The Mosquito Abatement Report

Summary:

The Sutter Yuba Mosquito and Vector Control District (SYMVCD) could easily be called Sutter Yuba Mosquito Control District because the majority of what they do relates to the control of the approximately 55 species of mosquitoes in California. When you look at the types of diseases that these little blood-suckers can potentially transmit, you soon come to realize that without control and abatement programs, we humans would not be able to live, work, or play without misery accompanying our every action. The District's area of responsibility covers approximately 706 square miles, 486 of which are located in Sutter County and 220 square miles in Yuba County.

The Grand Jury relied on the SYMVCD website: http://www.sutter-yubamvcd.org/ for some of this report. Each year, the District prepares for the coming season utilizing a set of standards contained within a document called Best Management Practices Manual. The document is assembled from a number of sources including scientific literature, state and inter-agency documents, and experienced vector control professionals. Other procedures contained within this document come from District Affiliates, the California Department of Public Health: 2014 California Mosquito-Bourne Virus Surveillance and Response Plan and the U.S. Fish and Wildlife Service, specifically, a document titled: Environmental Effects of Mosquito Control appendix K4.

The goal of this report is to enlighten citizens of our counties, and highlight the myriad of activities of the District that are required to successfully control mosquitoes and the diseases that they bring. This report will cover the history, entomology, species, diseases transmitted, and areas where disease is found. The Grand Jury explored methods of detection, control, and abatement employed by the Mosquito Control Technicians (MCT) of the District. In 2012, the start of the current ongoing drought in California, the number of cases of West Nile Virus (WNV) infected humans tripled from 158 to 479, the most since 2005. In 2014, there were 798 reported cases of WNV throughout California and this year is predicted to be another year with a high count of WNV cases. The diseases of concern transmitted by mosquitoes within the Sutter-Yuba District are West Nile Virus, Dengue Fever, Chikungunya, Encephalitis, Heartworm, Malaria, Hanta Virus, Lyme disease, and Rabies.

Introduction and Background:

Before California was settled by pioneers and gold seekers, thousands of seasonally flooded acres of lowlands, marshes and other wetlands produced hordes of mosquitoes impacting the lives of Native Americans. Certain evidence of an archeological and anthropological nature suggests that these native cultures were seasonally compelled to move or abandon coastal and lowland areas. Similarly, other tribes inhabiting mountain environments would face springtime hatches of snow-pool and floodwater mosquitoes. As the Gold Rush drew miners to California in the 1850's, the prospectors were quickly

introduced to the mosquitoes, their bites and the pathogens they transmit.

The origins of organized mosquito control in California began in the Bay Area. Salt marshes were producing massive numbers of mosquitoes, disrupting the lives of residents. Initial control efforts focused on constructing drainage canals and ditches in these marsh areas. In 1903-04, an attempt was made to form a national organization of mosquito control workers, called National Mosquito Eradication Society (NMES). The society was formed by noted entomologists. Unfortunately, the association only held two meetings. In 1905, New Orleans had a massive outbreak of yellow fever that was eradicated by a concentrated effort by entomologists which proved conclusively that abatement works. In 1913, New Jersey became the first state to pass a law authorizing mosquito abatement districts. In 1915, California passed a law creating its first abatement district. Today, there are more than 60 abatement districts throughout the state.

Methodology and Approach:

Documents and Reference Sources:

- http://www.sacbee.com/news/state/california/water-and-drought/article11054219.html
- http://www.cdc.gov/malaria/about/biology/mosquitoes/
- http://wwwnc.cdc.gov/eid/article/8/12/02-0536_article
- http://www.mosquito.org/history
- http://www.sutter-yubamvcd.org/district_history.asp
- http://cvec.ucdavis.edu/about
- http://www.cdph.ca.gov/programs/vbds/Pages/default.aspx
- http://www.sutter-yubamvcd.org/mosquitofish.asp
- http://www.sutteryubamvcd.org/Public%20Health%20Pesticide%20Application%20Notification.asp
- http://floridamosquito.org/App_Docs/Meetings/2014/2014_FMCA_Annual_Meeting_Packet.pdf
- http://floridamosquito.org/App_Docs/Meetings/2014/FMCA_2014_Fall_Program.pdf

- The first mosquito control board of renowned entomologists: Wilton E. Britton, Daniel W. C. Quilett, Harrison G. Dyer, Ephrim P. Felt, Leland O. Howard, Vernon L. Kellogg, Herbert Osborn, and John B. Smith.

