

2019 ANNUAL REPORT



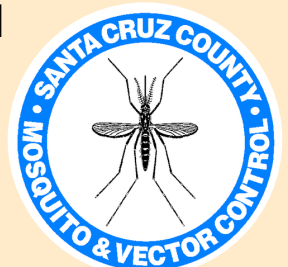
SANTA CRUZ COUNTY
AGRICULTURAL COMMISSIONER
MOSQUITO AND VECTOR CONTROL
CSA 53

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MESSAGE FROM THE MANAGER

2019: Service, Loss, and Resilience

In 2019 we began the year with great optimism and a prepared and enthusiastic staff. For twenty-five years we had served County residents by providing a professional level of public health pest control and advice, with data-driven best practices in mosquito and vector control. Our mission has always been to preserve public and environmental health while improving quality of life, and we have been constantly innovating and refining our techniques in order to efficiently achieve those goals.

The year was highlighted by the extra efforts of staff to develop more effective trap surveillance procedures and analysis tools, prepare invasive Aedes mosquito detection methods, improve our outreach information, provide more community talks, respond to increasing service requests, and to obtain a waste tire collection grant and collaborate with Public Works in a waste tire drive. In the field our mobile map-driven operations were highly successful. In the laboratory our system of disease surveillance for mosquitoes, birds and ticks was going well.

All of this seemed secondary in June when one of our veteran Vector Control Specialists became desperately ill and hospitalized with pneumonia. Our beloved Melanie Benedetti, a kindly young mother, devoted wife and public servant who had been in robust health, passed a month later. Our shocked response was to reach out to try to provide support to her aggrieved family and provide each other with counseling, caring and comradery and make some sense of the tragedy. Mel is irreplaceable and will be deeply missed. She was very well liked here and in the Santa Cruz community where she worked, and so deserving of a long, happy life. It is for her that this report is dedicated.

To say that work carried on as usual would be untrue. We soon realized, however, that we owed it to her memory to apply ourselves to serving her zone with the same dedication and passion as Mel always had, and to stay ahead of the mosquito breeding. Staff showed exceptional courage, resilience, and responsibility in dividing up the extra workload, and although shocked and numb for weeks, fulfilling our public trust.

We are grateful for a supportive and cooperative community that appreciates our hard work and recognizes their own role in reducing mosquito breeding, also the assistance of the State, other County departments and the Board of Supervisors, the universities and the MVCAC. Please enjoy this record of our achievements and provide your feedback so that we can further improve our public health services. We strive to serve and be efficient and transparent.

Respectfully,

Paul Binding



Staff 2019:

Juan Hidalgo
Director / Agricultural
Commissioner

Paul Binding
Assistant Vector Control
Manager

Rafaela Hoessel
Senior Account Clerk

Ray Travers
Vector Control Specialist

Nader Sidhom
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Melanie Benedetti
Vector Control Specialist

Steve Driscoll
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Vector Control Specialist

Amanda Poulsen
Vector Ecologist

Gabriel Alvarado
Seasonal Aide

Martina Axner
Seasonal Aide

Mark Dingler
Seasonal Aide



MELANIE ANANDA BENEDETTI

On July 26, 2019, we lost a dear friend and colleague. Melanie Benedetti was taken by cancer within a month of her feeling ill in June. A model for healthy living and cheerful attitude, Melanie, 44, left a six year old son and her devoted husband, John.

After graduating from UC Santa Barbara, Mel started her career with the County in 1998, working in the commodity inspection and pest detection programs in the Agricultural Commissioner's Office. In 2006, she was promoted to our Mosquito and Vector Control Division (MVC) as Vector Control Specialist, applying her communication skills and knowledge of science to the effort of protecting County residents from vectors capable of transmitting disease.

Mel was a terrific worker who put her heart and soul into providing service to the zone that included the City of Santa Cruz. She contributed significantly to the success of MVC over the years, working in mosquito abatement, yellowjacket control, tick monitoring, rodent inspections, public education and outreach. Melanie loved living and working in Santa Cruz County, and her dedication and cheerfulness endeared her to her co-workers and the public alike. We still grieve as we have applied ourselves to serving her zone with the same dedication and devotion as she would. Her commitment to our department and to the County will always be appreciated, and she is greatly missed by all who knew her.

