

**MOSQUITOES AND THEIR DISEASE THREATS DON'T ABIDE BY COUNTY
BORDERS: A READY, WILLING AND ABLE (RWA) ANALYSIS OF SACRAMENTO
REGION MOSQUITO CONTROL DISTRICTS' EMERGENCY PREPAREDNESS
EFFORTS**

A Culminating Project Presented to the Faculty of the Department of Public Policy and
Administration at California State University, Sacramento Submitted in Fulfillment of the
Requirements for the Degree of Master of Public Policy and Administration

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SPRING
2024

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Executive Summary

Mosquito-borne public health emergencies are becoming a new normal in today's climate and can overwhelm mosquito and vector control districts in California. In 2023, two cases of dengue in Pasadena and Long Beach proved California is now vulnerable to locally transmitted mosquito-borne diseases through the bite of an invasive mosquito. A mosquito and vector control district's ability to mobilize emergency efforts to prevent a widespread outbreak of a disease like dengue can keep Californians safe. Mosquito districts can test mosquitoes for diseases like West Nile virus and dengue before people start getting sick and take appropriate actions or mosquito control measures to limit human transmission - but this immediate mobilization can be costly, resources are scarce, partnerships may not be established, and staff may not be prepared or trained. In addition, in some cases, districts with invasive mosquitoes are not testing mosquitoes for dengue yet, and public health agencies in California counties can be slow to report human cases to local mosquito districts or confirm a human case as locally transmitted which delays active mosquito control response.

In this analysis, I apply the Ready, Willing, and Able (RWA) framework, an organizational framework used to analyze public health emergency preparedness in the past, to identify gaps in Sacramento-area mosquito and vector control districts' emergency preparedness efforts by gauging staff and district's readiness, willingness, and ability to respond to a mosquito-transmitted disease outbreak to improve preparedness levels and efficient response activation. The RWA framework serves as a guide to identify recommendations and improvements to strengthen emergency preparedness programs for Sacramento-area mosquito control districts and in the event of a mosquito-borne disease threat, keep their residents, county and California safe. I examine emergency preparedness through a combination of document

review and stakeholder interviews with Sacramento-area mosquito control district managers representing five counties and a southern California district that experienced an emergency response activation due to a locally acquired case of dengue in their service area.

I find that Sacramento-area mosquito and vector control districts display adequate readiness, strong willingness, and a mixed level of ability to respond to an emergency. These findings are dependent on the magnitude and length of the emergency and the district's service area size, staffing size, and budget. Based on these findings, I recommend four different areas and emergency preparedness gaps for improvements to their district, management, and staff to improve planning, preparing, and practicing for an emergency to close preparedness gaps. These four improvement areas include planning and collaboration, annexations and MOUs, training and mock drills and funding mechanisms.

Acknowledgments

I would like to extend my heartfelt gratitude, first and foremost, to my family. From the moment I applied to the Sacramento State Master of Public Policy and Administration program, they have offered support, encouragement and of course childcare. A special appreciation goes to Andrew, my partner, and to our daughter Sage, who entered our lives during the program. Your support, flexibility, and countless times you've said "you've got this" have been motivating me to the finish line. We made it just in time for baby number two to join our family in August.

Thank you to the Sacramento State MPPA program faculty and especially to my advisor Dr. Amal Kumar for guiding me in this project.

I also want to express my thanks to the Placer Mosquito and Vector Control District and its Board of Trustees for their steadfast support throughout this academic journey. I consider myself fortunate to work for an organization that not only values academic pursuits but also actively supports the professional development of its employees.

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 A. Interview Questions

I. Introduction

Is another pandemic knocking on California's front door? The spread of invasive *Aedes* mosquitoes in California pose a serious public health threat to Californians especially if mosquito and vector control districts and their partners are unprepared to respond to a locally transmitted disease outbreak. Although mosquito and vector control districts are bound legislatively to specific service areas, environmental and biological factors impact public health risks across county borders. Unlike other infectious diseases, mosquito and vector control districts can identify risks before people get sick through mosquito surveillance and testing. The testing and reporting locally of mosquito populations and their diseases allow people to take preventative measures and mosquito and vector control districts to conduct control measures - this is most recently important since as of November 2023, California has reported two human cases of locally acquired dengue transmitted through the bite of an invasive mosquito in Pasadena and Long Beach (County of Los Angeles Public Health, 2023).