Video and Picture Sources:

- "Mosquito Mayhem" Cartoon Guy's "Mosquito Mayhem" Uploaded to YouTube by Joep Vrienten May 23, 2013

- "Protect Your Family" picture

Site visits:

On September 15th a tour of the SYMVCD was conducted by the Grand Jury.

Interviews:

The following were interviewed by the Grand Jury:

- SYMVCD Board of Trustees
- District Manager
- District Entomologist
- Mosquito Control Technicians

Discussion and Narrative:

The District operates on an abatement schedule that is based upon the seasonal reproductive cycles of the various mosquito species found within the Districts' area of responsibility. Batches of various formulas using a pesticide family called pyrethrins are the poisons which have been the most effective against mosquitoes for quite some time. However, when they become resistant, the District Manager is responsible for choosing when and which poisons to test for resistance. The method used in the testing is called an assay. The District continually sends Mosquito Technicians and members of the Board of Trustees to state, and national conferences to learn of new and better ways of mosquito abatement. One recent new technique for early detection of resistance to pesticide formulas was learned at the annual Florida Mosquito Control Association's meeting held in Palm Beach last November. Once perfected, this new tool will allow managers to change a formula long before mosquitoes can build resistance to it. This will save money by not having to purchase new pesticides, and not having to discard resisted pesticides.

The District gives notice that it intends to control immature and adult mosquitoes in the District as necessary to protect the public's health. Applications may be made between

January 1st, and December 31st; however, fogging usually doesn't begin until May 1st, and ends September 30th. The District takes advantage of the local newspaper, direct mail, radio stations, and the internet to make residents aware of when fogging operations will occur. Dates and times for spraying depend upon which areas will need it. A spraying schedule is available on the SYMVCD website during the season which typically begins in late June and continues through July, August, and September. For additional information about pesticide safety in residential environments, check the Centers for Disease Control (CDC) website on pesticides used for mosquito control. The philosophy of the District is to approach the control and abatement by utilizing their operations manual titled: Best Management Practices Manual. Within the manual is an Integrated Mosquito Management program that is an ecosystem-based strategy.

Integrated Mosquito Management Program

The Integrated Mosquito Management program outlines four types of mosquito control options set in an algorithmic format which is practiced by the District. These methods allow for a common sense approach to accomplish abatement using the most economical means and with the least possible hazard to people, property, and the environment.

Control Method 1: Source reduction, manipulation, and/or elimination; also called Physical Control.

Control Method 2: Biological mosquito control uses biological agents to reduce larval populations.

Control Method 3: The use of federal and state registered pesticides to control mosquito populations. Adulticides are used to kill adult mosquitoes and Larvacides for immature aquatic-stage (larvae) mosquitoes.

Control Method 4: Cultural control is designed to change the behavior of the county's residents through public education and outreach so that their actions prevent mosquitoes.

Each method of control is designed to eliminate or minimize breeding sites, reduce mosquito populations, and reduce transmission of vector-borne diseases. These materials are registered by the Environmental Protection Agency and applied according to label directions by the District's trained certified technicians. A list of pesticides potentially used by the District is available on the SYMVCD website. "Mosquito" a 3:49 animation

Laboratory Work

During a tour of the facility, mosquito control in the Sutter-Yuba District begins in the on-site laboratory staffed by a trained, educated medical entomologist. Walking into the

lab one gets a sense of order, and purpose. The attention to detail, and efficiency with professional routine became more evident as the tour continued. Upon visiting the workplace; one would find there are shallow pans filled with water. Inside the pans, mosquito eggs hatch into larvae and go through the pupal stage until they metamorphose into adult structures. Once this change is complete, an adult mosquito will emerge from the pupal case. The whole process from eggs to emergence is 4 to 14 days. The entomologist then places the adult mosquitoes into special testing jars to monitor their tolerance for the chemicals that are used in the spray that is specially formulated. Periodically, the mosquitoes build tolerances to the mixtures, thereby necessitating changing the formulas from time to time. Should the adult mosquitoes last as long as 45 minutes in a test jar, that would be an indicator that resistance to that formula has been achieved, signaling the need for the introduction of a new poison.