MISSION

Santa Cruz County Mosquito Abatement / Vector Control (MVC) is committed to protecting the public from pests capable of transmitting disease or creating a nuisance. MVC's public services include:

- Mosquito control and mosquito-borne disease surveillance
- Providing mosquito fish to residents with ponds, animal troughs, fountains, and unused pool
- Control of hazardous yellow jackets in public areas
- Surveying tick populations and monitoring tick-borne diseases
- Educational presentations about vector biology and control to public groups and schools
- Rodent Inspections to inform residents on areas and techniques to exclude rodents from their property
- Advice on other vectors including bees, wasps, ticks, rodents, bats, raccoons, flies, bed bugs, mites, head lice, fleas, and more
- Accountable, efficient service to residents and use of environmentally sustainable methods



HISTORY OF SERVICE

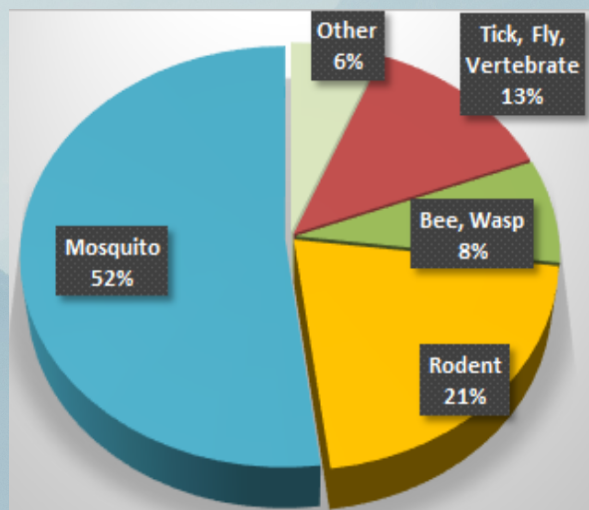
MVC was established in 1993 as a County Service Area program within the Agricultural Commissioner's Office in response to public interest in mosquito relief. In August 2005 residents voted to enhance our services to include other vectors and expand the service area from the south county to the entire county (446 square miles, population 275,100).

Figure 1. Number of Service Requests from 2010 to 2019



MVC recorded 632 requests for service in 2019, an increase of 13% over 2018, and 39% over the last 10 years (Figure 1). Slightly over half of the calls regarded mosquitoes, including requests for mosquitofish. The rest of the calls regarded other vectors, primarily rodents and ticks. The "Other" category in Figure 2 included mites, fleas, bedbugs, spiders, and unknown parasites.

Figure 1. Types of Service Requests received in 2019



Mosquitoes are actively controlled county wide, and wasps are controlled when they occur on public property and present a danger. Inspections and consultation are offered for rodent problems at homes and businesses. Consultation and education are provided for all other vectors to enable callers to resolve problems and protect themselves with a better understanding of vector biology, behavior and the diseases that vectors may spread.

MOSQUITO CONTROL

Decisions to control mosquitoes are based on the species and numbers of mosquitoes, their potential to spread disease and nuisance, proximity to human activity, and the presence of natural predators and protected wildlife species.

To control mosquitoes we first try to reduce their breeding sources whenever possible. We give water management advice to residents, consult on new development projects, and stock mosquito fish when appropriate. When breeding exceeds intervention thresholds, we apply low-toxicity mosquitocides to water sources to control the larval stages.

Targeting adult mosquitoes is a last resort for our program as control of larvae is more selective and efficient. Wide area "spraying" or fogging (the dispersal of products via micro-droplets into the air) is not part of our current program and would require approval by the County Board of Supervisors as part of the emergency disease response plan.

We also use barrier treatments applied to shrubbery on occasions when controlling mosquitoes in the larval stage is not feasible, as with adult treehole-breeding mosquitoes. The product is a garlic oil-based sugar bait.

In addition to ground-based larvicide applications, two helicopter-based applications were made to South County sloughs and lakes to reduce mosquito larvae using granular bacterial larvicides. The EPA-approved larvicides have low toxicity to non-target organisms at the concentrations applied.



Photo: Santa Cruz County MVC



Photo: Santa Cruz County MVC

Table 1. Mosquito source treatments from 2015 to 2019

Year	Larvicide Applications*	Locations Stocked With Mosquitofish	Acres Treated by Helicopter
2019	5345	114	82
2018	2901	117	102
2017	3552	121	21
2016	4140	176	95
2015	2896	118	180

*Includes mosquito sources treated with various larvicides simultaneously, counted as additional applications.

Where Do Some of Our Mosquitoes Come From?



Have you ever tried to get water out of a tire? It is not easy to do. Various mosquito species take advantage of ideal breeding conditions created by tires.

Mosquitoes can come from natural sources of standing water like ponds, creeks and various wetlands; and they may also come from places you might not suspect. Artificial containers, unlike natural water bodies typically have no natural predators and are prone to stagnate with organic debris and create a nutrient rich, sheltered environment that can continually breed over 1,000 mosquito larvae per square foot, most of which survive and emerge as adult mosquitoes. Additionally, the invasive species *Aedes aegypti* and *Aedes albopictus* (both not yet in our county) are also "container breeders" and are capable of spreading human diseases. Thus, residential sources of standing water rank among the greatest challenges to mosquito control as they may harbor disease-vectoring mosquitoes in even the smallest pockets of water such as in drains, buckets, plant saucers and pots, fountains, tarps, etc.



The Treehole mosquito, *Aedes sierrensis* breeds in treeholes as well as various containers that collect water. Accessible treeholes near your home may be filled with sand or construction foam in order to eliminate standing water.