Invasive *Aedes* mosquitoes can transmit debilitating and deadly diseases such as dengue, chikungunya, yellow fever, and Zika (CDC, 2023). The discovery of *Aedes albopictus*, also known as the "Asian tiger mosquito," in 2011 in Los Angeles County, and of *Aedes aegypti*, also known as the "yellow fever mosquito," in 2013 in urban areas of Fresno, Madera, and San Mateo counties, demonstrated that California was vulnerable to colonization by these mosquitoes (CDC, 2023). In the past ten years, climate change has magnified the risks of invasive *Aedes* mosquitoes, and these species of mosquitoes can now withstand temperate California winters, remaining a threat year after year (Metzger et al., 2017). Drought and wildfires have also created more attractive habitats for mosquitoes to reproduce. *Aedes* mosquitoes have spread to over four

hundred towns and cities throughout California and twenty-three counties, increasing the transmission risk for these diseases (CDC, 2023).

In 2023, Tulare Lake, a once dried-up lake, in both Tulare and Kings County refilled after catastrophic flooding and unprecedented rains in central California (Klein, 2023). This refilled lake caused a proliferation of West Nile virus spreading mosquitoes in an area that was not in a mosquito and vector control district's service area. Due to the increase in mosquitoes and West Nile virus risk in parts of the refilled lake, the California Office of Emergency Services (CalOES) and the California Department of Public Health (CDPH) intervened in the emergency response. CalOES and CDPH sent \$6.3 million of disaster relief to districts neighboring the refilled lake and a mosquito and vector control contractor to provide aerial spraying, surveillance, and other mosquito control techniques to prevent a public health emergency. However, the process of accessing emergency funds and working collaboratively was not clear to local districts and is not promised for future emergency events (Klein, 2023). In this case, the emergency response problem was that the area causing a public health threat was not in an existing mosquito and vector control district's service area. This leaves the question: if mosquitoes don't know county or service area borders, how do vector control districts respond to an emergency like the one at Tulare Lake? That answer is not explicitly clear.

While mosquito and vector control districts continue to work diligently to prevent the spread of invasive *Aedes* mosquitoes, it is only a matter of time before these diseases are transmitted locally. Preparing for a locally transmitted disease outbreak caused by the bite of an invasive mosquito is important to keep Californians healthy. Research into whether mosquito and vector control districts are prepared to detect and respond quickly to regional disease threats may involve investigating collaboration relationships, existing processes, training, and funding since

the need for a locally tailored approach is necessary in protecting public health (Global Vector Control Response 2017–2030, 2024). Previous research adjacent to the topic has mostly been done on public health, other diseases, and future natural disasters. Specific research of geographic areas like the Sacramento-region’s mosquito and vector control emergency preparedness efforts is understudied.

Identifying gaps in the emergency response efforts of Sacramento region mosquito and vector control districts can better prepare districts for the potentially inevitable locally acquired disease outbreak which can contribute to better public health outcomes. Due to the cross-county nature of these disease threats, a collaborative approach between neighboring mosquito and vector control districts can protect public health across county lines in the event of an emergency locally transmitted disease case. Mosquito and vector control districts in California help their counties protect public health through mosquito surveillance and control efforts and public outreach by communicating the risk to people. Collaboration between neighboring districts can help identify opportunities to bridge gaps in surveillance, staffing, and response plans when a neighboring county experiences an emergency-level disease outbreak or detects a record number of disease-infected mosquitoes which alerts surrounding counties that transmission risk is nearby.

In this culminating project, I will evaluate existing emergency preparedness efforts of Sacramento region mosquito and vector control districts using a Ready, Willing, and Able (RWA) framework to analyze and identify opportunities or gaps that can increase preparedness levels in the event of an invasive *Aedes*-transmitted disease outbreak in the Sacramento-region to keep Sacramento safe and healthy. I find that Sacramento-area mosquito and vector control districts display adequate readiness, strong willingness, and a mixed level of ability to respond to

an emergency. Based on these findings, I recommend four different areas and emergency preparedness gaps for improvements to their district, management, and staff to improve planning, preparing, and practicing for an emergency to close preparedness gaps. These four improvement areas include planning and collaboration, annexations and MOUs, training and mock drills and funding mechanisms. In the following section, I will profile Placer, Sac-Yolo, Sutter-Yuba, and San Gabriel Valley mosquito and vector control district's geographic location in California, service area size, staff size, and budget and establish the RWA framework I will be using to analyze preparedness levels of these districts. Then, in Section III: Methodology, I will detail the documents I reviewed, important organizations and plans, and the stakeholder interviews I conducted. Then in Section IV: Findings/Implications, I will outline what I found in the document review and stakeholder interviews and their implications to improving emergency preparedness. This section will lead to Section V: Recommendations which will include four different areas of improvements for district to consider in closing preparedness gaps. Finally, in Section VI: Conclusion, I will conclude the findings and recommendations.

