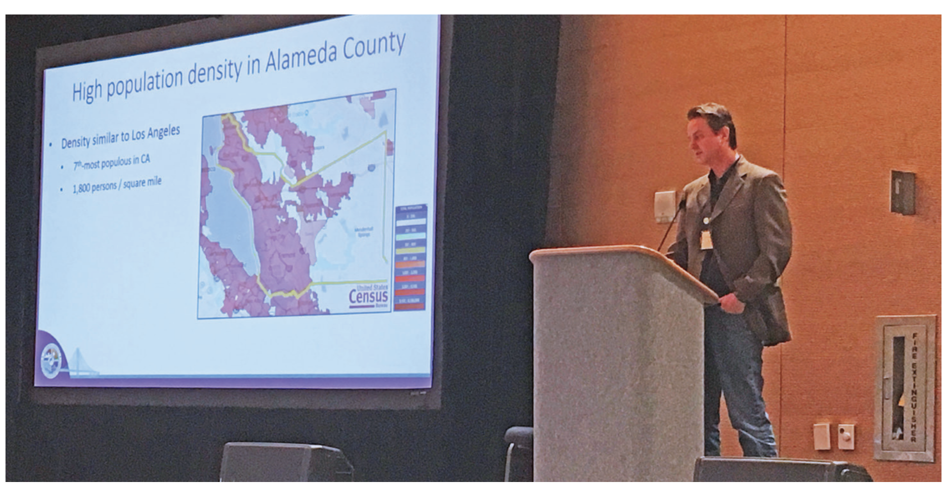
2019 AMCA

Opportunities with the advancement of tidal marsh restoration in the San Francisco Bay Area
Erika Castillo, Ryan Clausnitzer

Mosquito and vector control as special districts: opportunities and challenges
Ryan Clausnitzer, Kyle Packham

Mandated trash capture devices: impeding trash without impeding mosquito abatement
Joseph Huston

Assessing mosquito breeding sites and abundance from above
Eric Haas-Stapleton, Ryan Clausnitzer



PRESENTATIONS TO PARTNERS

Alameda County Mayors Conference
February 15, 2018, Emeryville
Modern mosquito control challenges and opportunities
Ryan Clausnitzer

UC Berkeley: Introduction to Comparative Virology
2018 and 2019
Guest Lecture: West Nile and Zika viruses
Eric Haas-Stapleton

Pleasanton Rotary
August 16, 2018
Ryan Clausnitzer

CSU East Bay: Medical Entomology
September 26, 2018
Guest Lecture: **Eric Haas-Stapleton, Joseph Huston**

MVCAC Continuing Education Forum
November 5, 2018, San Leandro
A Multi-pronged approach to understand and improve methods to detect invasive *Aedes* mosquitoes
Dereje Alemayehu

ACSDA Chapter Meeting
November 14, 2018
Controlling mosquitoes to limit disease and nuisance biting
Eric Haas-Stapleton

City Council and Board of Supervisor Presentations (14 total):
Winter and spring of 2019
Ryan Clausnitzer

SF Bay Wetlands Regional Monitoring Program Mosquito Workshop
March 2019
Assessing mosquito breeding sites with unoccupied airsystems
Miguel Barretto

Collaborative planning and design review for restored wetlands
Erika Castillo

CSU East Bay: Vector Control
March 12, 2019
Guest Lecture: **Joseph Huston**

San Joaquin Storm Water Quality Partnerships Annual Regional Training Event
May 16, 2019, Manteca, CA
Joseph Huston

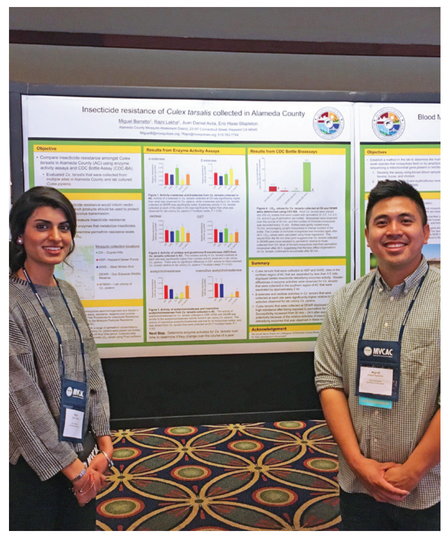
Biohub Meeting
May 24, 2019, San Francisco, CA
Eric Haas-Stapleton

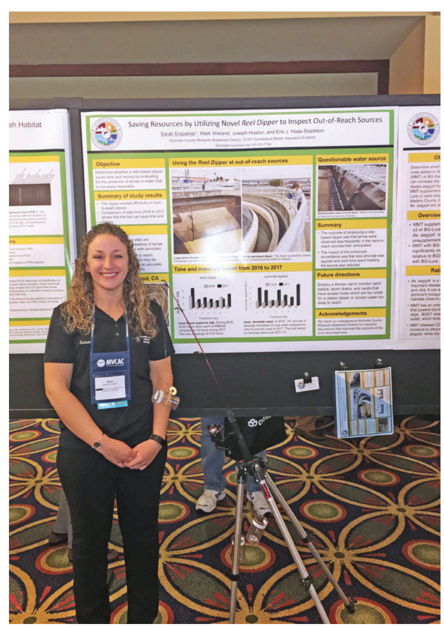
CSDA General Manager Summit
June 23, 2019, Newport Beach, CA
So you want to become a General Manager?
Ryan Clausnitzer

A General's Manager's guide to bringing out the best in their boards, commissioners, and elected officials
Ryan Clausnitzer

14th Annual Master's Research Symposium: UC Berkeley/UCSF Joint Medical Program
November 15, 2019
First universal *Culex* mosquito reverse transcriptase PCR assay detecting knockdown resistance to pyrethroids
Kelli M. Hager[1,2], Erick Gaona[1], Amy Kistler[3], Kalani Ratnasiri[3], Hanna Retallack[3], Sarah Wheeler[4], **Eric Haas-Stapleton[1]**

1 Alameda County Mosquito Abatement District, Hayward, CA
2 UC Berkeley School of Public Health, Berkeley, CA
3 Chan Zuckerberg Biohub, San Francisco, CA
4 Sacramento-Yolo Mosquito & Vector Control District, Elk Grove, CA





OPERATIONAL DATA

	2015	2016	2017	2018	2019
PHYSICAL CONTROL OPERATIONS					
Maintenance of ditches (lineal feet)	0	0	0	13,491	15,752
MOSQUITOFISH OPERATIONS					
Total number of sites stocked with *Gambusia*	606	891	762	558	610
Total number of fish planted	10,664	13,099	11,656	7,370	7,612
CHEMICAL CONTROL OPERATIONS					
Pyrenone 25-5 adulticide (oz)	159	0	0	98.55	0
SURFACE AGENTS					
BVA2 larvicidal oil (gallons)	2,170	1,011	638	425	462
Cocobear (Gallons)	0.42	0	0	0	0
BIORATIONAL LARVICIDES					
Bacillus thuringiensis israelensis (B.t.i.)					
FourStar Bti CRG (pounds)	0	0	0	0	17
FourStar 45 Bti (pounds)	0	0	0	0	0.4
FourStar 150 Bti (pounds)	0	0	0	1.4	0.4
Vectobac 12AS liquid concentrate (gallons)	103	232	243	161	211
Vectobac GS (pounds)	481	1	0	0	0
Vectobac G granular (pounds)	3,923	7,894	5,493	6,867	5,953
Bacillus sphaericus (B.s.)					
Vectolex FG (formerly CG) (pounds)	1,460	2,783	868	2,061	352
Vectolex WSP (pounds)	34	1.14	0	0	0
Vectolex WDG (pounds)	140	5	1	0	30
Bacillus thuringiensis israelensis and Bacillus sphaericus					
FourStar 180 day Briquets (pounds)	5	33	0	1.4	0
Vectomax WSP (pounds)	2	5	2	3	4.4
Vectomax FG (pounds)	4,927	1,917	2,496	1,000	2,082
Spinosad					
Natular XRT (pounds)	1,277	1,098	833	1195	999
Natular G30 (pounds)	1	80	5	29	53.25
Natular G30 WSP (pounds)	0	0	0	0	2.2
Insect growth regulator (methoprene)					
Altosid Liquid Larvicide 20% (ounces)	626	1,024	1,152	787	1,311
Altosid Briquets (each)	3,072	1,873	1,566	1,631	1,131
Altosid XR Briquets (each)	2,510	2,793	3,535	2,325	3,576
Altosid Pellets (ounces)	2,289	2,514	5,706	5,561	12,168
Altosid WSP (pounds)	0	5	2	0	0

OPERATIONS REPORT

OPERATIONS OVERVIEW

As ACMAD enters into its 90th year of existence, it is important to note that while some of the methods utilized in Operations to control mosquitoes are the same, others have evolved greatly over time. Operations is where the core mission of controlling both disease transmitting, and nuisance species of mosquitoes is conducted. As time has progressed, Operations has become more and more intertwined with the other branches of our District; the Lab, IT, public education, regulatory, mechanical, and administration. This collaboration was very much showcased in the years 2018-2019.

ACMAD's mosquito control program has long been driven by focusing on integrated vector management (IVM) principals and targeting mosquito larvae in the water. This approach utilizes physical, biological, biorational, and chemical control strategies. Alameda County has 22 mosquito species within its borders. Each species has its own distinctive biology and natural history. In recent years, the District has also had to prepare for the potential arrival of at least three species of invasive mosquitoes that have the potential to vector some very significant diseases. Controlling larval mosquito populations requires an intimate understanding of the biology, behavior, and habitats for each species. Many external factors such as rainfall pattern, temperature, tides, and numerous human variables also must be considered. Once a larval mosquito pupates and emerges as an adult, it has the ability to disperse into the environment from just a few hundred yards to well over fifteen miles depending on the species. This is why a larval-based control program has been the focus of Operations at ACMAD. Simply put, if you control the larvae in their aquatic breeding site, you are working with a specific environment within a clearly defined area. If the larvae are allowed to emerge as adults, they can disperse into a much wider geographic area, making it more difficult to control.

Another driving force behind ACMAD's larval based control program is that it affords Operations staff the ability to utilize materials that are very mosquito specific. These materials have little to no impact on other aquatic organisms, including insects, arthropods, amphibians, and fish. Many of these organisms' prey on larval and/or adult mosquitoes and help slow the rebound of mosquito populations after treatments have been conducted. ACMAD Operations staff have, and always will, consider themselves as stewards of the environments they work in. Our goal is to control mosquito larvae and prevent their emergence as adults to protect public health and comfort by utilizing methods, materials, and technology that leave the lightest footprint possible on the environment.

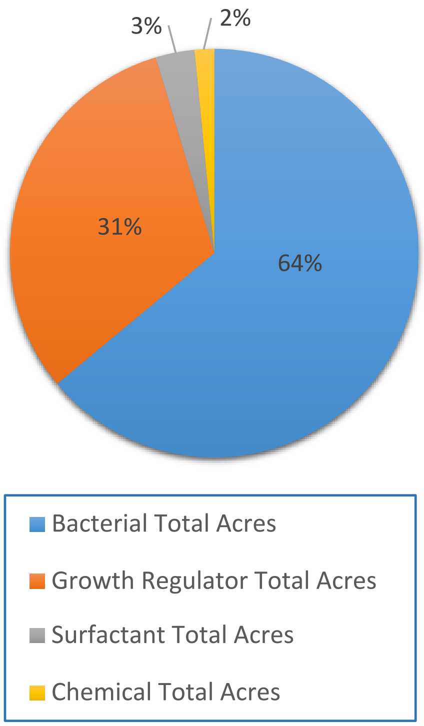


FIGURE 1: Product usage for 2018-2019 based on acreage treated.

MOSQUITO CONTROL TREATMENTS

To emphasize that the proceeding statements are not merely talking points, but rather a philosophy put into practice on a daily basis, please refer to the operational data page proceeding this report and to Figure 1. In the years 2018-2019, Operations staff treated over 7,392 acres for mosquitoes. Over 7,277 acres were treated for larval mosquitoes, and 95% of these acres (7,050) were treated with biorational and mosquito-specific materials including bacteria and insect growth regulators. Mineral oil, a surfactant, coats the water surface and suffocates mosquito larvae and pupae that must come to the surface to get air. Operations utilized mineral oil for treatment of larval and pupal populations in just over 227 acres. A majority of this usage occurred in foul water and sites that are difficult to treat such as sewer plant infrastructure, flooded basements/crawl spaces, and underground infrastructure such as catch basins and storm drains. In 2018 just under 115 acres (two percent of the entire acreage treated in both 2018 and 2019) were treated with a chemical mosquito adulticide. Data from ACMAD's Lab on West Nile virus (WNV) positive birds and WNV positive mosquito populations indicated a higher risk for potential human transmission of the virus. This led to the adulticiding treatment by Operations with aid from the Mechanical Specialist. Though not our preferred methodology, adulticiding is an important tool. It is utilized very rarely, and only after careful analysis of lab and field data; this approach involves all branches of the District in the decision making, planning, and execution processes.

NEW TECHNOLOGIES AND EQUIPMENT

New technologies spear headed by ACMAD's Information Technology Director working in conjunction with Operations staff took leaps forward in 2018-2019. This has greatly enhanced how Operations collects, records, analyzes, and utilizes data to help drive its program. Data driven analysis and decision making have streamlined the ability of Operations to assess its overall program, to collect and access data, and to incorporate data collected from the Lab. Adding the application of artificial intelligence (AI) and business intelligence (BI) has further allowed for more precise and efficient planning, assessment, and utilization of data. One example of this technology at work was in the District's control program for unmaintained swimming pools. Unmaintained swimming pools can be major sources of breeding for several species of mosquito, and they can be difficult to locate and access. At least two mosquito species that utilize this environment for breeding are significant, potential vectors for WNV and other diseases. For over a decade, ACMAD has utilized a private pilot to fly over sections of the county and photograph swimming pools that are not being maintained. Up to and including the year 2018, the flyover photos were all analyzed manually to determine if the image was a pool that merited inspection (Figure 2). The photos, data such as address, and prior history (if available), were passed on to the technician assigned to the area where the pool was located. Operations staff then began the often-arduous process of going to each home in question, often leaving one or more notices for the homeowner in order to get

FIGURE 2: Aerial imagery from unmaintained swimming pool project. (A) Original view of flyover photo. (B) Photo A cropped to focus on unmaintained swimming pool.

access to inspect and if needed, treat the pool. This was often a very time-consuming process. In many cases the pools had been cleaned and were up and running for summer since the photos had been taken, processed, and distributed to Operations staff. In 2018 Operations staff went through the normal process and directly inspected 511 pools.

In 2019 a new system was brought online in a collaborative effort with IT, Operations, and administrative staff. A flyover was conducted, and unmaintained swimming pools were photographed per usual: however, this time much of the analysis of the pools was conducted by training and using AI. The updated District database was then utilized to generate notices to homeowners of properties with potentially unmaintained pools. The notice instructed the owner to contact the District via phone, email, or text and provide photographic evidence that the pool that appeared to be a potential breeding issue (and thus a violation of California public health and safety code), was chlorinated and operating. The 2019 flyover photographed 543 potentially unmaintained pools that in the past would have been distributed to Operations staff for inspection. By utilizing the new system and process, 420 of these pools were cleared from the system by office staff. This dropped the number of pools that required physical inspection by Operations staff to 123. As with most new systems, there were some bumps in the road, and certainly some fine tuning, but it was a giant step forward and will continue to be refined and utilized in the future. The end result was a saving of time and resources that allowed Operations staff to focus on the many other mosquito breeding sites within Alameda County.