Septic Tanks often create the primary mosquito problem in many neighborhoods: *Culex pipiens*, the House mosquito, which readily enters homes, bites only at night, and can spread human diseases including West Nile virus. Mosquitoes usually access a septic tank through small gaps in unsealed lids.



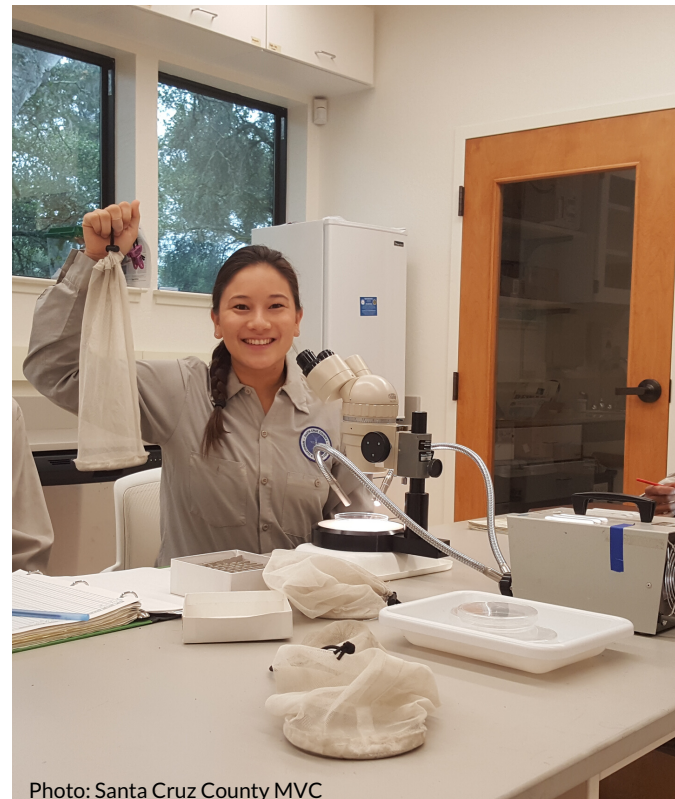
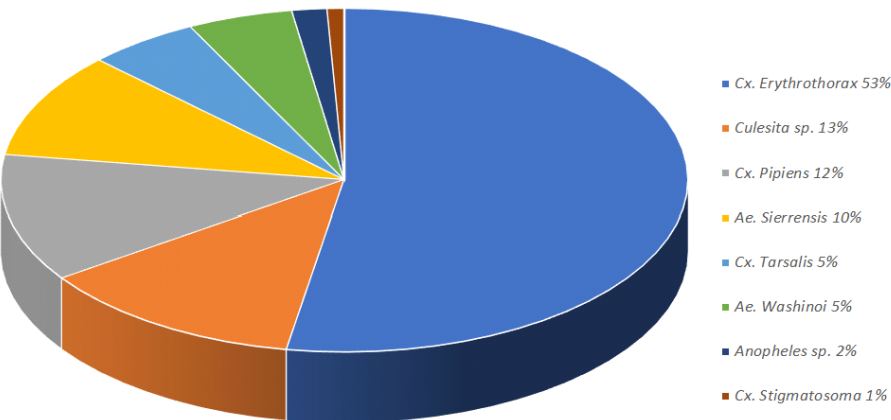
MOSQUITOES WE FOUND

Carbon dioxide (CO₂) baited traps were used to collect and monitor the adult mosquitoes capable of transmitting disease. A total of 850 CO₂- baited traps were deployed from April to December 2019, in which a total of 25,152 adult mosquitoes were captured.

Of the species in our county capable of transmitting viruses like West Nile, *Culex pipiens* made up 12% (n = 3,012) of all mosquitoes caught and *Culex tarsalis* made up 5% (n = 1,328). Both species are competent "bridge vectors" that can spread virus from birds to humans and other animals. *Culex erythrothorax*, the Tule mosquito, were the most numerous as they made up 53% (n=13,252) of the total numbers. Tule mosquitoes present a significant biting nuisance near their marsh sources, but do not fly far and are not considered competent vectors of West Nile virus to humans but do spread the virus between birds (Figure 3).

Each week, 40-50 traps were deployed throughout Santa Cruz county. Vector species (*Culex pipiens*, *Culex tarsalis*, and blood-fed *Culex erythrothorax*) were sent to the University of California, Davis for pathogen testing. These weekly trap counts are used to inform our staff so that they can focus their mosquito control activity.

Figure 2. Percentage of mosquito species caught in Santa Cruz County in 2019. The majority of the catch was *Cx. erythrothorax* (53%), which can transmit West Nile virus to birds but not humans.



LOCAL VECTORS & VECTOR-BORNE DISEASES IN SANTA CRUZ COUNTY

MOSQUITOES AND WEST NILE VIRUS

Santa Cruz County had no reported human cases of West Nile virus (WNV) in 2019. WNV activity is typically lower in coastal areas, due to lower average temperatures which are less conducive to the amplification of WNV than the warmer temperatures found inland. Two hundred and thirty-three samples of mosquitoes were submitted to the State laboratory and no samples tested positive for WNV or any other mosquito virus. Three hundred blood samples from 'sentinel' chicken flocks hosted by Watsonville and San Lorenzo Valley high schools tested negative for WNV. Two out of 44 dead wild birds tested positive for WNV. All of the dead birds collected were found via calls from the public. Surveillance is increased in areas where we find WNV activity.