II. Analytic Framework

District Profiles

I will analyze the Placer, Sac-Yolo, Sutter-Yuba, and San Gabriel Valley mosquito and vector control districts emergency preparedness efforts in this analysis. These districts are different in service area, size, population, staff and board size, and operating budgets which are important to note before reviewing emergency preparedness efforts. In addition, the emergency funds each district has set aside for responding to a mosquito threat also vary and can be important to note. *Figure 1: Geographic Location of California Mosquito and Vector Control Districts* is a map of the geographic regions and service area borders of the different districts I am analyzing in this review and which districts neighbor each other. *Table 1: California Mosquito and Vector Control District Profiles* outlines the district's statistics and identifying information.

Figure 1: Geographic Location of California Mosquito and Vector Control Districts

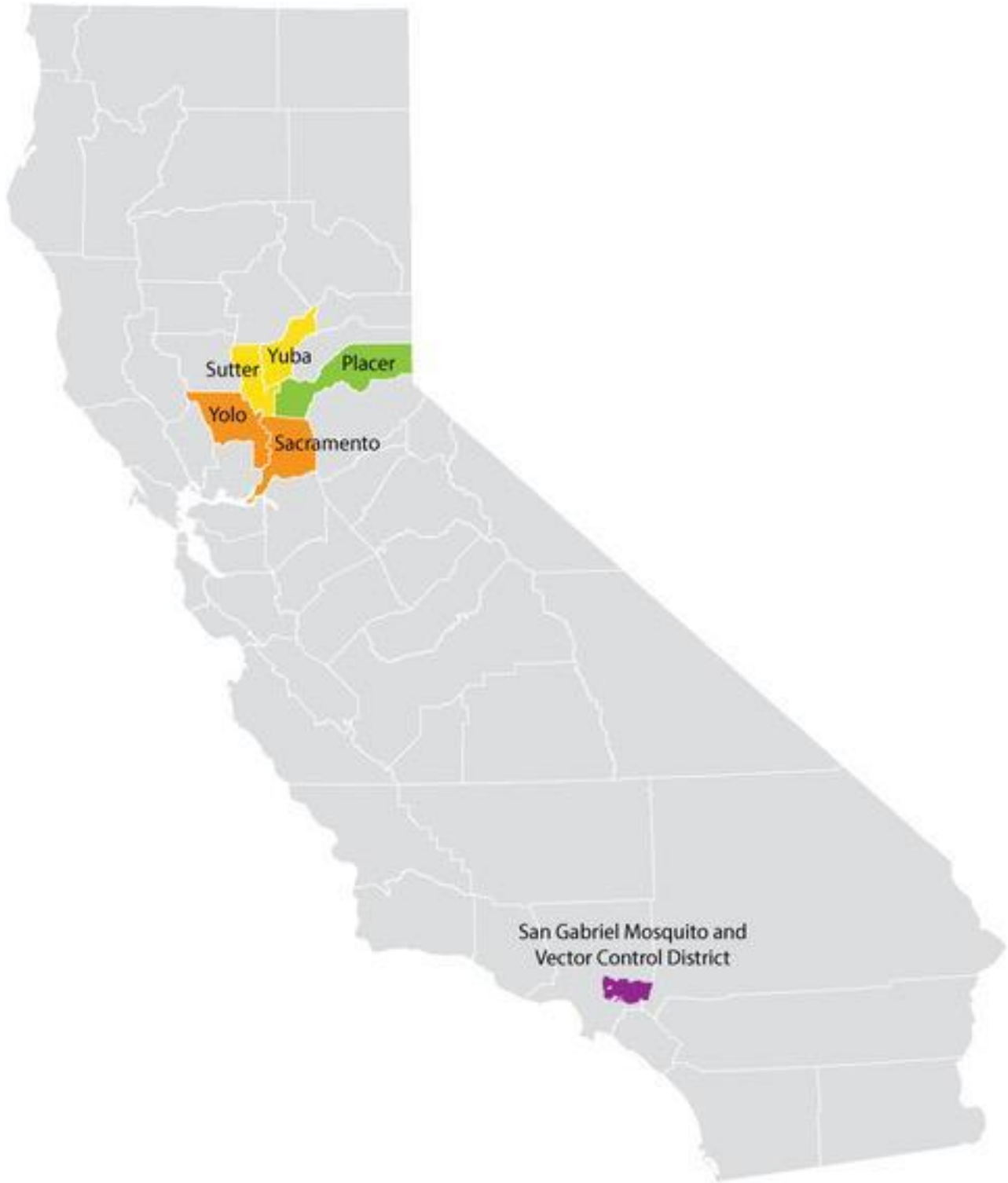


Table 1: California Mosquito and Vector Control District Profiles

District Name	Service Area Size	Residents	Staff	Board of Trustees	Operating Budget	Emergency Fund
Placer Mosquito and Vector Control District	All of Placer County from Roseville to the Tahoe Basin. 1,506 square miles	412,300 residents (United States Census Bureau, 2024)	25 full-time staff + seasonal employees	7 members	\$5,841,607	\$550,000 (Placer Mosquito and Vector Control District, 2024)
Sacramento-Yolo Mosquito and Vector Control District	Sacramento and Yolo Counties. 2,013 combined square miles of urban, commercial, and agricultural land	Sacramento: 1.6 million residents Yolo: 216,986 residents (United States Census Bureau, 2024)	75 full-time employees + 10-15 seasonal employees	13 members	\$20,261,187	\$3 million (Sacramento Yolo Mosquito Vector Control, 2024)
Sutter-Yuba Mosquito and Vector Control District	Sutter and Yuba counties. 706 square miles	Sutter County: 99,063 residents Yuba County: 83,421 residents (United States Census Bureau, 2024)	16 full-time employees + 12 to 16 seasonal employees	7 members	\$4,708,375	\$625,000 (Sutter Yuba Mosquito and Vector Control District, 2024).

San Gabriel Valley Mosquito and Vector Control District	San Gabriel Valley and unincorporated portions of Los Angeles. 287 square miles	1.5 million residents	35 full-time employees	27 members	\$6,809,477	\$100,000 (San Gabriel Valley MVCD, 2024)
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The Ready, Willing, and Able Framework