Another area of new technology, inconceivable not too many years ago, are Unmanned Aircraft Systems (UAS or drones). In 2018-2019, ACMAD's Lab utilized this new tool for analysis and surveillance of mosquito habitats. During those years several members of the Operations staff passed the Federal Aviation Administration tests required to become certified UAS pilots. Operations will be purchasing a treatment capable UAS unit in 2020. This will allow for treatments in areas that have been limited to expensive helicopter treatments in the past or that are difficult to access and treat with current operations equipment. It will also likely lead to further treatment efficiency on a number of large sites. UAS treatments will become a significant focus of Operations' strategy in the future.

In 2019 the District purchased an A-1 mist blower in a coordinated effort with Operations and the Mechanical Specialist. This equipment is being used nationwide for WALS (Wide Area Larvicide Spray) in response to invasive *Aedes sp.* mosquitoes. It can blow a mist of mosquito specific larvicide into cryptic/inaccessible sites to control larvae of these container breeding species. It can also be utilized to treat larvae in dense vegetation and in areas where current District equipment either cannot access or is prohibited.

SCIENCE, PUBLIC EDUCATION, REGULATORY AND PHYSICAL CONTROL

Both 2018 and 2019 saw Operations working closely with the Lab in several areas. This included scientific testing of new materials, new technologies, and new trapping systems and techniques. Much of this joint work resulted it presentations, posters, and journal publications. This work is a benefit to not only ACMAD but to mosquito abatement entities across the country.

The same two-year period also had Operations involvement with the public education and regulatory branches of ACMAD. Operations staff consistently worked public education events and presented talks at conferences. Operations staff also participated in numerous meetings regarding marsh and source restoration projects and long-term shoreline planning to be sure mosquito issues were discussed and mitigated. Operations also continued its leading role in trash capture regulation, both state-wide and on the national level. This included a presentation at the annual national meeting of the American Mosquito Control Association (AMCA) in Orlando, Florida and a cover featured article in *Wing Beats*, the official publication of the AMCA distributed to mosquito abatement districts nationwide (Figure 3). Also during this period, years of work on the part of ACMAD's regulatory and Operations branches were able to acquire permits to maintain ditches in tidal marsh areas. This involved working with the Army Corps of Engineers, the U.S. Fish and Wildlife Service, National Marine Fisheries Service, the California Regional Water Quality Board, and

FIGURE 3: Spring 2019 cover of *Wing Beats* magazine featuring Field Operations Supervisor Joseph Huston.

the San Francisco Bay Conservation and Development Commission. This form of physical control was the backbone of ACMAD for many years after the formation of the District in 1930. Laws and regulations put into place over the years have made securing the permits to conduct this important work much more difficult and involved. It had been over five years prior to 2018 since ACMAD was able to obtain a permit. This physical control, clearing existing ditches of vegetation, debris, and silt all by hand by Operations staff, is difficult work. The end result and benefit is that when these ditches are clear they provide a good conduit for tidal waters to enter on high tides, but also to drain the marsh as the tides recede. When tidal or rainwater creates pools during high tides or after rain events, it provides habitat for mosquito breeding. Several species of mosquito native to Alameda County are very salt tolerant and readily breed in this in these situations. One of the main reasons for the formation of ACMAD in 1930 was to deal with these salt marsh species because much of the shoreline area was virtually uninhabitable. By enhancing water circulation, pools are drained, thus eliminating breeding and the need for mosquito treatments in certain sources. During the ditching seasons of 2018 and 2019, Operations staff cleaned/cleared 29,000 linear feet of ditches.

SERVICE REQUESTS

Requests for service are received from Alameda County residents and businesses year-round. A service request or "SR" is a request to either receive mosquitofish, report a mosquito problem, report standing water, report a dead bird (possibly infected with West Nile virus), or request identification of an insect specimen. Operations staff are also requested to pick up mosquitofish from ponds and pools that are being drained, removed, or overpopulated with fish. For the years 2018-2019, ACMAD received 2,273 SRs. Figure 4 depicts the type of SR, and the percent each type equates to. Dependent on where in the county the SR originates, it is assigned to an Operations staff member responsible for that area. Figure 5 breaks down the percentage of SRs received per city and Figure 6 is the population distribution of Alameda County. The goal of Operations is to respond to any SR within a 24-hour period (excluding weekends and holidays). Service requests are the foremost way in which ACMAD interacts directly with our public. This interaction is utilized to further educate the public about our operations, mosquito breeding and biology, and to resolve the nature of their request.

Typically, the highest number of requests received in a given year are for mosquitofish (Figure 4). In 2018 and 2019 the District received 972 requests for mosquitofish; 1,168 sites were stocked with 14,982 fish. Mosquitofish, *Gambusia affinis*, have been utilized in mosquito control in California since the early 1900's. These little fish form the cornerstone of ACMAD's biological control component of our IVM program. This species is non-native to our region so Operations staff only stock them into man-made, contained sources such as ornamental ponds, larger fountains, live-stock watering troughs, and unmaintained swimming pools. These hardy fish live upward of three years, reproduce well in the aforementioned sources, can each eat hundreds of mosquito larvae in a day, and provide excellent, long-term control of mosquito larvae in these sites.

Requests to report mosquito problems are the next highest category of SRs received in 2018-2019 (Figure 4). These requests are often the result of localized mosquito breeding especially in urban settings. Often, this type of SR requires some detective work on the part of an Operations staff member. Sources can be hidden in containers or used tires in backyards or adjacent properties. Mosquito breeding also occurs in flooded crawl spaces, drains, ponds without fish, tree holes, unmaintained swimming pools, creeks and canals, and other containers holding water. This is a major reason why a lot of the District's public education program centers around teaching homeowners and residents to inspect their properties for standing water and to dump or drain them or to call ACMAD for assistance.

The next SR class by volume received, are requests to report standing water (Figure 4). These reports are received on a regular basis year-round but are at their peak in late winter and early spring. Reports of rainwater, water not draining from street gutters and water standing in parks, fields, and along trails are common. This is also the class of SR utilized to categorize neighbors reporting unmaintained ponds, containers, tires, unmaintained swimming pools, etc. With eight Operations staff covering the entire 821 square miles of Alameda County, these calls, along with calls to report mosquitoes, can be very helpful in alerting Operations to potential mosquito breeding sites.

A good number of SRs are also received to report dead birds. Reports of dead birds are an important component of ACMAD's WNV program. WNV can kill several species of birds. When we receive this type of SR, the bird is recovered and transferred to our Lab where it is then tested for WNV and several other mosquito-borne diseases. Testing in-house allows for rapid results as well as rapid response. If a positive bird is detected, both Operations and the Lab can respond to the collection location right away and check for larval mosquitoes and trap for adult mosquitoes which can also then be tested for the presence of WNV.

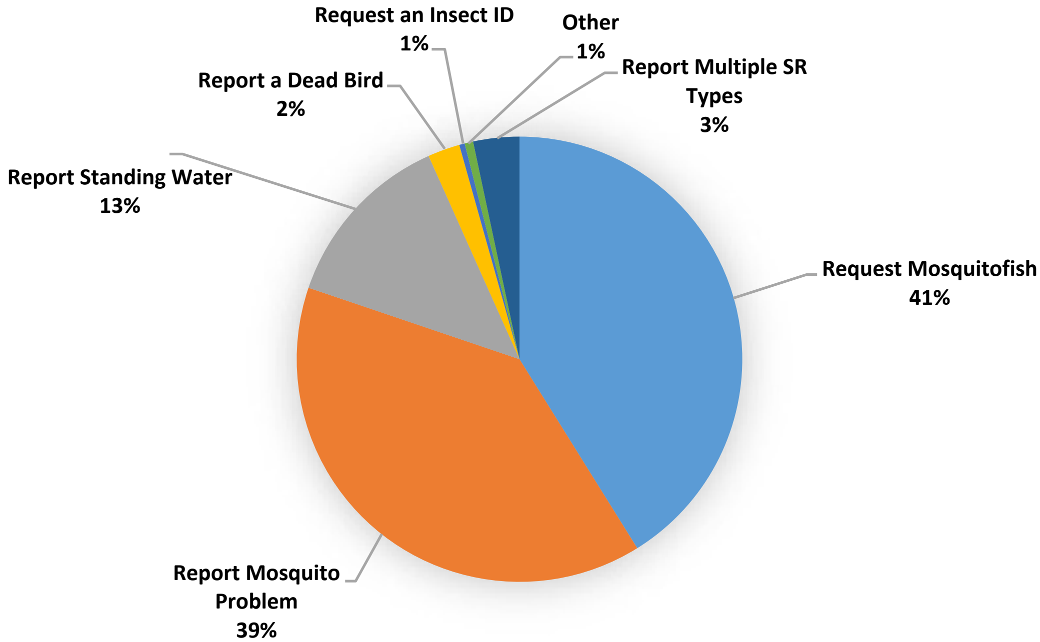


FIGURE 4: Service Request Types

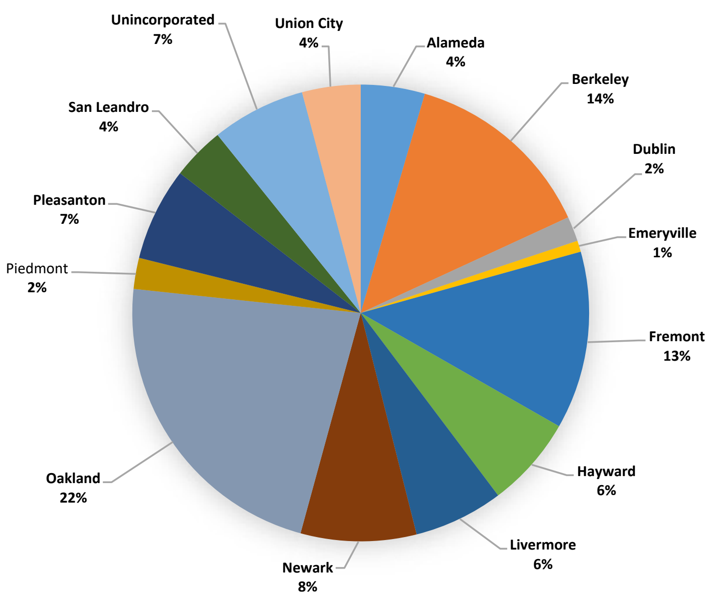


FIGURE 5: Service Request Percentage by City

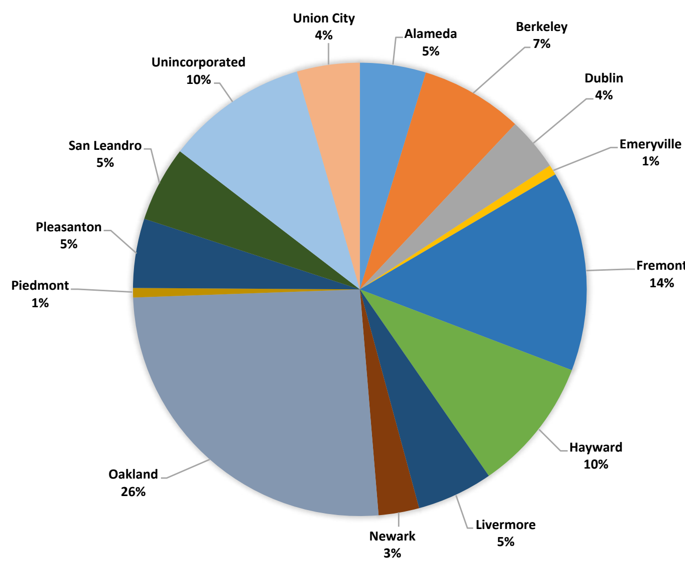


FIGURE 6: Population Distribution of Alameda County

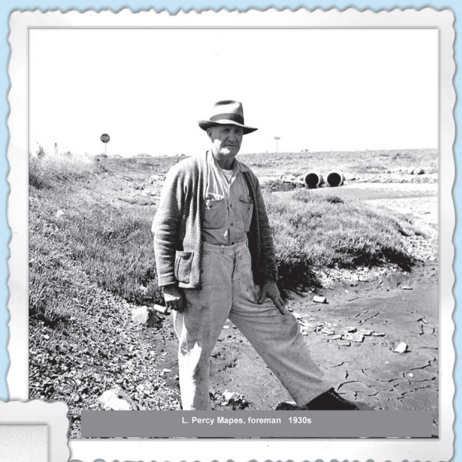
As mentioned earlier "other" SRs are usually requests to retrieve mosquitofish from one of the aforementioned sites. SRs to request an insect identification round out the classes of SRs received by ACMAD. We are fortunate to have several District staff members, including some in Operations, that are well trained in entomology and are usually able to identify an insect or other arthropod specimen down to at least the genus if not species level. This service has been greatly appreciated by the public we serve. We can often provide additional information about the specimen such as its biology, behavior, and breeding habitats to inform the requester if it is something they should be concerned about.

CONCLUSION

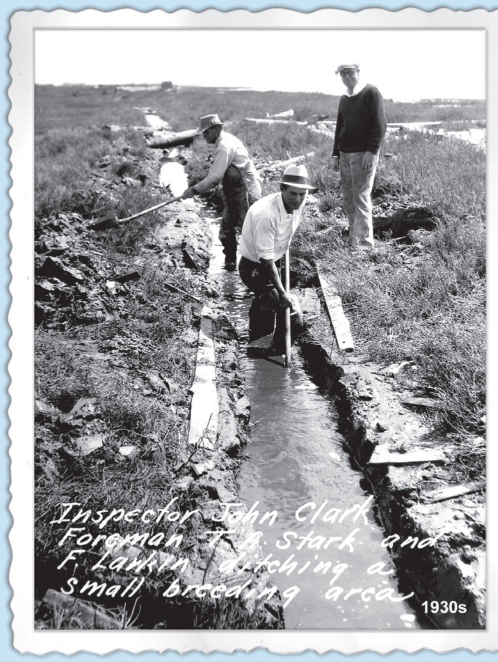
As ACMAD enters its 90th year anniversary and enters into a new decade, Operations is determined to maintain the highest possible level of service to the public. We will continue to utilize new technologies and equipment, analyze our data and programs, test new materials and techniques, continue training, prepare for potential introduced mosquitoes, continue to work together with all of the other branches of ACMAD, and strive to be both reflective on the past and innovative into the future.

ACMAD in the 1930's

Marsh oiling by airplane 1930s

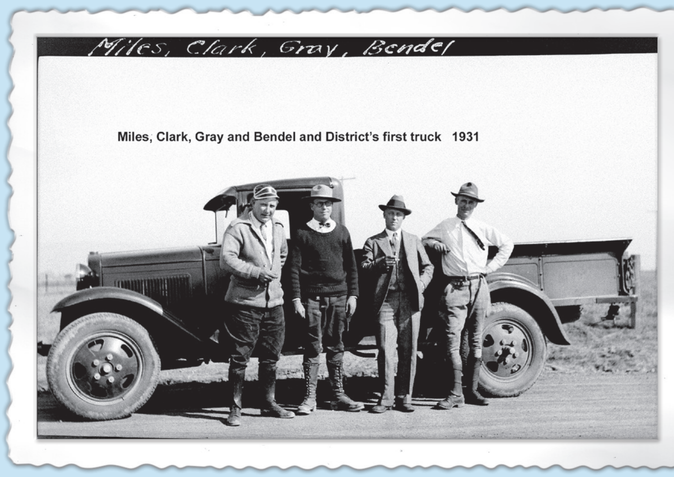


L. Percy Mapes, foreman 1930s



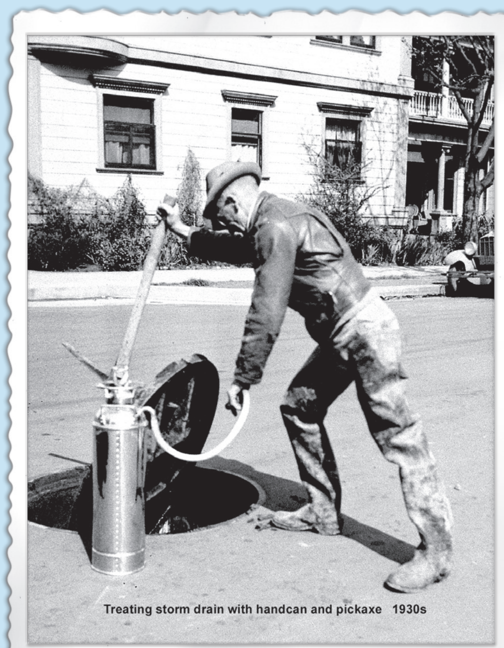
1930s

Taking motion pictures of marsh oiling 1930s



Miles, Clark, Gray and Bendel and District's first truck 1931

Oliver tractor and crew creating ditches 1930s



Treating storm drain with handcan and pickaxe 1930s

Treating storm drains 1930s

LABORATORY REPORT

OVERVIEW OF ACMAD LAB ACTIVITIES

The ACMAD Lab is principally responsible for assessing the abundance of adult mosquitoes, testing for the presence arboviruses (arthropod-borne viruses) in mosquitoes, evaluating mosquito resistance to insecticides, and conducting research that supports the assessment of mosquito abundance and mosquito control.