Mosquito Species around Sutter-Yuba

Culex tarsalis

The Culex tarsalis is sometimes referred to as "The Encephalitis Mosquito." This mosquito is the primary genera strain that the entomologist uses to maintain colonies of mosquitoes in various stages of development. The "cup test" is laced with Bacillus Thuringensis Israelensis. It prefers standing water to lay its eggs directly on the surface in groups called rafts. Some favorite breeding sites include: ditches, rice fields, and wetlands. This mosquito carries the WNV that can infect humans and birds. It also causes encephalitis in humans and horses.

Anopheles freeborni

There are approximately 3,500 species of mosquitoes grouped into 41 genera. Human malaria is transmitted only by females of the genus Anopheles. Of the approximately 430 Anopheles species, only 30-40 transmit malaria; i.e. vectors, in nature. In Sutter and Yuba counties the Anopheles, also known as Western Malaria Mosquito and Western Rice Mosquito, are standing water mosquitos, and can be found in ditches, rice fields, rain pools, and wetlands.

Aedes sierrensis

As a flood water mosquito, this female lays her eggs individually in rot holes that develop in some trees. As spring rains or irrigation water fills the tree-hole, the eggs are stimulated to hatch. The adults do not fly far from that location. They can transmit the canine heartworm parasite and is a severe pest of humans. They take blood meals any time of day, even in full sun.

Aedes melanimon

Sometimes called "The Wetlands Mosquito" is also a flood water mosquito. The female lays eggs singly on damp or muddy soil. The eggs may lay dormant for long periods of time until stimulated to hatch when flooded. It can also become involved in the

encephalitis transmission cycle. These mosquitoes are found in irrigated pastures, and intermittently flooded duck club ponds. Like the Aedes sierrensis, the Aedes melanimon will take blood meals any time of day, even in the full sun.

Culex pipens

This mosquito is possibly the most common of the five or so genera of mosquito in Sutter and Yuba Counties. It prefers to lay its eggs in rafts in standing water. It loves foul, stale or stagnant water found in containers, such as catch basins, sumps, tires, roof gutters, uncovered boats, ornamental ponds, and fountains, neglected swimming pools and hot tubs, barrels, or other artificial containers. Although it prefers birds, it commonly enters houses in search of a blood meal during the night. The Culex pipens is another competent WNV vector.

Detection and Monitoring:

The District employs three primary methods for detecting the presence of mosquitoes carrying WNV throughout the two counties.

Sentinel Chickens

When the term "sentinel chickens" is heard, one envisions a chicken dressed in a little uniform, and helmet, and shouldering a weapon while patrolling a perimeter.

Chickens are used in the detection of WNV because they are not adversely affected when they are bitten by mosquitoes carrying the virus. Instead, their immune systems develop anti-bodies that can be detected by entomologists, and lab technicians through blood testing. They serve as an early warning system by alerting officials of the presence of the WNV in a specific location. By identifying the locations where WNV is present, the appropriate abatement recipe can be selected and applied. The sentinel chicken program begins anew each year in April with the acquisition of eight flocks of seven chickens ordered from hatcheries licensed by the State of California.

There is a hatchery in Modesto which serves Northern California mosquito abatement districts. At 18-19 weeks old, the young pullets are mature enough to begin service. They are placed strategically throughout the District. The chickens are tested before being placed in the field. Blood samples are taken from the chickens comb and kept for a base-line comparison if the chicken later tests positive for WNV. Each week, a small sample of blood is drawn, labeled, dated, and recorded from each chicken. The samples are then sent to the California Department of Food and Agriculture, or the U.C. Davis Center for Vectorborne Diseases for analysis. Results of the tests become available electronically within days. The Sutter-Yuba Abatement District performs a service for other Northern California abatement districts by taking a large truck to Modesto to pick up many flocks,

and brings them back for distribution. Once a chicken is infected it is retired to a farm for the rest of its life.