To my knowledge, no specific criteria have been established specifically for mosquito and vector control districts’ emergency preparedness. However, the Ready, Willing, and Able (RWA) framework has been used in the past for the evaluation of public health emergency preparedness. This can be an appropriate framework to apply to mosquito and vector control districts since vector control falls into the overall public health industry (McCabe et al., 2010). According to the U.S. Environmental Protection Agency (EPA) and the U.S. Centers for Disease Control and Prevention (CDC) mosquito-borne diseases are among the world's leading causes of illness and death today. The CDC and EPA work with state, local health departments, and mosquito control districts to monitor the potential sources and outbreaks of mosquito-borne diseases, provide advice and consultation on prevention and control of these diseases to protect public health and ensure that state and local mosquito control departments have access to effective mosquito control tools without posing unreasonable risk to human health and the environment (*Joint Statement on Mosquito Control in the United States 2024*).

The RWA framework evaluates an organization’s readiness, willingness, and ability to be prepare for public health emergencies Readiness is referred to as the preparedness and available resources to take on a new emergency (McCabe et al., 2010). This criterion will evaluate the district’s plans, processes, procedures, and protocols in place. Readiness also evaluates existing

relationships and collaboration efforts like a formal agreement between neighboring districts, trainings, and mock drills. Willingness in the RWA framework refers to the organization’s motivation and commitment to take on the emergency event. Although much more difficult to gauge, willingness will dive into the district’s staff sentiment and ability to adapt, volunteer history, and gaps that have been addressed in past response experiences. Lastly, the ability criteria will assess the true capabilities of the district to respond to an emergency. This criterion will evaluate financial health, skills, past successful responses, infrastructure maintenance, and staffing levels (McCabe et al., 2010). Overall, the RWA framework provides a roadmap to evaluate whether mosquito and vector control districts are prepared for an emergency by assessing readiness, willingness, and ability. *Table 2: RWA Framework* outlines more detailed metrics for measuring readiness, willingness, and ability to respond to an emergency specifically for a vector control agency.