Mosquito abundance and arbovirus prevalence in birds and mosquitoes were monitored in each city and unincorporated region of Alameda County during 2018 and 2019, with the exception of the City of Albany (because it has not yet been annexed into ACMAD). West Nile virus (WNV), Saint Louis encephalitis virus (SLEV) and Western equine encephalitis virus (WEEV) are arboviruses that can be transmitted to humans and birds by mosquitoes that are native to Alameda County. The prevalence of WNV, SLEV, and WEEV were assessed by testing dead birds and mosquitoes that have the capability to transmit these viruses. Mosquito resistance to insecticides was evaluated using functional (bottle bioassay), biochemical (enzyme activity), and genetic assays to ensure that products used for mosquito control are efficacious. A summary of mosquito abundances and arbovirus prevalence in Alameda County is reported herein. Notably, *Aedes aegypti* (a non-native and invasive mosquito that transmits Zika, chikungunya, and dengue viruses) was detected during 2019 less than 20 miles from the eastern border of Alameda County. Consequently, the ACMAD Lab intensified its mosquito monitoring programs in the eastern region of the County.

Research during 2018 and 2019 included: (1) Developing an assay to measure pyrethroid resistance in all *Culex spp.* of mosquito that have been tested to date, (2) Utilizing an unmanned aircraft system (UAS, *i.e.* drone) to assess marsh habitats for accumulated surface water that support mosquito breeding and to visualize mosquito larvae in water, (3) Evaluating a novel magnetic sticky light trap to assess mosquito abundance in catch basins. We continued our collaboration with CZ Biohub to support their now global-wide Grand Challenges Exploration Project to learn of the commensal and pathogenic microorganisms that inhabit mosquitoes. We also have embarked on a new collaborative project with CZ Biohub to determine whether artificial intelligence and machine learning can be leveraged to automate mosquito identification.

Over the prior 90 years, ACMAD has been the lead agency that monitors and controls mosquitoes in Alameda County. These efforts have been effective in keeping mosquito abundance low so that people can live comfortably near marshlands that abut the San Francisco Bay where mosquito abundance would be intolerably high in the absence of ACMAD's abatement programs. During the prior five years, the ACMAD Lab has transformed its mosquito monitoring program from one that counts mosquitoes in a dearth of traps (55 ± 11 CO_2-baited traps per year from 2010 - 2014) to one that develops

innovative and effective mosquito monitoring approaches via collaborations and partnerships while significantly increasing its mosquito trapping efforts (2010 ± 181 CO_2-baited traps per year from 2015 – 2019, a 3555% increase relative to the prior 5 years). Changes over the coming 90 years in the geographic distribution of *Ae. aegypti* will likely bring this pestiferous mosquito to the warmer regions of Alameda County and sea level rise (driven by anthropogenic climate change) is likely to inundate the San Francisco Bay shoreline with water, thereby increasing the acreage in the County where native mosquitoes can proliferate. The culture and practice of science-driven inquiry and collaboration that have been fostered in the ACMAD Lab during the prior five years strengthens our resiliency and effectiveness to efficiently plan for and adapt to these and other changes that may arise in the coming 90 years and beyond.

ARBOVIRUSES IN ALAMEDA COUNTY

WNV is typically detected each year in Alameda County and is spread when an infected mosquito bites a bird or other animal. The resulting disease is often fatal in birds such as ravens and crows. WNV infection in humans rarely cause noticeable neurological symptoms (0.00025% of California residents during 2018) and mortality is very uncommon. Two other arboviruses, SLEV and WEEV, also cause neurological disease in humans, but have not been detected in Alameda County for over a decade. WNV is transmitted by species of mosquito that are common in Alameda County (*Culex erythrothorax*, *Culex pipiens* and *Culex tarsalis*). When these species were collected in CO_2-baited encephalitis virus survey traps (CO_2 traps), they were tested in the ACMAD Lab for the presence of WNV, SLEV, and WEEV using quantitative polymerase chain reaction (QPCR). Whenever a dead bird was determined to be infected with WNV, Lab personnel placed 25 – 30 CO_2 traps in an area approximately a quarter of a mile from where the infected bird was found in order to determine if WNV-infected mosquitoes were present. The geographic distribution of WNV detections in Alameda County is shown in Figure 7. During 2018, WNV was detected in 20 birds and was found in 15 collections of mosquitoes that were captured in CO_2 traps (Figure 8; 7 *Cx. tarsalis*, 4 *Cx. pipiens*, and 3 *Cx. erythrothorax*). WNV was not detected in any bird or mosquito in Alameda County during 2019 (Figure 8). While no human cases of WNV were reported in Alameda County during 2018, one was reported during December 2019 (Figure 8), several months after the person no longer displayed symptoms.

Two species of mosquito that do not currently occur in Alameda County, *Ae. aegypti* and *Aedes albopictus*, have recently become established elsewhere in California. Notably, *Ae. aegypti* was detected during 2019 in San

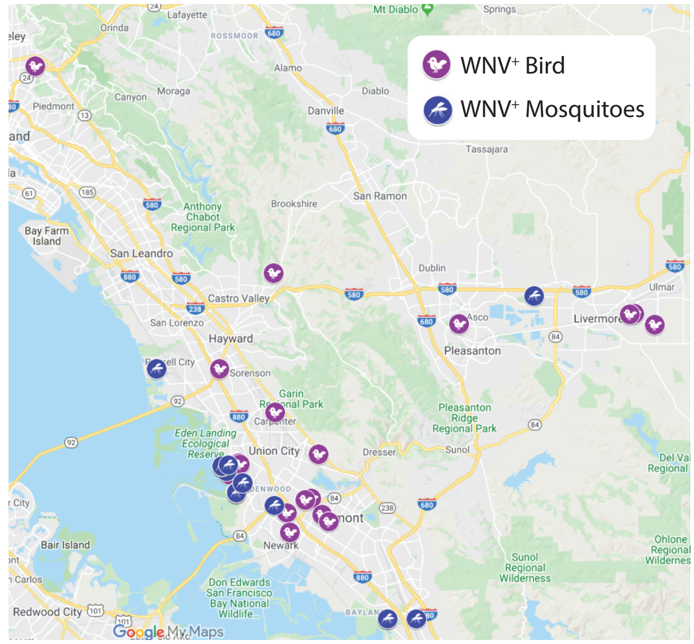


FIGURE 7: Geographic distribution of WNV in mosquitoes and birds during 2018. WNV was not detected in birds or mosquitoes during 2019.

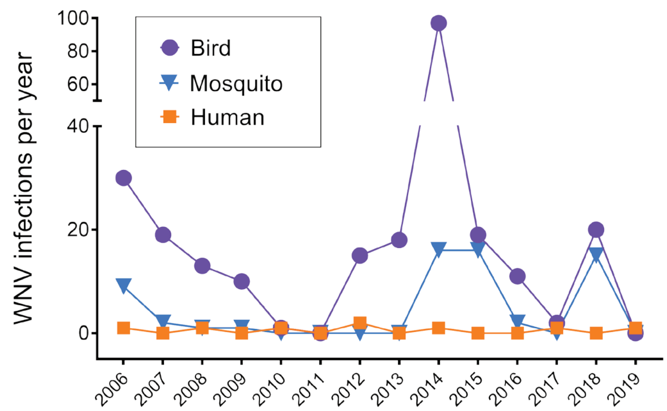


FIGURE 8: WNV in birds, mosquitoes and humans from 2006 – 2019.

Joaquin County, which borders Alameda County to the east. These so-called "invasive *Aedes* mosquitoes" can transmit dengue, chikungunya and Zika viruses to humans. Although an extensive invasive *Aedes* mosquito monitoring program has been in place for Alameda County since 2016, these species have not yet been detected in the County.

MOSQUITO ABUNDANCE ASSESSMENTS

OVERVIEW OF ASSESSING ABUNDANCE.

The ACMAD Lab assesses mosquito abundance by placing traps that capture adult mosquitoes or the eggs they lay (*i.e.*, after oviposition). Several trap types are used because they employ different mosquito attractants. These include: light traps (light attractant), CDC carbon dioxide (CO_2) encephalitis virus surveillance traps (CO_2 attractant), oviposition traps (water attractant), Mosquito Magnet traps (CO_2, heat, and water vapor attractants), and BG-Sentinel traps (artificial human scent attractant).

WEATHER AND GEOGRAPHY IN ALAMEDA COUNTY DURING 2018 AND 2019.

Alameda County can be divided into two distinct climate regions: (1) the area on the bayside of the coastal foothills that run between Berkeley and Fremont, and (2) the inland area east of those coastal foothills. Climatic conditions, particularly air temperature and rainfall quantity, substantially impact mosquito abundance. Mosquito growth rate is correlated with ambient temperature and mosquitoes require accumulated surface water to complete their life cycle. If the ambient temperature falls below 50° F, mosquito growth slows precipitously. Growing Degree Days base 50° F (GDD) is a summary heat index that measures heat accumulation in the environment when surface temperatures exceed 50° F, conditions that facilitate rapid mosquito growth. GDD can be calculated as the average of the sum of the maximum and minimum temperature minus 50° F (*i.e.* GDD = [(Tmax + Tmin)/2] - 50° F). Climatic conditions during 2018 and 2019 in the bayside region were less favorable to mosquito growth relative to the inland region (Table 1; *i.e.* it was cooler and drier in the bayside region relative to the inland region).

Given that GDD and rainfall were higher in the inland region of the County relative to the bayside region, one might expect the inland region to have higher mosquito abundance. However, mosquito abundance in the bayside region was actually substantially higher for both 2018 and 2019. While rainfall and ambient temperature are key drivers in the physiological development of mosquitoes, there must be an appropriate ecological habitat available to mosquitoes for them to reproduce. Wetland habitats support the growth of several mosquito species that occur in Alameda County, including *Cx. tarsalis* and *Cx. erythrothorax*, both of which can spread WNV to people. *Aedes dorsalis* and *Aedes squamiger*, two of the more aggressively biting mosquito species in the County, also rely on marsh habitats for growth. Marsh habitat is common in the bayside region but rare in the inland region. Thus, while climatic conditions for mosquito reproduction are more favorable inland, essential habitat for the larval development of native mosquitoes predominates in the bayside region. Thus, this region supports the highest mosquito abundance in the County. Invasive species of mosquito such as *Ae. aegypti*, however, are adapted to living in suburban and urban habitats. Were *Ae. aegypti* to become established in Alameda County, and because the inland habitat is optimal for that species, mosquito abundance in that area could increase substantially.

	GDD		Precipitation	
	2018	2019	2018	2019
Bayside	120.3	119.6	11.1	14.0
Inland	126.2	129.1	12.3	15.6

TABLE 1: GDD and precipitation measured in rainfall inches for 2018 and 2019 in the bayside area (represented by Hayward, CA) and inland are (represented by Livermore, CA). Data from US National Centers for Environmental Information.

ASSESSING MOSQUITO ABUNDANCE USING TIGHT TRAPS.

Light traps (LT) were deployed at 16 sites in the County during 2018 and 2019 (Figure 9). LT were operated continuously throughout the year and trap contents were collected every seven days and analyzed. Both male and female mosquitoes were collected in LT, informing ACMAD staff when biting adults are present (via adult female abundance), and when mating has occurred (via adult male abundance). The bright light attractant of LT brings a high number of non-mosquitoes into the trap and is thus less specific of a trap for mosquitoes relative to CO_2 traps (described later).

Mosquito abundance as measured using LT was lower in 2019 relative to the prior year (16,595 mosquitoes were collected in LT and identified to species during 2018 and 6,596 in 2019). When the data was normalized to adjust for the number of trapping events each year, there were on average 2.59 mosquitoes collected per trap night during 2018 and 1.37 mosquitoes per trap night during

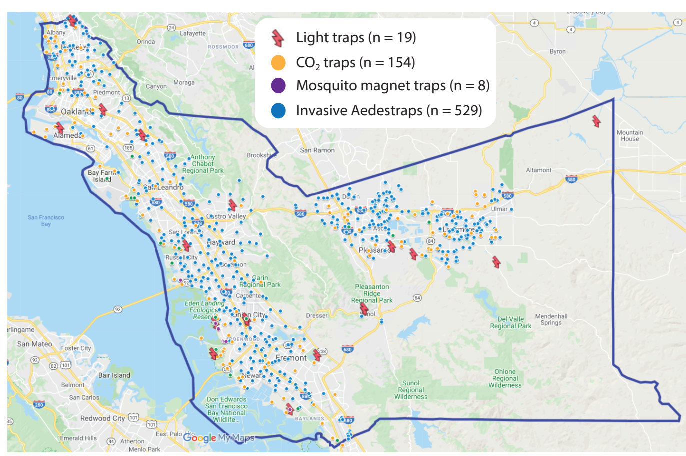


FIGURE 9: Location of mosquito trap sites in Alameda County during 2019. The boundary of Alameda County is indicated in blue.

2019. *Culiseta incidens*, which does not transmit WNV, was the most abundant species in LT during 2018 and 2019, representing 25.8% and 44.8% of the total mosquitoes collected for each year, respectively (Figure 10A). The WNV vector *Cx. tarsalis* was the second most common species of mosquito that was collected in LT during 2018 and 2019 (Figure 10A; 23.1% and 20.1% of the total, respectively). Monthly trends measured using LT show peak mosquito abundance occurred in May during 2018 and June for 2019 (Figure 10B). Atypically high mosquito abundance observed in LT during November 2019 was due to *Cx. tarsalis* captured at bayside and inland trap locations. Higher mosquito abundance was observed from May – July during 2018 relative to 2019. This may have resulted from late-season rainfall that provided more habitat for increased mosquito reproduction through April 2018 (3.0 and 0.47 inches of rainfall measured in Hayward, CA for April 2018 and 2019, respectively).