Mosquito Traps

Mosquitoes are attracted to heat, carbon dioxide, certain odors, and incandescent light bulbs. The entomologist incorporates these items into red box traps. They are devised to attract, and then trap mosquitoes in the field. Once per week, mosquitoes are collected and sent back to the lab to be processed. They are put through a centrifuge and blood samples are dried on slips of specially coded lab paper and recorded. They are then sent to the California Department of Public Health (CDPH), or the Center for Vectorborne Diseases (CVEC) for testing. The District pays for these tests. Larger mosquito abatement Districts have the necessary funding and equipment to do their own testing. Results of those samples are readily available using a computerized program that accesses the State database. All red boxes are registered by number with the California Department of Public Health.

Dead Birds

The District provides an online WNV hotline for reporting dead birds found by citizens.

Fogging:

Bti

Bacillus Thuringensis Israelensis are spores that produce a crystalline toxin. Some of it is ingested by mosquito larva. The product causes the gut wall to disintegrate resulting in the death of the larva. Bti is target specific. It only produces these effects on mosquito, and black fly larvae. Many years of research with Bti have shown it has no harmful effects in humans, animals, plants, fish, or other aquatic organisms, including predators of mosquitoes even at rates higher than the maximum prescribed label application rates. This is good because the District currently treats in excess of 100,000 acres of rice each growing season with Bti. Larvacides work on stage two of the four stages that mosquitoes must go through to become adults. Fogging for these large areas is accomplished by aircraft equipped with foggers.

Adulticides

Adulticides are used when adult mosquitoes emerge from areas not well-suited for or too expensive to use a larvicide. Years ago, mosquito abatement districts used thermal foggers to create space sprays for subjecting mosquitoes to toxic doses of a pesticide. That method produced too many hydrocarbons because thermal foggers burn a concentrated pesticide diluted with a petroleum oil to create a thick smoke.

Today's foggers use alternative technologies that don't emit hydrocarbons as they produce the tiny particles necessary to kill mosquitoes, while at the same time using small amounts of pesticides. Fogging must be done during a temperature inversion.

During the summer months, temperature inversions typically occur at dawn and dusk. For the foreseeable future town fogging will begin at dusk. Fogging at this time will better target the mosquito responsible for transmitting the WNV. When the possibility for public exposure increases, only the safest materials are considered for use.

Mosquito Fish

Mosquito fish are bred by the District specifically for distribution throughout the two counties to control mosquitoes. They are small compared to other fish with females reaching an average length of 2.8 in. and males 2.5 in. The fish eat mosquito eggs, larvae, and pupa arresting mosquitoes at a very early stage of their development. One mosquito fish can eat up to 50 mosquito larvae in a 30 minute period, and 168 in an eight hour period. They are live bearers and can give birth from just a few to a couple of hundred baby fish. This process can occur three to five times a season, usually in warmer months. Mosquito fish are very resilient, able to survive in waters with low levels of dissolved oxygen where other species would suffocate. They have a wide range of temperature tolerance. They have been known to survive temperatures in Utah as low as 32.9 degrees F, and in Arizona living in hot springs as hot as 107 degrees F. They also do well in brackish waters.

The District makes use of mosquito fish in thousands of mosquito sources annually. Technicians evaluate a mosquito source based on how long they believe a water source will last, and if it will support fish life. Some typical sites where mosquito fish are used include stock troughs, ditches, ornamental ponds, rice fields, sewage oxidation ponds, barrow pits, sumps, agricultural or irrigation seepage, and any other area that will produce mosquito larvae for a long period of time. One of the free services provided by the District includes making mosquito fish available to residents from April through September each year.

The Future of Mosquito Control

A further example of the proactive nature of the District is that several members of the Board of Trustees and employees attend conferences held around the country sponsored by various mosquito abatement associations and districts. At its annual conference last fall the Florida Mosquito Control Association's four day meeting featured a representative from a company called Oxitec. The representative presented a lecture on the subject of genetically modified mosquitoes that could be used to reduce the number of biting female mosquitoes in an environment. Briefly, the way it works is Oxitecs workers begin by modifying a select swarm of mosquitoes then manually remove females, aiming to release only males, which feed on nectar and don't bite for blood like females do. The modified males then mate with wild females whose offspring die, reducing the