Table 2: RWA Framework

Criterion/Metric	Definition	Application
Readiness	Availability of a public health agency and the individuals who work in the agency, for prompt action, service, or duty to respond with appropriate resources to a public health emergency. (Chiang et al., 2020).	Process, Plans, Procedures <ul style="list-style-type: none"> ● Thorough processes and plans in place in the event of an emergency. ● Updated plans that outline the process of actions for a district to take in the event of an outbreak. ● What is the first step? Is this documented? Have these plans been updated in the last five years? Collaboration <ul style="list-style-type: none"> ● Ready to work together collaboratively in the event of an outbreak. ● Are there communications channels in place with stakeholder agencies and surrounding districts? ● Have partnerships been built? Are there official memorandums of understanding for mutual aid or resource sharing? Training/Mock Drill Scenarios

Criterion/Metric	Definition	Application
		<ul style="list-style-type: none"> ● Well-trained team who knows what to expect in any event and the exact steps to take when there is an outbreak. ● If Districts have participated in emergency training or mock drills, I would expect they are more prepared for an emergency.
Willingness	The state of being inclined or favorably predisposed, individually, or collectively as an agency, toward a public health emergency (McCabe et al., 2010).	<p>Motivation and Volunteering</p> <ul style="list-style-type: none"> ● District and staff sentiment to respond to an emergency. ● Are staff volunteering to step up? ● Are they motivated to try or adjust to new protocols when experiencing an emergency? Is there hesitancy or mistrust?
Ability	The actual operational power like skills, expertise, or knowledge of an organization or individual to perform response-related tasks during a public health emergency (McCabe et al., 2010). Includes financial preparedness.	<p>Fiscal Health</p> <ul style="list-style-type: none"> ● Districts emergency fund, budget preparedness for an emergency, insurance, and risk management, and overall financial well-being. ● For example, if a local district had an emergency outbreak, would this put them in the red or sink their operations? <p>Staffing & Skillset</p> <ul style="list-style-type: none"> ● District’s adequate staffing. ● Staff skillsets to responding more efficient and effectively. <p>Infrastructure Maintenance</p> <ul style="list-style-type: none"> ● Keeping infrastructure up to date and in good condition can make a district able to respond quickly because equipment and tools are ready to activate. ● Decaying and unmaintained infrastructure can keep districts from being able to respond adequately in the event of an emergency.

III. Methodology

Document Review

To better evaluate whether the districts identified in *Table 1* are prepared for an emergency mosquito issue, I chose to review a variety of different documents. The below review includes a summary of publicly available statewide plans, local emergency response plans, and any previous literature close to or adjacent to the topic. In general, there has been little research done on mosquito and vector control districts and their emergency preparedness plans and collaboration efforts specifically focused on a geographic area. There is some published work about mosquito response in the wake of a hurricane in the southern part of the U.S. (Connelly, 2020), but these articles mostly focus on mosquito control response and not emergency planning that went into the response since hurricanes are natural disasters and unpredictable. To my knowledge, no literature evaluates district-by-district collaboration efforts, relationships, and existing emergency preparedness plans. I found that most disease outbreak plans are outdated with most plans citing the last time being updated in 2020 and a statewide plan on how local, state, and federal agencies can work together in the event of a disease outbreak dated back to 2013 without any updates or changes since the COVID-19 pandemic (CDPH, 2013). I will note more frequently updated CDPH plans below but this finding begs the question on how often on average a plan should be updated like annually or every five years and the implications of these updates.

A report by the National Association of County and City Health Officials (NACCHO) released in 2017 found that 84 percent of United States vector control agencies need improvements organization-wide (NACCHO, 2017). A 2020 report by NACCHO found that through a capacity and challenge analysis of local vector control programs in the United States

by evaluating funding, staffing, surveillance, and response capabilities, continuous funding, enhanced collaboration between local health departments and vector control programs, and the need for additional resources to address emerging vector-borne diseases and environmental threats was important to emergency preparedness (NACCHO, 2020). In 2022, a study was done that allocated some efforts into looking at creative and proactive approaches to vector-borne disease threats in the U.S. and found some training efforts and funding by the CDC were established to help better prepare districts (Dye-Braumuller et al., 2022). This article also cited that the U.S. tends to be reactive in mosquito control efforts which makes the U.S. vulnerable to disease outbreaks (Dye-Braumuller et al., 2022).