ASSESSING MOSQUITO ABUNDANCE USING CO_2 TRAPS. During 2018 and 2019, over 150 sites in Alameda County were monitored for mosquito abundance using CO_2 traps (Figure 9). While LT are monitored the entire year, CO_2 traps were deployed from February to November because cool and rainy climate conditions limit the efficacy of CO_2 traps. The traps were baited with dry ice that sublimates

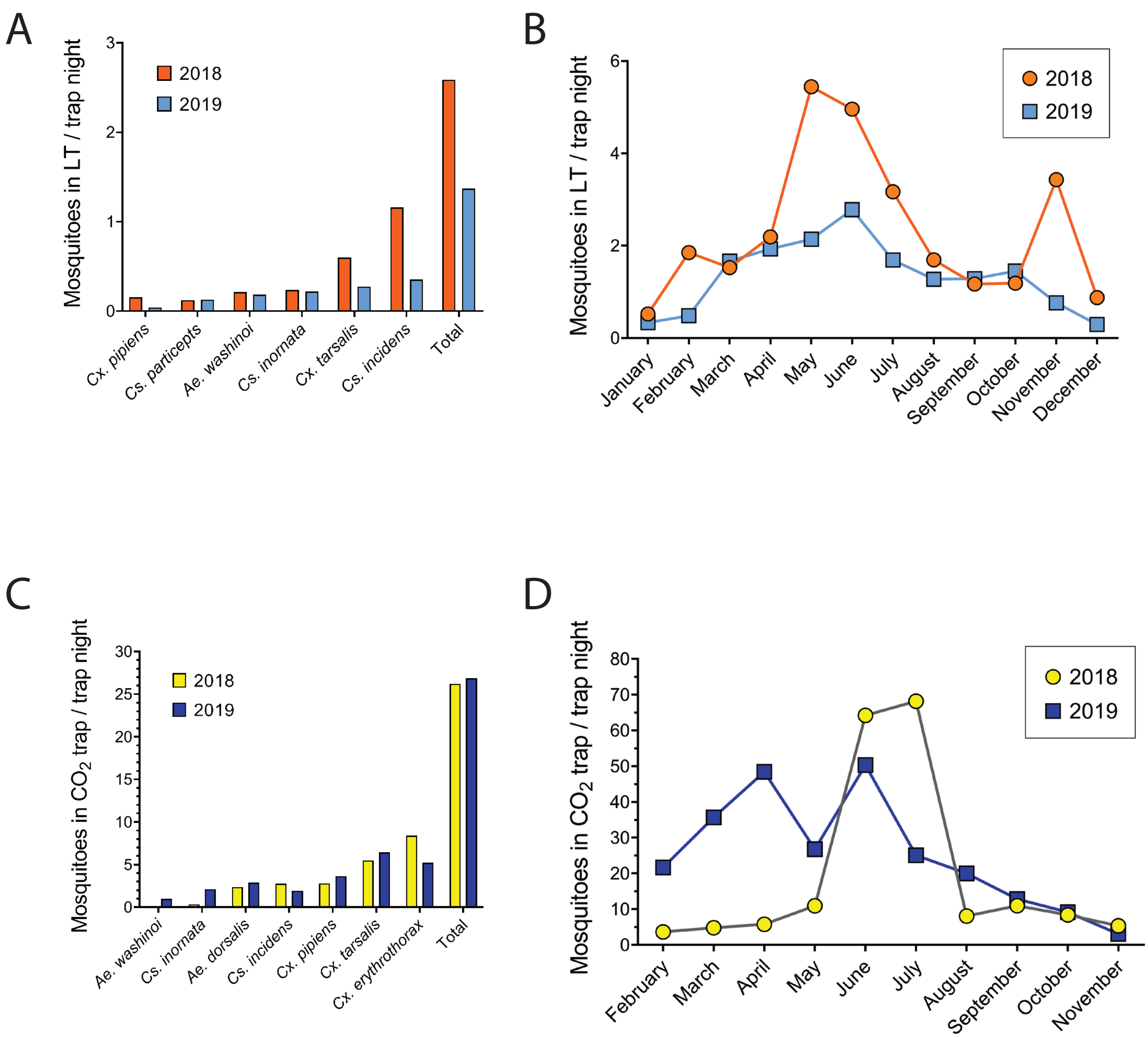


FIGURE 10: Summary of mosquito abundance in Alameda County for 2018 and 2019 measured using light traps (LT) and CO_2-baited encephalitis virus survey traps (CO_2 traps). The six most abundant species of mosquito collected in LT or CO2 traps during 2018 and 2019 (A, C). Numbers of mosquitoes collected each night in LT or CO2 traps during each month of 2018 and 2019 are shown (B, D).

to release CO_2 gas that primarily attracts adult female mosquitoes seeking a blood meal. Traps were placed at sites for one day to capture adult mosquitoes when they are most active (*i.e.*, the hours around sunset and sunrise).

The number of mosquitoes captured per trap night was similar for 2018 and 2019 (average = 26.2 and 26.9 mosquitoes / trap night; total of 50,633 and 40,512 adult mosquitoes, respectively). The most abundant species in CO_2 traps for 2018 and 2019 were *Cx. erythrothorax*, *Cx. tarsalis*, and *Cx. pipiens* (Figure 10C). While *Cx. erythrothorax* are restricted to marsh habitats, *Cx. tarsalis* occur in both marsh and urban environments. *Culex pipiens* occur predominantly in urban and suburban habitats. Mosquito abundance during 2019, as measured using CO_2 traps, peaked during April and June (Figure 10D). The sharper peak in mosquito abundance during June and July of 2018 (Figure 10D) may have resulted from the late-season rainfall, as described previously.

ASSESSING MOSQUITO ABUNDANCE USING MOSQUITO MAGNET TRAPS (MMT).

Mosquitoes are attracted to MMT because this trap burns propane to release CO_2, heat and water vapor. A single propane tank can power a MMT continuously as long as 20 days. During 2018, MMT were placed at three sites that had high mosquito abundance where they collected a total of 18,324 mosquitoes. Because these MMT reduced mosquito abundance in those areas substantially, an additional 5 MMT were deployed during 2019, capturing nearly 350,000 host-seeking adult mosquitoes.

INVASIVE *AEDES* MONITORING PROGRAM.

The geographic distribution of *Ae. aegypti* has expanded substantially since 2017. During 2019, this species spread to Stanislaus, San Joaquin, Sacramento, and Placer counties. The ACMAD Lab developed the oviposition bucket trap (OBT) in 2016 and has deployed over 500 OBT to monitor the County intensively for the presence of invasive *Aedes* mosquitoes (Figure 9). Although *Ae. aegypti* were detected in San Joaquin County less than 20 miles from the eastern border of Alameda County, ACMAD has yet to detect this mosquito in any of our traps. To increase the likelihood of detecting *Ae. aegypti* before it becomes established, ACMAD Lab intensified its invasive *Aedes* monitoring program in the eastern region of the county where we anticipate it may arrive first.

MOSQUITO RESISTANCE TO INSECTICIDES

Insecticide resistance in *Cx. pipiens* and *Cx. tarsalis* was evaluated in the County during 2018 using enzyme activity assays that assess the capability of mosquitoes to detoxify insecticides. Relative to a lab strain of *Cx. pipiens* that is susceptible to pyrethroids, *Cx. pipiens* that were collected at a waste-water treatment plant did not have significantly increased activity of enzymes that metabolize insecticides (*i.e.* acetylcholine esterase, glutathione-S-transferase, oxidase, alpha esterase and beta esterase). In contrast, *Cx. tarsalis* that were collected at a regional park had significantly elevated alpha- and beta-esterase enzyme activity relative to the susceptible lab strain of *Cx. pipiens* (unpaired t test, $P < 0.05$).

Pyrethroid resistance in *Cx. pipiens* that were collected during 2018 in the northern region of the County was assessed with a standard QPCR assay that uses genomic DNA to detect the L1014F single nucleotide polymorphism (SNP) in the knockdown resistance (*kdr*) loci of the voltage-gated sodium channel (VGSC) gene that is associated with resistance to pyrethroid insecticides. The results showed that 70% of the *Cx. pipiens* contained the *kdr* SNP that is associated with susceptibility to pyrethroids while the remaining 30% contained at least one allele of VGSC that is associated with resistance to pyrethroids (n = 80 mosquitoes tested). During 2019, the ACMAD Lab developed an improved *kdr* SNP assay that was used to assess pyrethroid resistance in 1,384 *Culex spp.* mosquitoes that were collected throughout Alameda County (described in the Research Section).

MOSQUITO RESEARCH

COLLABORATION WITH CZ BIOHUB.

The ACMAD Lab continued its collaboration with CZ Biohub during 2018 and 2019, primarily in support of the mosquito metagenome sequencing project to characterize the commensal and pathogenic microbes that inhabit mosquitoes. A manuscript describing the outcomes of this study will be submitted for publication to a peer-reviewed journal during 2020. This effort involved over 40 scientists at CZ Biohub and UC San Francisco. This collaborative project laid the foundation for motivating CZ Biohub to elevate this mosquito metagenome study in California to a Grand Challenges Exploration Project with global partners in Brazil, The Gambia, South Africa, Madagascar, Kenya, Malawi, Pakistan, Nepal, Cambodia and Vietnam. During late 2019, we established an additional collaboration with new investigators at CZ Biohub to determine whether artificial intelligence and machine learning could be utilized to automate the identification of mosquitoes that are collected in CO_2 traps.

UNIVERSAL CULEX PCR ASSAY TO DETECT RESISTANCE TO PYRETHROID INSECTICIDES.

District staff rarely use insecticides that target the adult stages of mosquitoes. However, when adult mosquitoes are found to contain arboviruses, insecticides may be used to reduce adult mosquito abundance to protect public health. During 2019, a Master's student intern from UC Berkeley School of Public Health worked in the ACMAD Lab to develop a reverse transcription QPCR assay that detects the *kdr* L1014F SNP in RNA transcripts of the VGSC gene that is associated with resistance to pyrethroid insecticides in *Cx. tarsalis*. The VGSC sequence data for this project were generated by CZ Biohub using mosquitoes that were collected by the ACMAD Lab. A *kdr* SNP assay was previously available only for *Cx. pipiens* and *Culex quinquefasciatus*. While developing the assay for *Cx. tarsalis*, we discovered that this one assay could detect the *kdr* SNP in all species of *Culex* that we have evaluated to date (*i.e.*, *Cx. erythrothorax*, *Cx. tarsalis*, *Cx. pipiens*, *Cx. quinquefasciatus*, *Culex stigmatosoma*, and *Culex apicalis*). This "Universal *Culex kdr* SNP Assay" was able detect whether a mosquito had one copy of VGSC with the resistance *kdr* SNP (heterozygous), two copies of the resistance SNP (homozygous resistant), or two copies of the gene contained the susceptibility *kdr* SNP (homozygous susceptible). The results of this improved *kdr* assay were validated by sequencing the QPCR products and searching for the *kdr* SNP. There was 99.4% agreement between the results from the *kdr* assay and sequencing data (n > 100 comparisons), demonstrating that this redesigned assay was highly accurate. Notably, we successfully used this assay to analyze the *kdr* SNP in both adult and immature larval mosquitoes that were frozen immediately upon death, and in adult mosquitoes that had been dead and dried at room temperature for over three months.

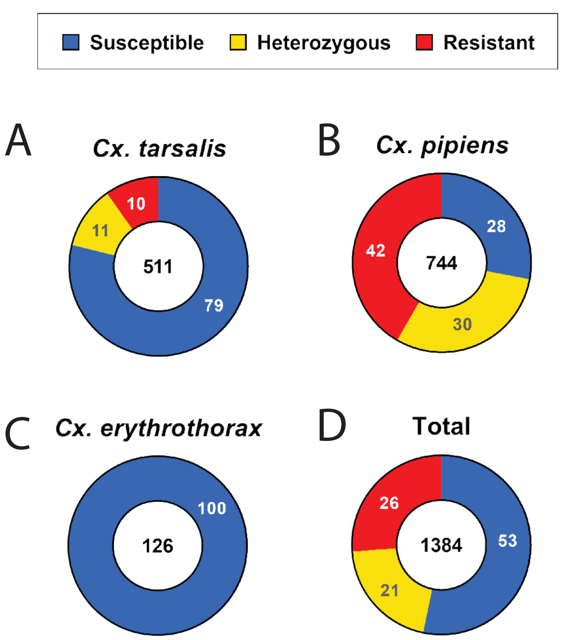


FIGURE 11: Proportion of mosquitoes with the *kdr* allele that is associated with resistance or susceptibility to pyrethroid insecticides. (A) *Cx. pipiens*, (B) *Cx. tarsalis*, (C) *Cx. erythrothorax*, and (D) all mosquitoes tested during 2019. Numbers within each segment of the doughnut graphs represent proportions and the number in the center of each doughnut graph reflects the number of mosquitoes tested.

The ACMAD Lab used this Universal *Culex kdr* SNP Assay to evaluate pyrethroid resistance in *Culex* mosquitoes that were collected at sites throughout the County. Of the 744 *Cx. pipiens* that were tested, 72% contained at least one copy of the *kdr* SNP that is associated with resistance (*i.e.* the mosquito was either heterozygous or homozygous resistant; Figure 11A). A lower proportion of *Cx. tarsalis* contained the resistant allele (21%) relative to *Cx. pipiens* (n = 511 *Cx. tarsalis* tested; Figure 11B). None of the *Cx. erythrothorax* that were tested contained the pyrethroid resistance *kdr* SNP (n = 126; Figure 11C).

The geographic distribution of the pyrethroid-resistance gene was substantially higher for *Cx. pipiens* that were collected in the inland region of Alameda County relative to those from the bayside region (Figure 12A; 89.4% and 53.4%, respectively). Similarly, more *Cx. tarsalis* in the inland region contained the resistant allele relative to those collected in the bayside region (Figure 12B; 30.5% and 12.7% respectively). Overall, the proportion of mosquitoes with the resistant allele was lower for *Cx. tarsalis* relative to *Cx. pipiens* (21.1% and 72.0%, respectively). The high proportion of mosquitoes in the inland region of the County with the *kdr* allele that is associated with pyrethroid resistance is striking because ACMAD rarely applies insecticides. In fact, ACMAD staff applied less than 10 ounces of adult mosquito-targeting insecticide during the nine years between 2010 and 2019. Commercial use of pyrethroids to control structural or agricultural pests may have contributed to the broad distribution of the resistant *kdr* allele in mosquitoes from the inland region.

USE OF UNMANNED AIRCRAFT SYSTEM (UAS; *i.e.* drone) TO ASSESS MOSQUITO BREEDING SITES.

Research using the ACMAD UAS was published in the Journal of the American Mosquito Control Association ("Assessing Mosquito Breeding Sites and Abundance with an Unmanned Aircraft"; 2019, 35(3), 228-232. doi.org/10.2987/19-6835.1). Therein we described our use of an UAS with an attached zoom and multispectral camera to visualize mosquito larvae in water and to quantify accumulated surface water on a 0.54 km2 tidal marsh that abuts the San Francisco Bay (Union City, CA). The study showed unequal accumulation of surface water that could be used to inform efforts to improve existing water channels that reduce mosquito breeding habitats. Mosquito larvae were visualized with the zoom camera at heights of up to 14 meters above the water surface and an artificial intelligence algorithm that was trained to analyze the images discriminated mosquito larvae from debris with up to 94.1% accuracy.

CAPTURING MOSQUITOES IN CATCH BASINS USING A MAGNETIC STICKY LIGHT TRAP (MSLT).