Table 2. West Nile virus activity in California from 2017 to 2019.

State-wide Statistics	2017	2018	2019
Human Cases	536	218	243
Human Fatalities	41	11	6
Dead Birds	510	501	226
Mosquito Samples	3,371	1,963	3288
Sentinel Chickens	305	163	139

For a map of West Nile and other mosquito-borne disease activity in California please visit: <https://maps.calsurv.org/arbo>

Why do we look for West Nile virus?

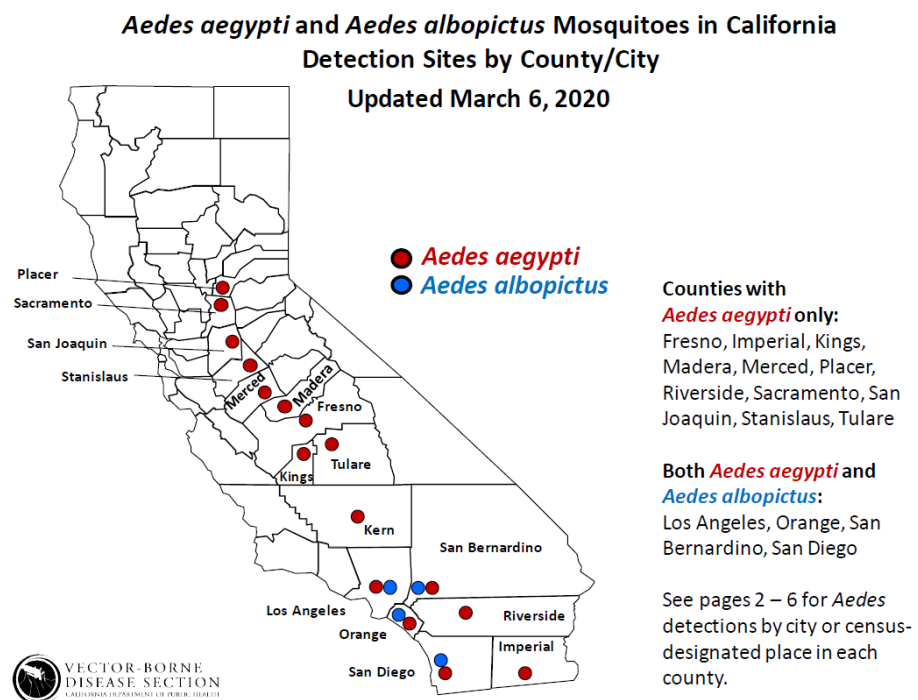
While most West Nile virus (WNV) infections are mild and at worst involve fever, the symptoms of neuro-invasive WNV infections can include meningitis, encephalitis, comas, seizures, and paralysis. There is no human vaccine, treatment is expensive, recovery can take up to several months and patients may experience permanent neurological damage.

INVASIVE AEDES SPECIES

Surveillance in Santa Cruz County for the Yellow Fever mosquito (*Aedes aegypti*), and the Asian Tiger mosquito (*Aedes albopictus*) continued with the deployment of specialized traps designed to attract and capture this pestiferous container-breeding mosquito. While invasive *Aedes* species remain established as near as Merced, Fresno, Kings, Tulare, and various Southern counties, none were detected in Santa Cruz county in 2019.

Figure 3. Map of Invasive *Aedes* detections in California 2019.

Map courtesy of the California Department of Public Health, 2020.



Mosquitoes

INVASIVE Aedes

Aedes albopictus - Asian tiger mosquito
Aedes aegypti - Yellow fever mosquito
Aedes notoscriptus - Australian backyard mosquito

Bite Multiple Hosts
more efficient virus transmission

Aggressive Day Biters

Black with White Stripes

Container Breeders

Short Flight Range
1/4 mile

3 Species found in LA County

Aedes albopictus *Aedes aegypti* *Aedes notoscriptus*

Infographic Courtesy of San Gabriel Valley Mosquito and Vector Control

Arrived in shipments of goods

Eggs are laid on the inside of containers, just above the water level

Eggs can lay dormant for several years while waiting for the right conditions

***Aedes* evolved to live in close contact with humans. Prefers urban environments**

Best Defense: DUMP and DRAIN standing water

THE DANGER OF INVASIVE MOSQUITOES

The Yellow Fever mosquito, (*Aedes aegypti*), Asian Tiger mosquito (*Aedes albopictus*), and Australian Backyard mosquito (*Aedes notoscriptus*) are important as they are responsible for Zika, dengue, chikungunya, and dog heartworm outbreaks in areas they infest. Where these day-biting mosquitoes have established in California, control efforts have not been able to completely control them and they are persistent biters.