In addition to the analyses of mosquito and vector control preparedness efforts above, The Trust for America's Health is a nonprofit, nonpartisan public health policy, research, and advocacy organization that annually develops the *Ready or Not: Protecting the Public's Health from Diseases, Disasters, and Bioterrorism* report that has tracked the nation's public health emergency preparedness since 2003. The report uses 10 key public health preparedness indicators to give state officials benchmarks for progress, point out gaps within their states' all-hazards preparedness, and provide data to compare states' performances against similar jurisdictions. The 2023 report analyzed sustained public health funding, disease surveillance capacity, healthcare access and quality, public health laboratory and hospital surge capacity, access to safe water, and paid time off for all employees and emergency preparedness. The report provided some recommendations for vector control including recruiting, training, and retaining public health personnel at all levels for retention of a diverse workforce, to strengthen leadership and coordination of the agencies tasked with protecting the nation against health threats to prevent outbreaks and future pandemics, prepare the health system to respond and recover and

prepare for environmental threats (Trust for America's Health, 2023). The report summarized that depending on the emergency and how long it lasts or the spread into multiple areas, a district's resources can be sustained or dried up quickly.

Regardless of the district's size and ability to respond, improvements in plan development locally and regionally, ongoing trainings and mock drills, emergency funding planning, analyzing opportunities to exercise cooperative agreements, MOUs or annexations, and considering mechanisms for future state or federal funding can help districts improve preparedness regardless. More research is needed in California and most existing research encompasses the entire country rather than a specific geographic area.

Organizations and Plans

Most mosquito and vector control districts in California belong to the Mosquito and Vector Control Association of California and lean on the association for assistance in collaboration and planning with other districts throughout the state and partners like the California Department of Public Health and UC Davis. The association's mission is to provide leadership for California mosquito and vector control to protect public health through advocacy, research, and collaboration (Mosquito and Vector Control Association of California, 2024). In 2023, the association established an emergency preparedness working group to help assist districts with emergency planning efforts which was born out of the Tulare Lake issue in central California.

The California Department of Public Health Vector-Borne Disease Section protects the health and well-being of Californians from diseases transmitted to people from insects and other animals (CDPH, 2024). Some of the services CDPH notes on its website include coordinating preparedness activities for detection and response to introduced vectors and vector-borne diseases like West Nile virus, conducting emergency vector control when disease outbreaks

occur, advising local agencies on public health issues related to vector-borne diseases, and overseeing local vector control agency activities through a Cooperative Agreement (California Department of Public Health Vector-Borne Disease Section, 2024). One of the most important documents to this evaluation is the Guidance for Surveillance of and Response to Invasive *Aedes* Mosquitoes and Dengue, Chikungunya, and Zika in California developed by the California Department of Public Health, Division of Communicable Disease Control, with input from the Mosquito and Vector Control Association of California and the California Conference of Local Health Officers and last updated in January 2024 (CDPHa, 2024). This document is meant to guide local vector control agencies and health departments to prepare for, conduct surveillance of, and respond to the detection of invasive *Aedes* mosquitoes and human cases of dengue, chikungunya, Zika, or other exotic mosquito-borne viral infections potentially transmitted by these mosquitoes (CDPHa, 2024).

This important plan outlines specific steps to take if there is a locally acquired human case of dengue, chikungunya or Zika at a district including who to collaborate with and what needs to be done in response to the detection. The plan also details more steps if there were one or more human infections of the previously mentioned diseases with a more aggressive and immediate response. Some steps outlined for districts to follow include facilitated testing of suspect cases and enhanced case finding, additional coordination between local and state public health epidemiologists and public health laboratorians, enhanced coordination and communication with clinical diagnostic laboratories, outreach and education to healthcare providers on the diagnosis and clinical management of dengue, chikungunya, and Zika viruses and an enhanced media campaign to the public. (CDPHa, 2024). In particular, the plan notes that CDPH may coordinate and lead the regional public health response including surveillance,

investigation, and control; rapid interagency communication with CDPH and the local vector control agency in the location of the outbreak would be critical to prevent outbreaks of dengue, chikungunya, or Zika.