Santa Clara Vector Control District shared with ACMAD Lab a prototype of a sticky light trap that they tested briefly in catch basins. ACMAD Lab staff modified the design to produce a magnetic sticky light trap (MSLT) with increased light intensity to attract mosquitoes and power to extend the duration of time that the trap functioned when placed in a catch basin (Figure 13A, 13B, 13C). To determine how long mosquitoes that were collected on the MSLT could be analyzed for pyrethroid resistance, *Cx. pipiens* mosquitoes were placed on MSLT, removed daily for 16 days, and tested with the QPCR *kdr* SNP assay. Although there was a significant reduction in the efficiency of *kdr* allele amplification in the QPCR assay as the time that the mosquitoes were on the MSLT increased (unpaired t-test, $P < 0.0001$), the *kdr* allele could be amplified and detected in all mosquitoes that were on the trap for 16 days (not shown). The MSLT was subsequently deployed in catch basins throughout Alameda County and the collected *Cx. pipiens* mosquitoes were analyzed for pyrethroid resistance using the QPCR *kdr* SNP assay. Greater than half (56%) of the *Cx. pipiens* from the MSLT were homozygous susceptible for the *kdr* SNP (Fig 13D). The remainder of the mosquitoes that were tested contained at least one *kdr* allele that is associated with pyrethroid resistance (44%; Figure 13D). The successfully trapping of mosquitoes on the MSLT, as well as the detection of the *kdr* allele in *Cx. pipiens* suggests that MSLT may be a useful alternative to CO_2 traps for evaluating pyrethroid resistance in mosquitoes that reside in catch basins.

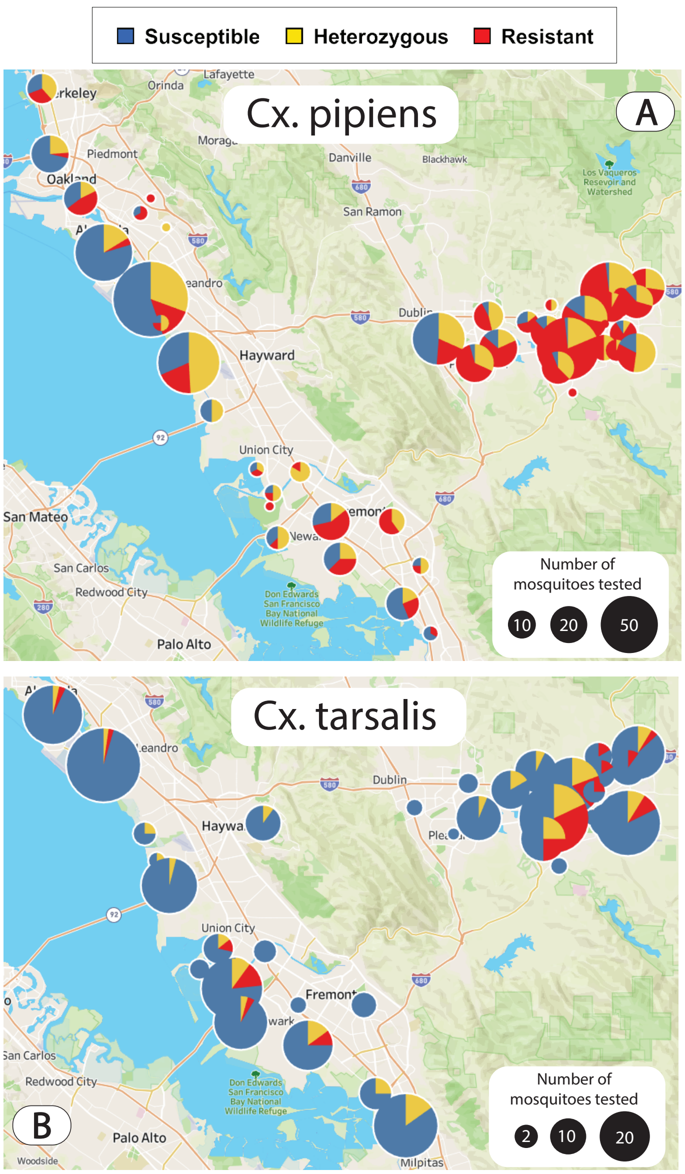


FIGURE 12: Geographic distribution of the *kdr* allele in *Cx. pipiens* (A) and *Cx. tarsalis* (B) in Alameda County. Pie chart sizes are proportional to the number of mosquitoes tested from each trap site.

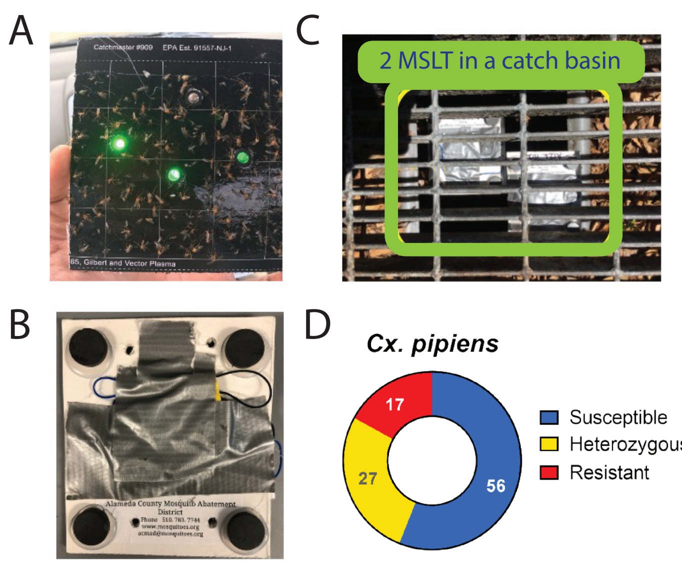
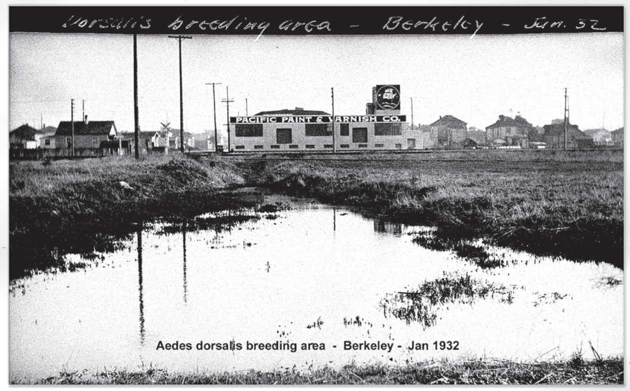


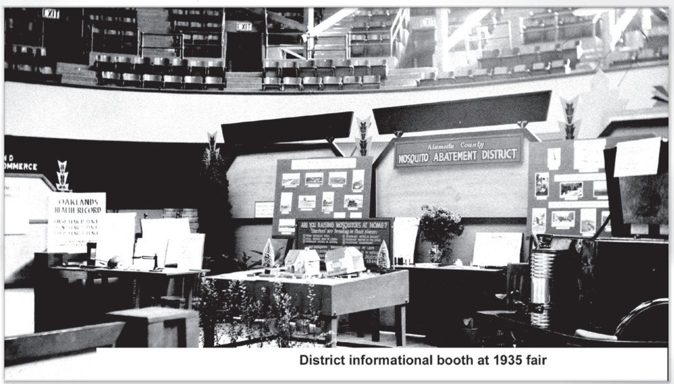
FIGURE 13: Preparing and evaluating the magnetic sticky light trap (MSLT). (A) Front sticky side of MSLT with lit LED lights and captured mosquitoes. (B) Rear side of MSLT that attaches to ferromagnetic surfaces. (C) Two MSLT shown in green box attached to the metal grate that covers a catch basin. (D) Proportion of *Cx. pipiens* with the *kdr* allele that is associated with susceptibility or resistance to pyrethroid insecticides.

ACMAD in the 1930's

Early hand ditching at Coyote Hills - 1931



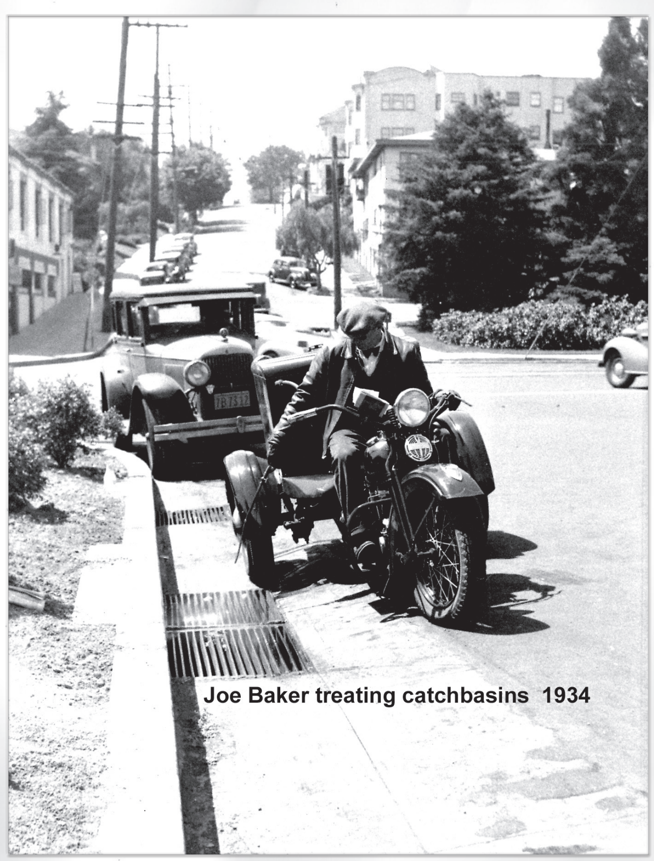
Aedes dorsalis breeding area - Berkeley - Jan 1932



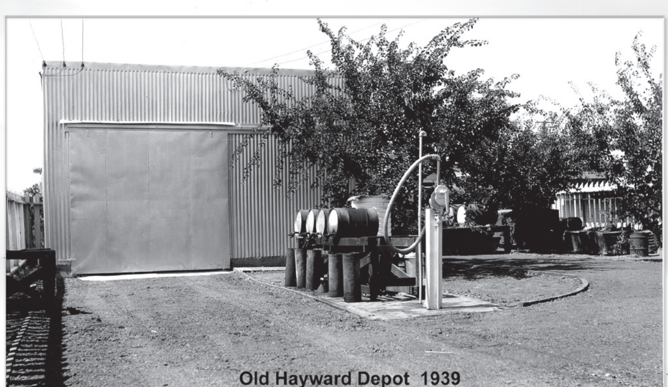
District informational booth at 1935 fair

Oakland Depot on 7th St 1939

1936 Oakland Troop 96 Backyard Cleanup



Joe Baker treating catchbasins 1934



Old Hayward Depot 1939

PUBLIC OUTREACH

Public outreach is a key component to an effective mosquito abatement program. Decreasing mosquito breeding sites can be nearly impossible without the community doing their part to eliminate standing water on their property. Outreach and educational presentations to community groups, school children, organizations, agencies, and the media have been a part of District activities since its formation 90 years ago. Over time, the District has built upon these methods by adding paid advertisements and social media.

In 2018 and 2019, efforts were made to compare the effectiveness of our public outreach methods. Website and social media analytics (Figure 17), staff surveys, customer surveys (Figure 18), and booth engagement data (Figure 14) were the primary means of measurement. The goal over the two years was to ensure our event attendance within the County covered almost every city (Figure 15). Events with the highest engagement, or that provide outreach to a new audience, will be prioritized in the future.

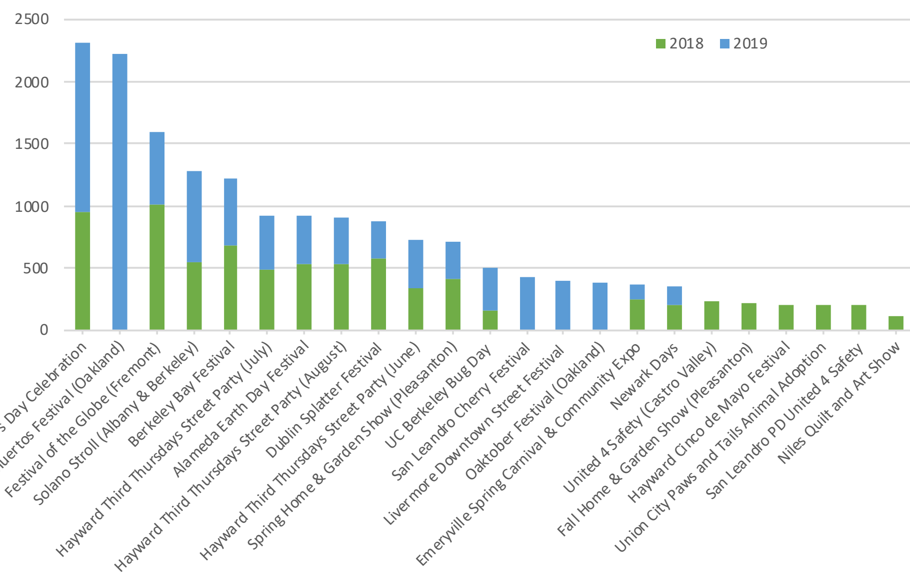


FIGURE 14: Booth visitors at public education events.

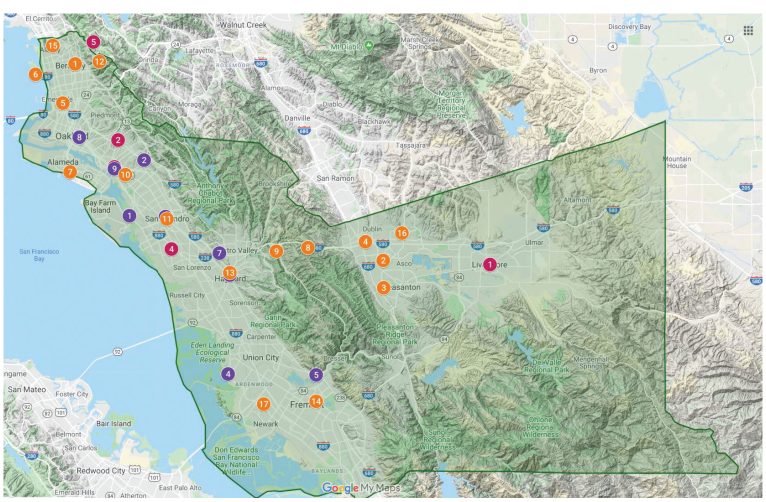


FIGURE 15: Geographic distribution of public education events during 2018 and 2019.

2019 Only Events

1. Livermore Downtown Street Fest
2. Oaktober Fest
3. Dia de los Muertos
4. Corvallis Elementary School Community ..
5. CSDA Climate Adaptation Roundtable

2018 Only Events

1. National Living Shorelines Conf.
2. Mills College
3. Cinco de Mayo Festival
4. Union City Paws and Tails Animal Adoption
5. Quilt and Art Show
6. San Leandro PD United 4 Safety
7. Urban Shield Preparedness Fair
8. Alameda County Watershed Confluence
9. Ascend Fall Festival

2018 & 2019 Events

1. CEND Tech Show & Tell
2. Hart Middle School STEAM Night
3. Home & Garden Shows
4. Dublin St. Patrick's Day Celebration
5. Spring Carnival & Community Expo
6. Berkeley Bay Festival
7. Alameda Earth Day Festival
8. Eden Area Ag Day
9. Palomares Elementary Science Festival
10. Share the Love Festival
11. San Leandro Cherry Festival
12. UCB Botanical Garden Bug Days
13. Hayward Third Thursdays Street Party
14. Festival of the Globe
15. Solano Ave. Stroll
16. Dublin Splatter Festival
17. Newark Days

On the digital front, the District launched an updated website in January of 2018 (Figure 16). Our new site still provides an abundance of mosquito information while highlighting our services and transparency. We also added to our social media presence by joining Nextdoor. This forum allows us to reach out to individual communities as well as the County as a whole. Engagement through Nextdoor has yielded high community response and rapid sharing of information.