Residents have the most important role in controlling *Aedes aegypti* as they can eliminate or manage sources of standing water that are otherwise hidden to mosquito control staff.

Residents can call us to report biting activity, cluttered yards and other container-water breeding sources in their neighborhood, and we can assist them in managing and eliminating these mosquito breeding habitats. We collaborate with the County Health department to track mosquito-borne disease cases and use the statewide surveillance database CalSurv to track establishment of invasive *Aedes* mosquitoes in the state.

TICKS AND LYME DISEASE

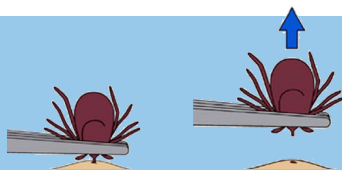
In 2019, there were 12 confirmed cases of human Lyme disease in Santa Cruz County. The 10-year average is 8 reported cases per year, making Lyme our most important vector-borne disease, transmitted by the bite of an infected Western black-legged tick (*Ixodes pacificus*). This tick can also transmit the bacteria that causes anaplasmosis however, a locally acquired human case has not been reported in Santa Cruz County in 2019 (~3-4 cases on average statewide). For an interactive map and more information, please visit the CDC site at <https://storymaps.arcgis.com/stories/f64d0c19a3ab42cf90e8ce38397e96e0> MVC continues to conduct outreach, post signs in areas of high tick exposure, study tick species diversity and sample for abundance in highly-visited recreational areas throughout Santa Cruz County.

We partner with the California Department of Public Health and UC Davis to test ticks for various pathogens, including the bacteria that causes Lyme disease.

Adult, female, Western black-legged tick.



Do a Tick Check! Quick Removal is Key



According to the CDC, the chance of getting Lyme disease is very low if ticks are removed within 24 hours of becoming attached. MVC identifies ticks for persons who have been bitten, and provides tick bite prevention and symptom recognition information to the public. If symptoms occur after a tick bite, speak to your physician as antibiotics are effective in treating Lyme disease in its early stages.

Other species of ticks can be found in Santa Cruz County, such as the American dog tick, and the Pacific Coast tick. These ticks can also transmit diseases such as Rocky Mountain Spotted Fever and Pacific Coast Tick Fever (12 human cases statewide in 2017), or Tularemia (~1 human cases statewide per year). Swift removal of the tick is always advised, even though these diseases are much less common than Lyme disease.

RODENT CONTROL

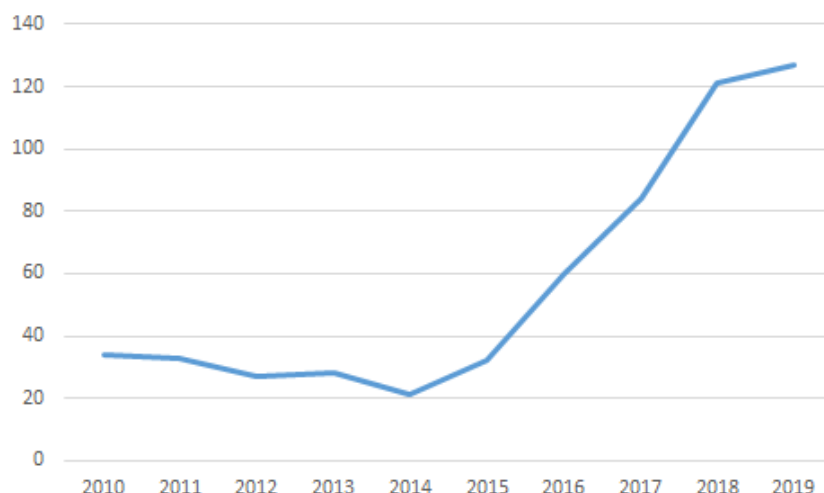
Rodents are capable of spreading about a dozen diseases to humans including: plague, salmonellosis, tularemia, rat-bite fever, leptospirosis, and Hantavirus pulmonary syndrome to name a few. Rodents also cause damage to personal property, house fires, and expensive damage by chewing on wires and hoses in the engine compartment of vehicles. Rodent control should thus be taken seriously, and measures taken to avoid infestations.

Exclusion and sanitation are the foremost means of preventing rodent activity in the home.

Twenty one percent of requests for service received in 2019 regarded rodents, primarily rats. Rodent service calls continue to increase from year to year.

MVC provided home and neighborhood inspections, gave advice on rodent exclusion and control, and distributed very informative pamphlets of our own design.

Figure 3. Number of Service Requests For Rodents 2010-2019



YELLOW JACKETES



Nearly eight percent of requests for service received in 2019 were for yellow jacket wasps. MVC provides control of yellow jacket nests found in public areas and presenting a danger to people. MVC does not control honey bees, but refers residents reporting wild hives and swarms to beekeepers, who often remove them for no charge.