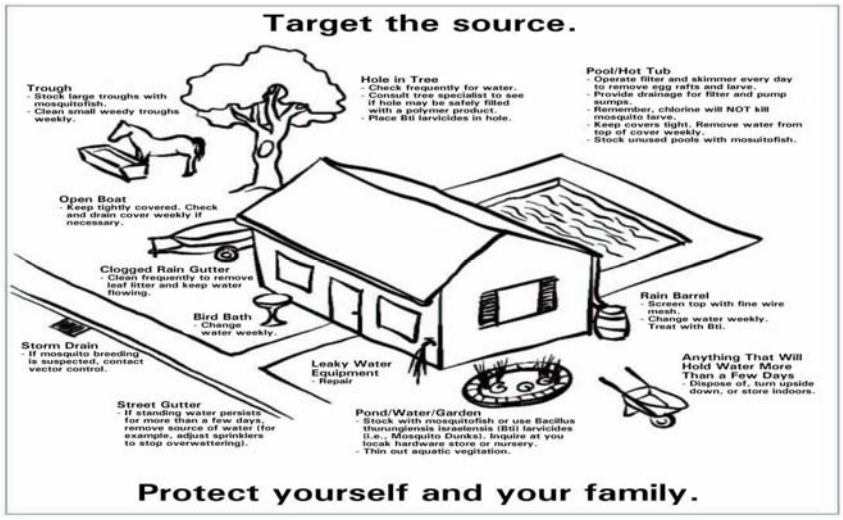
population. This technique is currently limited to Aedes Aegyptus mosquitoes which carry dengue, and chikungunya viruses.

Oxitec is awaiting permission to release its modified mosquitoes this spring in Key Haven Florida, a neighborhood of more than 400 homes closely clustered on a relatively isolated peninsula at the north end of Key West. There are ongoing concerns that accompany any discussion which involves genetic modification of plants or animals.

While genetic manipulation of any species of mosquitoes is still in its relative infancy, the mosquitoes responsible for transmitting WNV are just now getting attention from geneticists within the scientific community. The primary reason for low priority of concern over WNV is that compared to malaria, West Nile Virus is not only survivable, but is much less debilitating, especially in the long term.

The District provides plenty of detailed information on all of its operations on its website. The already abundant information is soon to be updated. The public's ability to report and request assistance with problems relating to mosquito or other vector issues, or just obtain information, can be easily addressed online or by calling the District's office.

Home and Property Maintenance



Finding:

F1. The Yuba County Grand Jury finds that the Sutter Yuba Mosquito and Vector Control District (SYMVCD) appear to be in compliance with their Best Management Practices manual. Genetically modified mosquitoes released into areas of concentrated West Nile Virus (WNV) cases could reduce the overall occurrences of the virus over time. Each year, the District prepares for the coming season utilizing a set of standards contained within a document called Best Management Practices Manual. The document is assembled from a number of sources including scientific literature, state and inter-agency documents, and experienced vector control professionals. Other procedures contained within this document come from District affiliates, the California Department of Fish and Game, and the U.S. Fish and Wildlife Service, specifically, a document titled: Environmental Effects of Mosquito Control appendix K4.

The Grand Jury relied on the SYMVCD website: http://www.sutteryubamvcd.org/Public%20Health%20Pesticide%20Application%20Notification.asp for the majority of this report.

Figure 1. *An example of a SYMVCD fogger unit. (January 2015)*

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Figure 2. *An example of a SYMVCD fogger unit in use. (January 2015)*

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Recommendation:

R1. The Grand Jury recommends that the Sutter Yuba Mosquito and Vector Control District not only continue furthering its current proactive approach to the control of mosquitoes; but explore next generation abatement techniques such as genetic modification of WNV transmitting mosquito species.

Commendation:

C1. The Grand Jury commends the Sutter Yuba Mosquito and Vector Control District in the compliance of their mandate as outlined in the Best Management Practices Manual.

Request for Responses:

Pursuant to Penal Code §933.05, the Grand Jury requests responses as follows:

From the following governing bodies:

- Chairman, Yuba County Board of Supervisors
- Chairman of the Board of Trustees of Sutter Yuba Mosquito and Vector Control District

The governing body indicated above should be aware that the comment or response of the governing body must be conducted in accordance with Penal Code §933(c) and subject to the notice, agenda, and open meeting requirements of the Brown Act.