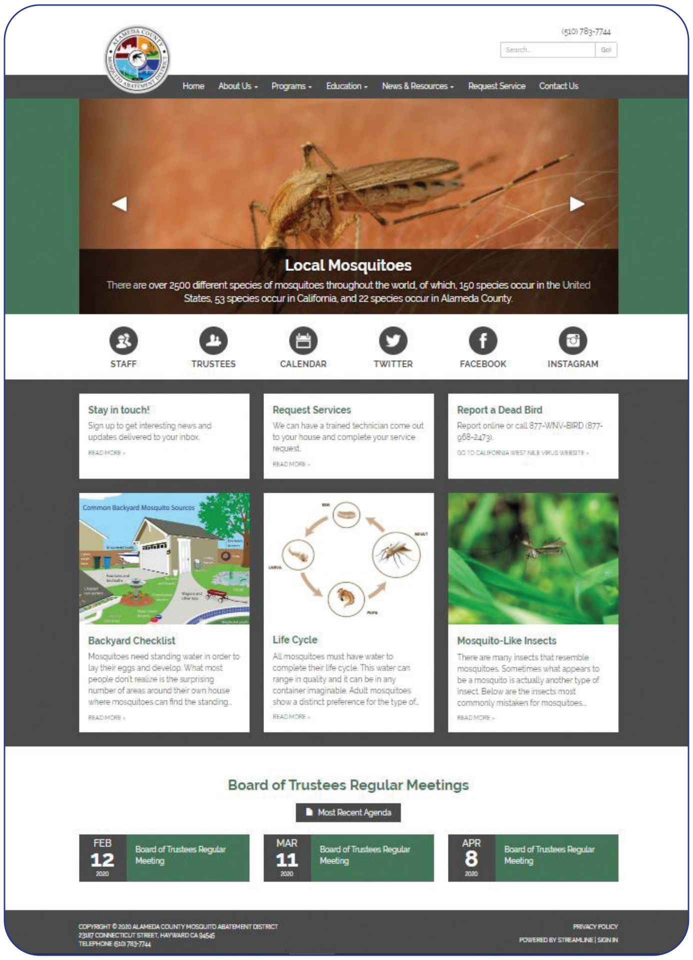


FIGURE 16: Updated website homepage.

Another addition to our education and outreach program over the last two years has been the participation in conferences through poster presentations and booth sponsorships. Staffing a booth or presenting posters at events attended by agencies that have overlapping interests allow us to make new connections and provide a mosquito-related public health perspective to potentially new audiences. Reaching out to organizations, researchers, and agencies involved in disease or water related issues was the focus of 2018 and 2019. In the future we hope to expand this form of outreach.

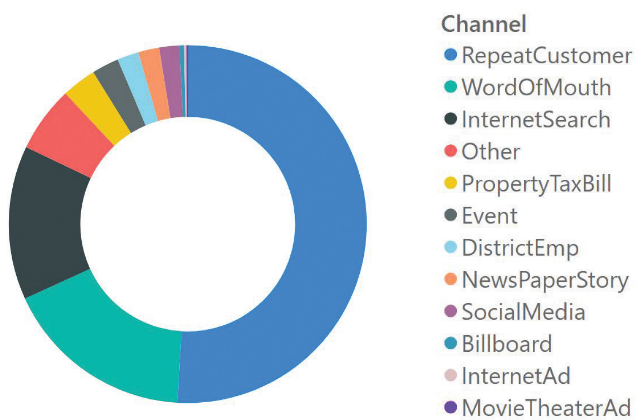


FIGURE 18: How did you hear about us? Survey data from residents who have requested service.

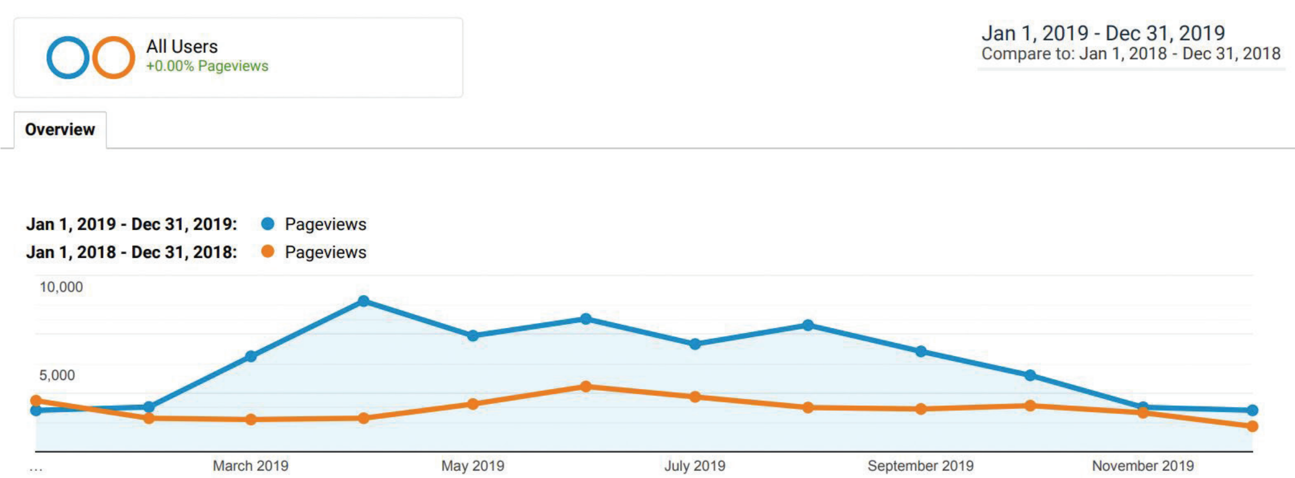


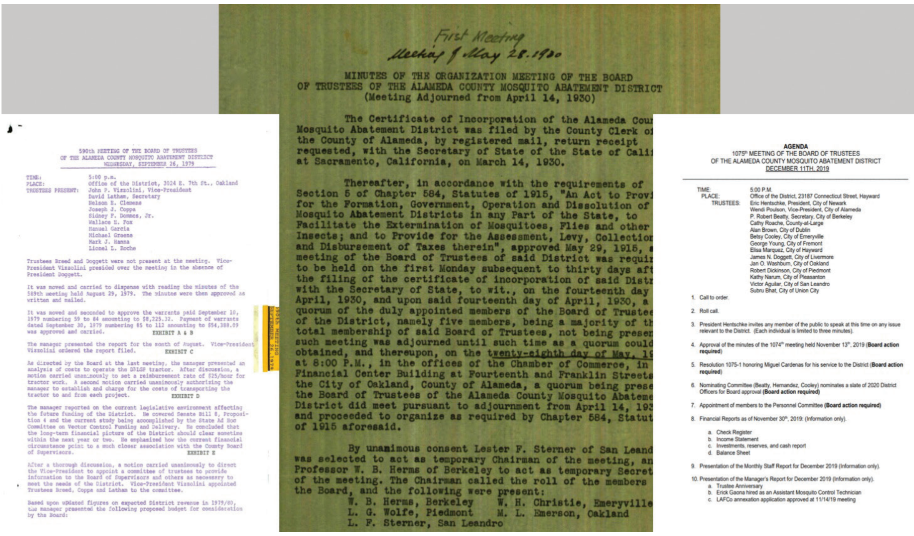
FIGURE 17: Google analytics. Pageviews on www.mosquitoes.org for 2018 (orange) and 2019 (blue).

INFORMATION TECHNOLOGY UPDATE

At the 590th ACMAD Board meeting On September 26th, 1979, the District manager Fred C. Roberts, asked the Board to invest in what he considered was the future. He asked the Board for approval to buy a microcomputer and justified the expenditure by proving the purchase would save the District $706 per year in improved efficiency. In May of 1980, the District received its first computer. Over the next few years, Pat Turney, Fred Roberts and Tom McMahon would build a groundbreaking program called EcoSim. This was the first program of its kind, combining a database, predictive analysis, and reporting in one system. Even in today's standards, EcoSim is considered visionary in the world of information technology (IT).

The District experienced many changes in 2018-2019, including a full remodel of the District headquarters. During this time, we upgraded network infrastructure and the ability to share information throughout the District offices. By moving all IT equipment and compute power to the cloud, the server room in now used for office equipment and supplies, except for one network rack. We added touchscreen monitors in the boardroom, laboratory, and entry area (Figure 19). All monitors are now connected and can share data.

FIGURE 19: New touchscreen monitors. (A) Newly installed touchscreen monitor in the remodeled boardroom. (B) Installation of the new touchscreen monitor in the boardroom. (C) New touchscreen monitor at the front entry.


First Meeting
Meeting of May 28.1930

MINUTES OF THE ORGANIZATION MEETING OF THE BOARD OF TRUSTEES OF THE ALAMEDA COUNTY MOSQUITO ABATEMENT DISTRICT (Meeting Adjourned from April 14, 1930)

The Certificate of Incorporation of the Alameda Cou Mosquito Abatement District was filed by the County Clerk o the County of Alameda, by registered mail, return receipt requested, with the Secretary of State of the State of Cali at Sacramento, California, on March 14, 1930.

Thereafter, in accordance with the requirements of Section 5 of Chapter 584, Statutes of 1915, "An Act to Prov for the Formation, Government, Operation and Dissolution of Mosquito Abatement Districts in any Part of the State, to Facilitate the Extermination of Mosquitoes, Flies and other Insects; and to Provide for the Assessment, Levy, Collectio and Disbursement of Taxes therein", approved May 29, 1915, meeting of the Board of Trustees of said District was requi to be held on the first Monday subsequent to thirty days aft the filing of the certificate of incorporation of said Distr with the Secretary of State, to wit., on the fourteenth day April, 1930, and upon said fourteenth day of April, 1930, a quorum of the duly appointed members of the Board of Truste of the District, namely five members, being a majority of th total membership of said Board of Trustees, not being prese such meeting was adjourned until such time as a quorum could obtained, and thereupon, on the twenty-eighth day of May, 1 at 8:00 P.M., in the offices of the Chamber of Commerce, in Financial Center Building at Fourteenth and Franklin Street the City of Oakland, County of Alameda, a quorum being prese the Board of Trustees of the Alameda County Mosquito Abatem District did meet pursuant to adjournment from April 14, 19 and proceeded to organize as required by Chapter 584, Statu of 1915 aforesaid.

By unamimous consent Lester F. Sterner of San Lean was selected to act as temporary Chairman of the meeting, a Professor W. B. Herms of Berkeley to act as temporary Secre of the meeting. The Chairman called the roll of the members the Board, and the following were present:

W. B. Herms, Berkeley W. H. Christie, Emeryville
L. G. Wolfe, Piedmont M. L. Emerson, Oakland
L. F. Sterner, San Leandro

FIGURE 20: Original board documents that are now digitized and searchable.

All board reports and board packets dating back to 1930 were scanned and stored in SharePoint (Figure 20). During the scanning process, we had the opportunity to add optical character recognition (OCR). OCR scans documents into a software which then reads and records the words on the printed page; the information is then saved with the original scanned image. Along with SharePoint, OCR gives us the ability to search through documents easily and if needed convert them into Word documents.

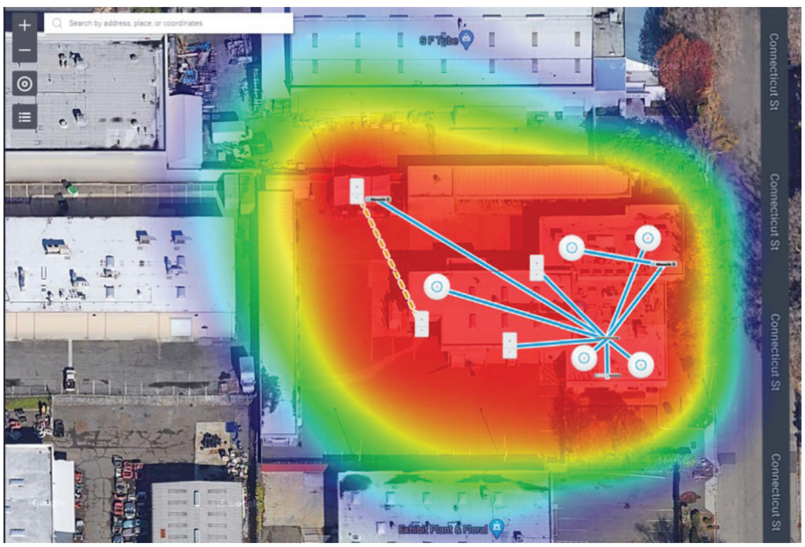


FIGURE 21: Coverage map of the District's 5GHz network.

The District wireless footprint has been expanded and upgraded to offer 5 GHz coverage anywhere on District property. A site survey determined the placement of outdoor access points, and where we needed to add additional indoor access points (Figure 21).

The District also transitioned to automated offsite backup and Cisco endpoint security (Figure 22). Having a very current backup of everything located off-site with effective security can help make defeating ransomware and other disasters easy. With the combination of security software and regular

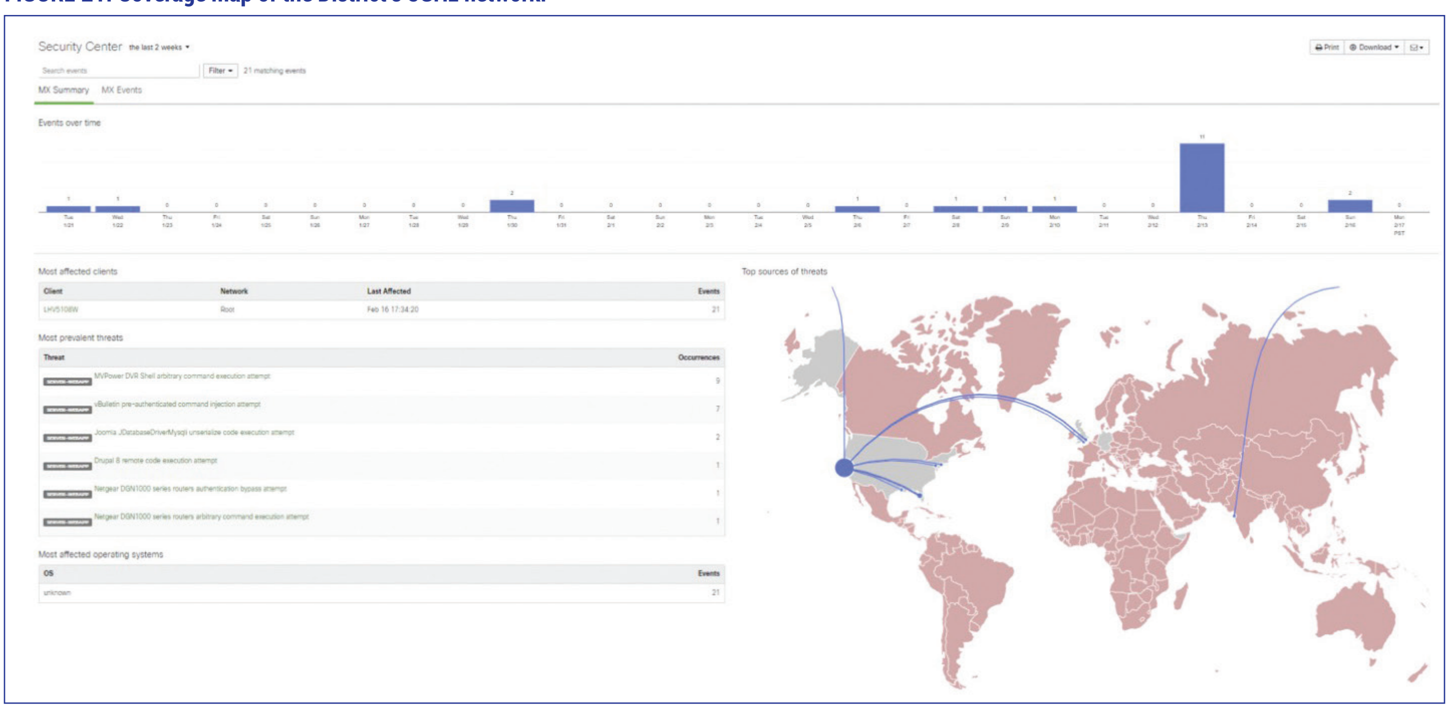


FIGURE 22: Cisco Firewall identifies threats to the District in real time and blocks malicious activities which include crypto lockers and forced entry attacks.

backups, we can spot threats as they occur, expel them from our network, and then revert our network back to its most recent, most secure state.