AFRICANIZED HONEY BEE



The "Africanized" honey bee (AHB) is an aggressive hybrid of African and European bees, initially introduced to the Americas with the intent of higher productivity. This hybrid quickly spread throughout South America and made its way north. The last detection in close proximity to Santa Cruz County was in September 2015--a population of AHB was discovered in Lafayette, Contra Costa County.

According to a recent study by Lin et. al. 2018, there have been additional discoveries throughout California and the recent advance in latitude may be linked to above average temperatures.

Mosquito and vector control agencies where the AHB is established have dedicated significant resources to AHB abatement programs. MVC will continue to monitor the movement of the bee and respond to reports of aggressive bees. For more information please see: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5773081/>

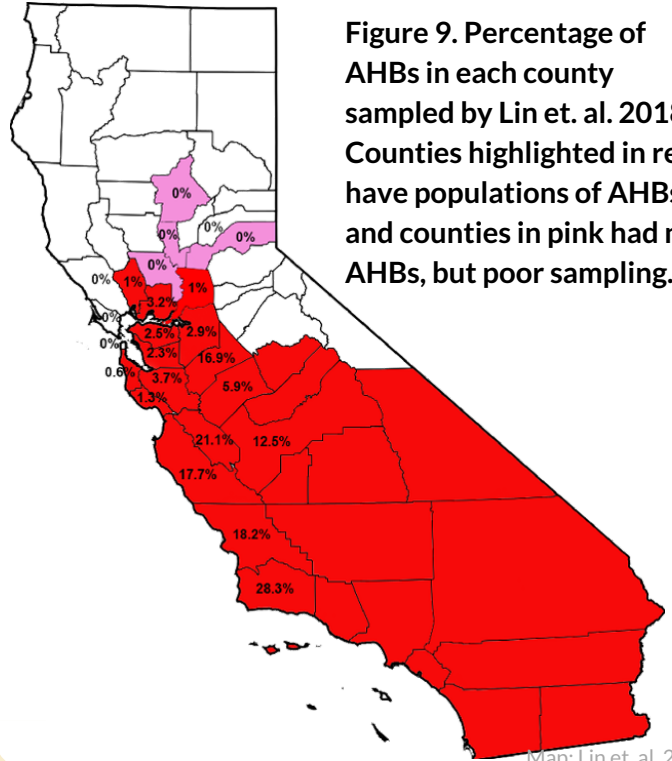


Figure 9. Percentage of AHBs in each county sampled by Lin et. al. 2018. Counties highlighted in red have populations of AHBs, and counties in pink had no AHBs, but poor sampling.

Map: Lin et. al. 2018

German Cochroach, *Blattodea cascuca*



Photo: Lmbuga CC BY-SA

COCKROACHES



We continued to assist our County Public Works, Sewer and Water Division in efforts to control an American cockroach infestation in a sewer system in Soquel that included 34 manholes, with good results. American cockroaches live primarily outdoors, typically in sewers and drains. However, it's not uncommon for them to inhabit structures especially where food is prepared or stored.

Roaches can foul food, damage wallpaper, books and clothing, and produce an unpleasant odor. Some home owners are allergic to roaches and the pests can contaminate food with certain bacterial diseases that result in food poisoning, dysentery, or diarrhea. Cockroaches can cause childhood asthma.

IN THE LABORATORY

In April 2018, we celebrated the remodel of our building, which included a new lab space for a microscope bench, molecular testing equipment, and the capacity for research. As we are in the process of setting up our testing capabilities, pathogen testing is conducted by the the UC Davis Arbovirus Research and Training at the University of California, Davis, or the California Department of Public Health, Vector Borne Disease Division in Richmond, California. In 2019:

- 4,104 mosquito larvae and 22,375 adult mosquitoes were collected and identified to species in our lab.
- 0 out of 233 samples of adult mosquitoes tested positive for West Nile virus (WNV), St. Louis Encephalitis virus (SLEV), and Western Equine Encephalitis virus (WEEV).
- Two out of 44 dead birds tested positive for WNV.
- 300 sentinel chicken blood samples tested negative for WNV, WEEV, and SLEV.
- 5 out of 409 (1.2%) adult *Ixodes pacificus* ticks submitted for testing were positive for *Borrelia* species: *Borrelia burgdorferi* (the bacterial agent that causes Lyme disease), or *Borrelia miyamotoi*.
- 587 samples from specialized Invasive *Aedes* traps (ovicups and AGOs) were inspected; invasive *Aedes* were not detected.
- Several ticks, mites, bedbugs, and insects were identified for the public at our lab.

COMMUNITY EDUCATION

MVC strives to inform the public about vectors in our community with special emphasis on mosquitoes and rodents and how to reduce their breeding sites. In 2019 our program provided:

- Educational exhibits on mosquito and vector control that reached several hundred people at the County Fair, Santa Cruz Earth Day, Soquel Water Harvest Festival, and Santa Cruz County MVC Open House.
- Community presentations on vector biology and control.
- Rodent exclusion talks at housing associations and mobile home parks.
- Newspaper and television interviews and public service announcements.