POOL PROJECT

2018 marked the beginning of the multi-project integration of the District's unmaintained swimming pool project into our database. Stage 1 of the project allowed us to move data and images from a camera carried by an airplane into MapVision, the District database, and quickly out to Operations. Operations staff is then able to process the unmaintained swimming pool graphically on their tablet in order to address the problem quickly. The picture from the flyover is also available to the homeowner to verify the presence of a swimming pool on the property.

In 2019 the District changed the entire pool process into a notice program. The flyover data and pictures were loaded into the database, and artificial intelligence (AI) was used to determine the presence of a swimming pool and if it was unmaintained or not. If the pool was unmaintained, the system then automatically produced the first notice to start the violation process. The District sent 1st, 2nd, and 3rd violation notices to the homeowner (Figure 23). The notices sent included a picture of the offending pool and ways to remediate the violation.

We also built an interface within our database so the homeowner could send a SMS (short message service) text message from their phone with a picture of the remediated pool. The SMS menu in the database would display the incoming message, then associate actions with the violations. The District now has the ability to process violations in one menu from the initial discovery to resolution.

Forty years ago, Fred Roberts saw the future and began the journey into electronic computing. In the next few years we intend to keep his vision alive by implementing new technology that enables us to predict and control mosquitoes more effectively. AI will continue to improve, and we will harness this technology in all facets of District operations. Cloud computing will ensure our data is always safe and protected.

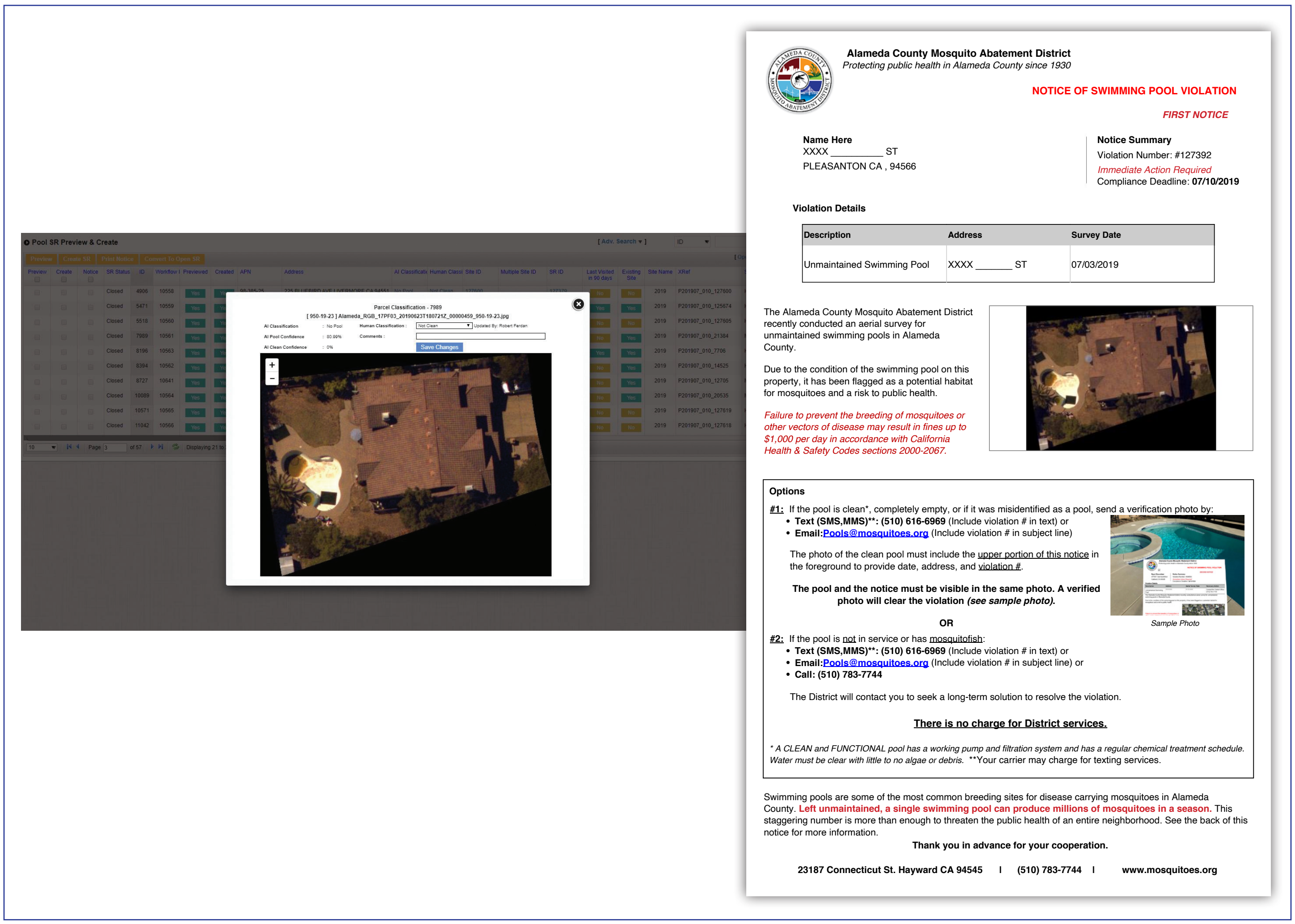
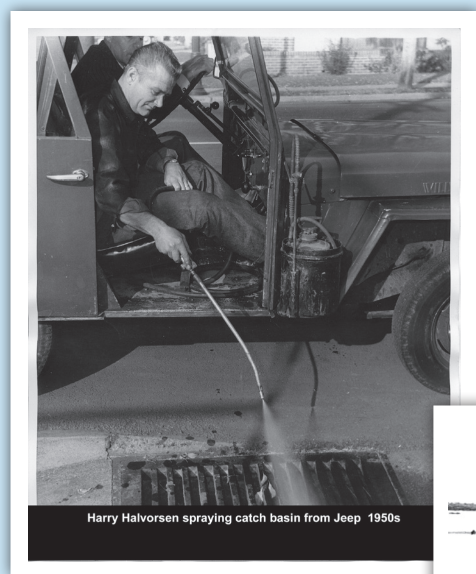
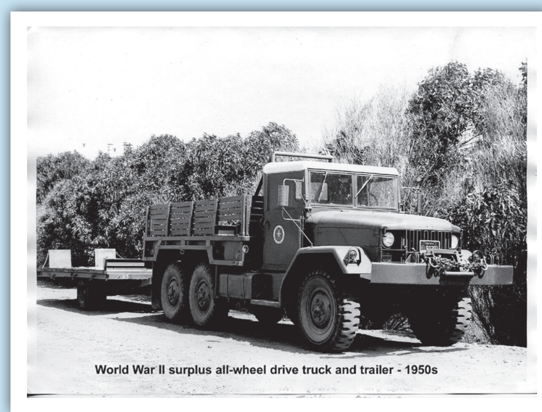


FIGURE 23: Unmaintained swimming pool images are automatically loaded into the District database (left) and then imported into a violation notice (right) that is sent to the registered homeowner with instructions how to clear the violation.

ACMAD in the 1950's

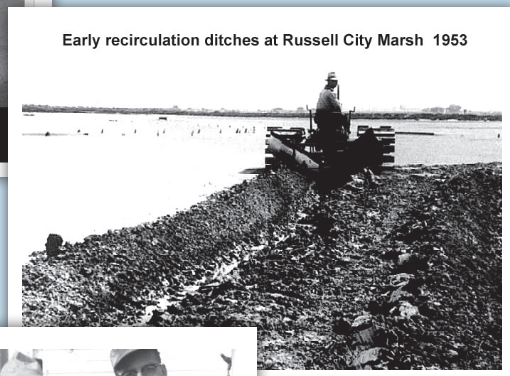


Harry Halvorsen spraying catch basin from Jeep 1950s



World War II surplus all-wheel drive truck and trailer - 1950s

Harry Halvorsen treating treeholes in Alameda - 1953



Early recirculation ditches at Russell City Marsh 1953

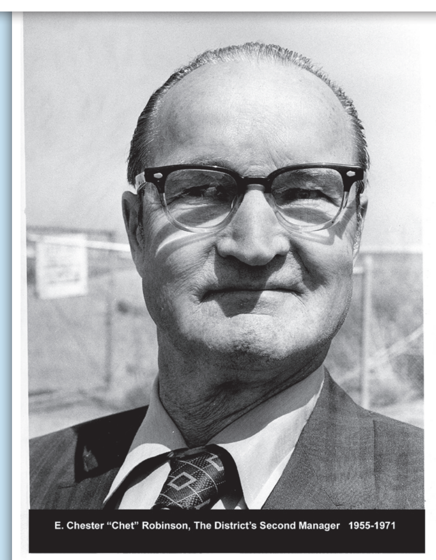
Decoto crew - 1954

Paul Garcia, Mel Mello, George Corea, Jack Rowlett, Ron Bendel, Woody Paxton

ACMAD Project - 1956 E. CHESTER Robinson 1956

Photo: Thomas Mulhern

Tom Branan, Bob Casterson Div 4 Pleasanton



E. Chester "Chet" Robinson, The District's Second Manager 1955-1971

FACILITY AND EQUIPMENT

PERIMETER FENCING

Privacy and security upgrades began early in 2018 with the replacement and repair of the District's perimeter fencing and security wire (Figure 24). The supports were straightened or replaced where needed and the original wood slatted chain link replaced with a 20-year redwood PVC chain link fabric.

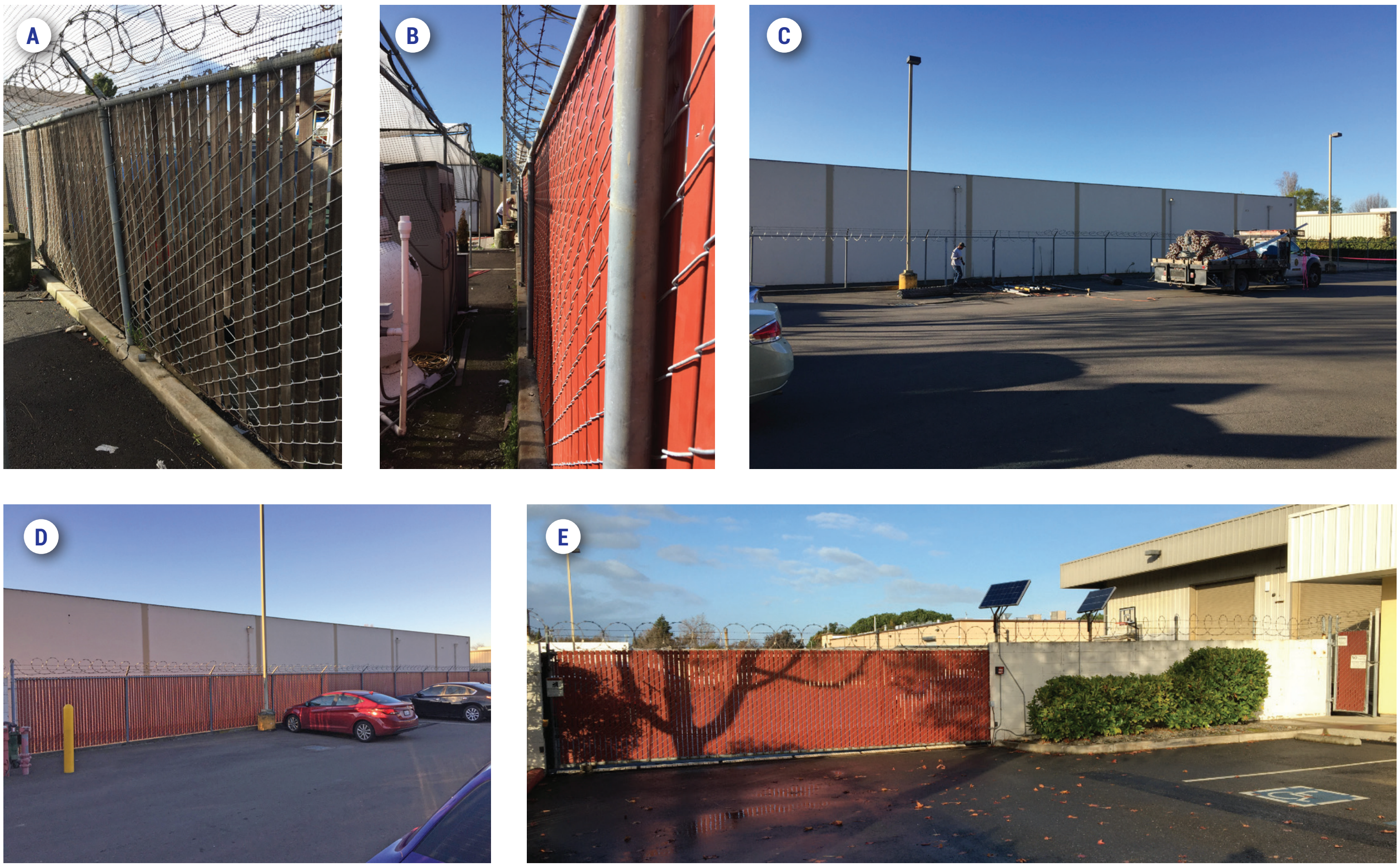


FIGURE 24: Perimeter fence replacement. (A) North side fence before replacement (B) North side fence after replacement. (C) South side fence during replacement. (D) South side fence after replacement. (E) Entry gate after replacement.

ROOF AND SOLAR PROJECT

In late 2018, as weather permitted, the District replaced the roof on the laboratory and the main office building (Figure 25), matching the shop roof that was resurfaced in 2015. Approximately 8,550 sq/ft of 60 mil thermoplastic polyolefin (TPO) membrane and decking material was used (Figure 25B), as well as upgrading 14 skylights (Figure 25C) and the removal of one. In the summer of 2019, 120 solar panels were installed on the two canopy equipment parking rooftops to the north and west of the District facility (Figure 25D, 25E), with a production rate of nearly 50 kW and 77,000 kWh annually, roughly 90% of our yearly use.

FIGURE 25: Roof replacement and solar panel addition. (A) Construction during the roof replacement. (B) Completed roof surface. (C) Newly installed skylights. (D) New solar panels on north parking rooftops. (E) New solar panels on west parking rooftops.

EQUIPMENT

The District proudly follows a vigorous larvicidal program that has been a key factor in our success. Nothing beats getting dirty doing a hand treatment, but sometimes the right tool makes life a little easier. Through the years, equipment and various application techniques have changed (or have been eliminated) with the development of new technologies, whereas some have not changed that much. The District now has two new pieces of application equipment that can be shared with neighboring districts.

Blowers (Figure 26) have always been a helpful tool for large area treatments where direct applications cannot be performed. Today the District utilizes a large cage larvicidal blower on a pivoting base with proper chemical injection, all controlled with a handheld fob (Figure 26C, 26D). This applicator is being used widely in other districts to prevent the growth and distribution of invasive mosquitoes as well.

Long gone are the District's days of thermal fogging (Figure 26B) to control adult mosquitoes, and especially the practice of riding along in the truck bed with such equipment. Properly calibrated, controlled, and monitored ultra-low volume (ULV) foggers (Figure 26C) have taken their place. With the ability to be operated from within the cab of the vehicle by laptop (Figure 26D), the London Fogger ULV Aerosol Generator is an equally important asset that has been added to the District's toolbelt.

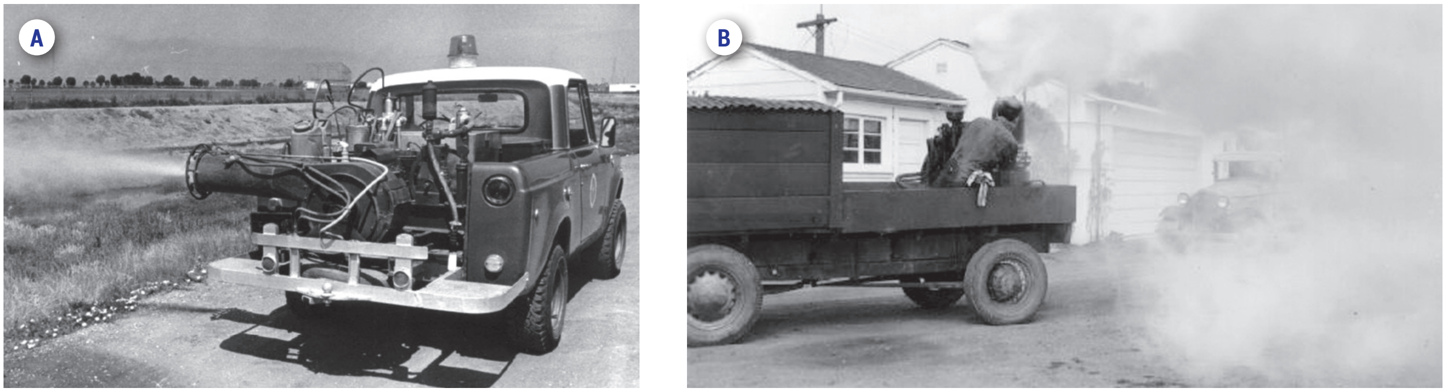


FIGURE 26: Historical and present mosquito control treatment equipment. (A) Larvicidal blower used by the District in the mid-1900s. (B) Thermal fogger used by the District in the mid-1900s. (C) New A1 Super Duty larvicide sprayer (left) and London Foggers ULV Aerosol Generator (right). (D) Laptop and software program used to control ULV fogger (back) and key fob used to control the A1 Super Duty larvicide sprayer (front).

Equipment upgrades went beyond equipment used to treat mosquitoes. The District replaced several trucks in last few years. Included are improved safety features, fuel economy, cargo space, and driver ergonomics. Truck bed covers (Figure 27A) add to the security and safety of both the driver and the public. Security and safety did not stop with the vehicles, even mosquito traps need to be protected from weather, wildlife, and theft. Custom protective cages that double as a cart and charging station (Figure 27B) accomplished this goal.

FIGURE 27: Equipment security upgrades. (A) New District vehicles with truck bed covers. (B) Mosquito trap cages with solar power.

INTERIOR REMODEL

What began as a discussion to modify the boardroom so the District could host trainings and interagency meetings, developed into a complete interior makeover for the facility. Flooring throughout the facility was upgraded (Figure 28). Vinyl flooring was removed, and the original concrete flooring was polished and stained to give the District a clean, new perspective (Figure 28A, 28B, 28C). The laboratory flooring was stripped, treated, and coated with a rubberized, chemical resistant sealant (Figure 28D, 28E, 28F). New carpeting was also installed in offices and meeting rooms (Figure 28G). The kitchen/breakroom was renovated for a more modern, industrial look (Figure 29). All renovations throughout the facility were done to code with ADA compliance. A filtered ice machine (Figure 30B) and water dispenser (Figure 30C) were also installed in the northwest corner of the shop, surrounded by stainless steel and ergo-safety floor mats (Figure 30). Locker rooms were not forgotten. Both restroom/locker rooms were steam cleaned and detailed after replacing the original metal partitions with new, colored composite material (Figure 31).

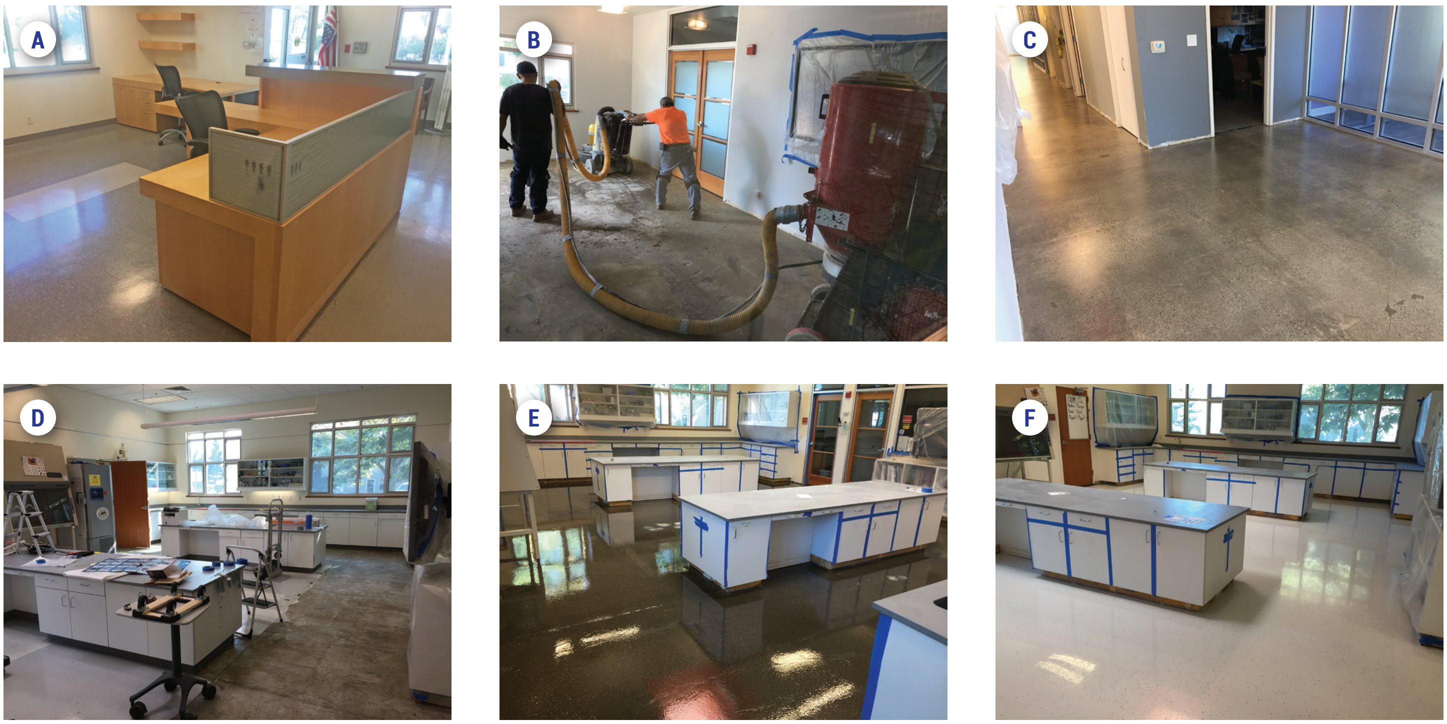


FIGURE 28: Updated flooring. (A) Reception area prior to flooring update with vinyl floors still intact. (B) Reception area during the flooring update. (C) Reception area after the flooring update with new polished concrete finish. (D) Laboratory during the vinyl removal process. (E) Laboratory during the new flooring process. (F) Laboratory with new chemical resistant flooring. (G) New carpet tile installation in meeting rooms and offices.

FIGURE 29: Kitchen/breakroom remodel. (A) Kitchen prior to remodel. (B) Kitchen during remodel. (C) Kitchen after remodel.

FIGURE 30: Shop improvements: (A) New ice and water filling station with stainless steel walls and ergo safety flooring. (B) New filtered ice machine. (C) New filtered water bottle filler.

FIGURE 31: New bathroom partitions

Making the best out of the space we have was a constant, as we incorporated new administration and support staff offices into the existing footprint (Figure 32). The clever reuse of some cabinetry and the removal and relocation of an office supply room increased the internal square footage of our original boardroom, turning it into our new board/conference room, complete with new LED lighting, 75 inch-networked-touchscreen-smart board, modular tables and chairs, and an assisted listening device. We can now comfortably entertain monthly Board meetings, training seminars, and meetings amongst colleagues and mutual agencies in this newly renovated space. Motivation, cooperation, and most of all patience, all played major roles in this project.

FIGURE 32: New office spaces. (A) The reception area was partitioned to create a office space for the accounting associate. (B) The former work area for the Environmental Specialist was remodeled to create a shared office workspace.

FIGURE 33: Boardroom remodel. (A) The boardroom prior to the remodel. (B) The boardroom after the removal of the partitioning cabinetry, dividing wall, and small corner supply room. (C) The remodeled boardroom is now a meeting space with modular furniture that can change configurations.

FINANCIAL REPORT

FOR FISCAL YEARS ENDING JUNE 30, 2018 AND JUNE 30, 2019

	2019	2018
REVENUES :		
Property taxes	$ 2,325,861	$ 2,054,129
Redevelopment distribution	$ 250,284	$ 236,382
Special Assessments	$ 1,939,212	$ 2,026,453
Homeowners Property Tax Relief, State Subvention	$ 16,138	$ 16,220
Interest	$ 167,488	$ 25,505
Miscellaneous	$ 223,566	$ 264,661
TOTAL REVENUES	**$ 4,922,549**	**$ 4,623,350**
EXPENDITURES :		
Salaries and fringe benefits	$ 2,683,156	$ 2,480,037
Materials, supplies and services	$ 886,491	$ 999,776
Transfer to OPEB trust	$ 0	$ 0
Capital outlay	$ 418,175	$ 499,979
TOTAL EXPENDITURES	**$ 3,987,822**	**$ 3,979,792**
NET CHANGE IN FUND BALANCES	$ 934,727	$ 643,558
FUND BALANCES, BEGINNING OF PERIOD	$ 7,057,069	$ 6,413,511
FUND BALANCES, END OF PERIOD	**$ 7,991,796**	**$ 7,057,069**

ALAMEDA COUNTY MOSQUITO ABATEMENT DISTRICT COMBINED BALANCE SHEET FOR THE YEARS ENDING JUNE 30, 2018 AND JUNE 30, 2019

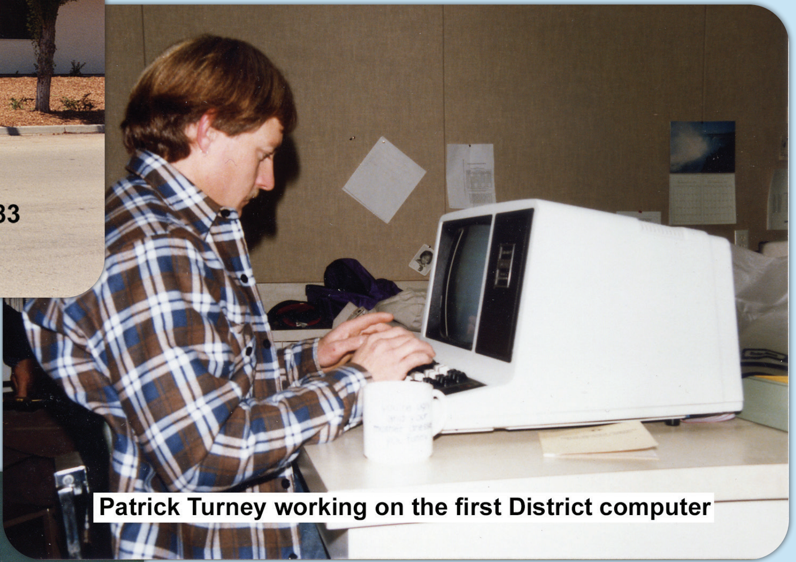
		JUNE 30, 2019		JUNE 30, 2018
ASSETS				
Current and Investments	$	8,157,216	$	7,138,612
Capital Assets (Net)				
Non-depreciable assets	$	391,333	$	61,406
Depreciable assets, net	$	2,461,588	$	2,687,400
Net OPEB asset	$	690,338	$	716,666
TOTAL ASSETS	**$**	**11,700,475**	**$**	**10,604,084**
		============		============
Deferred Outflow	$	1,208,279	$	818,392
LIABILITIES				
Account Payable	$	165,420	$	81,543
Compensated Absences	$	187,668	$	167,855
Net Pension Liability	$	2,952,714	$	2,642,666
TOTAL LIABILITIES	**$**	**3,305,802**	**$**	**2,892,064**
		============		============
NET ASSETS				
Invested in Capital Assets	$	2,852,921	$	2,748,806
Unrestricted	$	6,507,741	$	4,929,985
TOTAL NET ASSETS	**$**	**9,360,662**	**$**	**7,678,791**
		============		============

Harry "Chip" Shackleton and Kidd ATV 1978

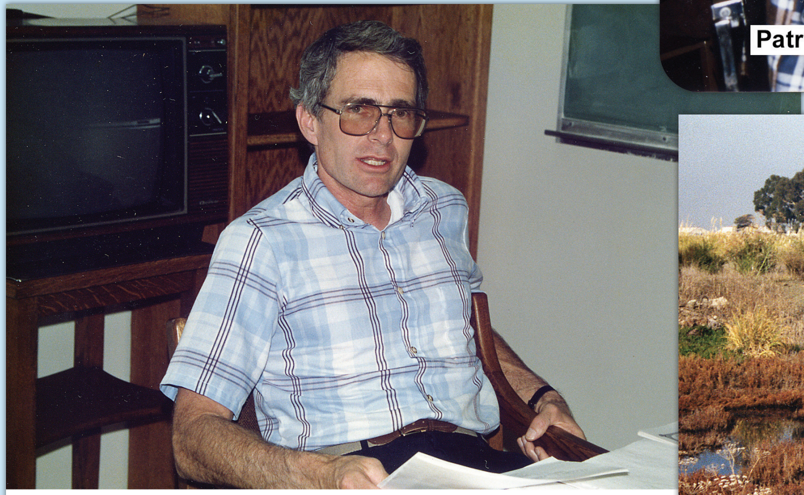
Jerry Brown clearing vegetation for source reduction work 1978

Newly opened Hayward office - 1983

ACMAD in the



Patrick Turney working on the first District computer



Fred C. Roberts, the District's third Manager 1971-1994

Jim Romeo drives the DMC "Snowcat" while Joseph Huston sprays Oakland Airport Tank Farm 1992

Everett King dipping for mosquito larvae in Springtown (Livermore) ~ 1995

1970's 80's and 90's

Everett King, Pat Turney, Lucia Hui (CDHS) and William Hamersky taking chicken blood samples ~ 1997

John Rusmisel staffing District public education booth

Helicopter treatment using granular Bti ~ 1997

Tom McMahon, Jim Romeo, Pat Turney and Joline Davison ditching at Trojan Marsh ~ 1997

ALAMEDA COUNTY
MOSQUITO ABATEMENT DISTRICT

An Independent Special District Protecting Public Health Since 1930

The Alameda County Mosquito Abatement District (ACMAD) has provided control of mosquitoes for the residents of Alameda County since 1930. ACMAD is an independent special district governed by a Board of Trustees comprised of one representative from each city in our service area and the County-at-large. Funding is provided by a combination of property tax, a special tax authorized by more than two thirds of the voters in 1982, and a benefit assessment approved in 2008.

ACMAD works closely with other public agencies and park districts to provide ecologically sound mosquito control programs. The District also works with planning agencies to minimize mosquito production in wetland restoration and enhancement projects.

510-783-7744

www.mosquitoes.org

Alameda County Mosquito Abatement District

@AlamedaMosquito

www.mosquitoes.org