Photo: Santa Cruz County MVC

PESTICIDE USE & THE ENVIRONMENT

MVC uses EPA-registered materials that are applied by trained and certified technicians. Our goal is to protect public health, prevent pesticide resistance by rotating products, and minimize the impact on non-target organisms. Many of the materials that are part of our rotation are OMRI-listed (Organic Materials Review Institute), and thus certified organic. Mosquitoes are normally controlled in the aquatic larval (juvenile) stage rather than the adult stage, to control mosquitoes before they can fly, bite us, and spread disease. MVC cooperates with the County Integrated Pest Management Departmental Advisory Group policies, has CEQA documents on file, and receives oversight from the CA Department of Public Health and the Agricultural Commissioner.

MVC applies EPA-registered aquatic larvicides through a cooperative agreement with the CA Department of Public Health and under a National Pollution Discharge Elimination System permit as required in waters of the United States, and reports use to the State Water Resources Control Board (WRCB) and the County Agricultural Commissioner. MVC has a Mosquito Management Plan on file with WRCB, the U.S. Fish and Wildlife Service and CA Dep't of Fish and Wildlife.

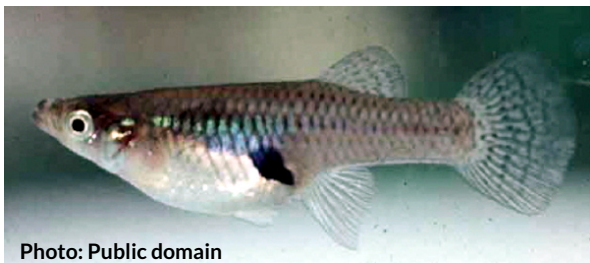


Photo: Public domain

Mosquitofish (*Gambusia affinis*) provide excellent control of mosquitoes in many situations. Their use in Santa Cruz County pre-dates our program, having been established statewide for several decades. MVC cooperates with wildlife management agencies by not introducing mosquitofish into natural water bodies where they may compete with native fish and amphibians. They are stocked in yard containers such as fountains, animal water troughs, fishponds, and unmaintained pools.

ENVIRONMENTAL CARE

MVC prioritizes care for the environment, and practices Integrated Pest Management involving:

- Emphasis on mosquito habitat reduction and water management techniques for property owners and planned development.
- Prioritization of least toxic means of pest reduction. Rotation of mosquitocides to forestall pesticide resistance.
- Selective and sustainable treatments when mosquitoes exceed threshold levels, considering disease risk, resident proximity, ecosystem balance and diversity, and other environmental factors.
- A focus on selective mosquito control in the larval stage, prior to emergence of the adult stage.
- Bio-control with fish where appropriate. *Gambusia* are stocked in contained water features with a written notice not to release them into natural bodies of water.
- Cooperation with wildlife regulatory agencies in refuges and preserves, and assessment of mosquito abatement activities with respect to sensitive species.
- Compliance with Water Quality Control Board requirements for water resource protection.
- Cooperative Agreement with the CA Department of Public Health agreeing to maintain application and calibration records, certifications and continuing education, to follow pesticide labeling and report adverse effects, and be subject to inspections.

SPECIAL PROJECTS

In 2019 we endeavored to exceed the ordinary scope of our work in order to advance our goals for mosquito and vector control and public health and safety:

Paul Binding worked on the legislative committee of the Mosquito and Vector Control Association of California (MVCAC) and attended meetings in Sacramento where he met with State legislators to discuss issues in mosquito and vector control including: AB 320, successfully sponsored by MVCAC, promoting recognition and funding by the State for the California Surveillance Gateway (CalSurv Gateway). Based in UC Davis, The CalSurv Gateway provides centralized data collection, analysis, and storage related to the presence of mosquitoes and mosquito-borne diseases throughout the state.

Staff gave presentations to various home owner's associations, involving hundreds of dwellings affected by rodents and mosquitoes to consult on rodent control and exclusion and mosquito production in septic tanks.

Our staff collaborated with the City of Santa Cruz and our County Health Services Agency to provide inspections and recommendations for a rodent infestation associated with a large homeless camp in Santa Cruz.

In collaboration with our Public Works Department, we continued to apply for and receive CalRecycle funds for bi-annual Tire Amnesty Grants. Since we we received our second two-year grant from CalRecycle, residents were able to recycle over 4,000 waste tires free of charge, representing a significant reduction in mosquito sources, as well as reductions in environmental pollution. County-wide Tire Amnesty events are usually held in April and October.

FINANCIAL AND RATES

The MVC provides free services but is funded by a tax assessment that appears on your property bill. For rates please see our website under the Documents tab www.agdept.com/mvc.html. For the MVC budget see the County website under the Government tab and Budget and Financial Reports. For 2019-20 see pages 35-36 and 285-286.

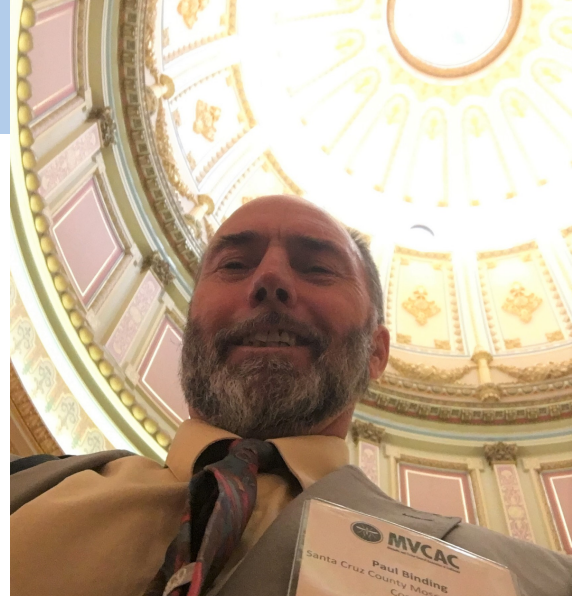


Photo: Santa Cruz County MVC



Photo: Santa Cruz County MVC



Photo: Santa Cruz County MVC



Photo: CalRecycle

Figure 10. Summary of acres treated with mosquito control products in 2019. Certified technicians applied material to 207 total acres for the year.

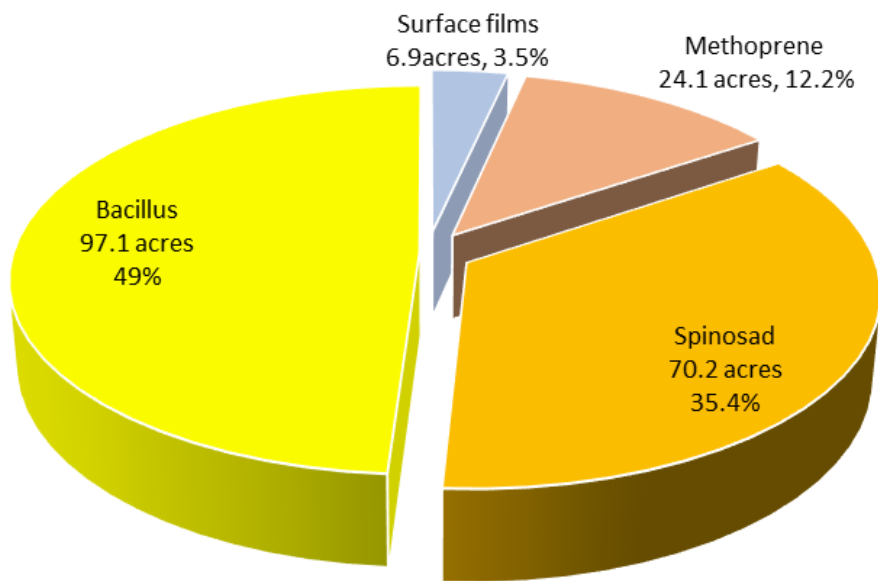


Photo: Vectobac labs

Bacillus thuringiensis israelensis (Bti) is a highly selective microbial larvicide for mosquitoes. Bti has an extremely low toxicity to humans, animals and other non-target pond life, and biodegrades in a matter of hours. ***Lysinibacillus sphaericus (Ls)*** is a related biological larvicide that is particularly effective in polluted sources such as dairy and septic ponds.

Spinosad was introduced for mosquito control in 2011 and like Bti and Ls, it is derived from bacteria that occur naturally in soil. It has low toxicity to non-target organisms at the labeled rates. The Organic Materials Review Institute (OMRI) have listed some formulations of Bti, Ls and spinosad as organic.

s-Methoprene is a synthetic insect growth regulator. It mimics the juvenile hormone and disrupts mosquito metamorphosis into the adult stage. It is biodegradable and breaks down rapidly in the environment. Methoprene is non-toxic to humans and other animals at labeled dosage rates, is approved for fish habitat and by the World Health Organization for controlling mosquitoes in drinking water.

Larviciding oils form a thin film that suffocates mosquito larvae and pupae and are used when mosquitoes are the dominant aquatic organism. We currently use BVA, a 99% mineral-oil based film, formulated to spread very thinly, evaporate, and biodegrade quickly. Larviciding oils are the only available larvicides that control mosquitoes in their pupal (non-feeding) stage.

Attractive Toxic Sugar Bait (ATSB) is a recent product used for barrier treatments for adult mosquitoes. Since the active ingredient is garlic oil, this product is exempt from pesticide registration with the Environmental Protection Agency (EPA) because it poses low risk to humans and the environment. Non-target insects are avoided by timing and site selection.

Herbicide treatments with glyphosate products are only used for targeted control of poison oak along access trails to mosquito-breeding sources. Two small spot treatments were made in 2019.

Mosquito-eating fish (*Gambusia affinis*) may eliminate the need for pesticide treatments in many situations. MVC has these fish available for ponds, fountains, animal water troughs and unmaintained pools, free of charge. Mosquito fish are not stocked where they may compete with native fish or amphibians.