In addition, CDPH's 2023 California Mosquito-Borne Virus Surveillance & Response Plan has models that can be used by districts to evaluate the level of response necessary to their current mosquito situations and appropriate response activities for normal season, emergency planning, and epidemic conditions (CDPH, 2023). One of the most valuable sections of this plan includes a key agency responsibilities list which outlines the multiple responsibilities for specific agencies including local mosquito and vector control districts, MVCAC, CDPH, UC Davis, California Department of Food and Agriculture, California Animal Health and Food Safety Laboratory, Local Health Departments and Public Health Laboratories, California Emergency Management Agency, United States Centers for Disease Control and Prevention and the State Water Resources Control Board. This plan has a supplemental plan titled Operational Plan for Emergency Response to Mosquito-Borne Disease Outbreaks which provides even more detailed response information for District's to follow if experiencing an emergency mosquito issue. These plans can also be extremely valuable to mosquito and vector control districts when establishing emergency response protocols. Overall, if these plans are living documents and updated regularly, these are the most explicit and detailed emergency response plans specific to mosquito and vector control districts I've found in my research.

In summary, there are not many publicly available plans or processes for mosquito and vector control districts to lean on in their emergency preparedness planning. There is also limited research on the mosquito and vector control industry and the value of its emergency preparedness efforts. Mosquito and vector control districts in California must rely on partners

like MVCAC and CDPH to receive valuable collaboration or explicit preparedness plans to improve and guide their preparedness efforts.

Stakeholder Interviews

To further evaluate whether the Sacramento region is prepared for a vector-borne disease outbreak, I scheduled three in-depth stakeholder interviews with Sacramento-area district managers to best allow me to obtain qualitative feedback from district representatives about their existing emergency response plans or relationships with agencies and surrounding districts in the event of a disease outbreak. I met over the phone, on Google Meet, and in person with the interviewees including Gary Goodman, District Manager of the Sacramento-Yolo Mosquito and Vector Control District, Steve Abshier, District Manager of the Sutter-Yuba Mosquito and Vector Control District, and Joel Buettner, District Manager of the Placer Mosquito and Vector Control District. In addition, I scheduled one interview with a southern California mosquito and vector control district who had experienced a locally acquired case of dengue in 2023, for this interview, I spoke with Jason Farned of the San Gabriel Valley Mosquito and Vector Control District. All districts and their representatives cited in *Table 3* agreed to be quoted in this project.

As a member of the Mosquito and Vector Control Association of California, I was in the unique position to attend quarterly board meetings and the association's annual conference in Monterey in January 2024. I used information I gathered during specific symposiums and meetings to help guide my project, document review, and develop questions for stakeholder interviews. I used the RWA framework in *Table 2* to develop stakeholder interview questions and visited all district websites to get a better understanding of their different districts and direct me to additional resources. I shared interview questions with participants who requested them prior to the interviews.

Table 3: Mosquito and Vector Control District Stakeholder Interviewees

District	County	District Manager
Placer Mosquito and Vector Control District	Placer County	Joel Buettner
Sacramento-Yolo Mosquito and Vector Control District	Sacramento and Yolo Counties	Gary Goodman
Sutter-Yuba Mosquito and Vector Control District	Sutter and Yuba Counties	Stephen Abshier
San Gabriel Valley Mosquito and Vector Control District	Los Angeles County (Pasadena, location of locally transmitted dengue case)	Jason Farned

By allowing an hour time slot for an interview with each of the contacts, I was able to ask in-depth questions, probe for more information, and still have time for interviewees to provide in-depth responses, immediate feedback opportunities, and time for the interviewee, myself, to seek clarification if necessary. In addition, interviewees could be candid and comfortable answering my questions because of existing relationships we have from my involvement in MVCAC. Using the RWA framework, I asked interviewees 15 questions each as part of either the readiness, willingness, or ability criteria but also included some general questions at the end to receive feedback on the overall preparedness of their districts – see the appendix for the interview questionnaire. All district managers include in *Table 3* were very open and honest and were able to answer questions succinctly.

IV. Findings/Implications

By using the RWA framework to organize and evaluate the emergency preparedness of Sacramento-area mosquito and vector control districts to respond to a mosquito-borne disease emergency, most districts felt moderately ready and extremely willing, and their ability was mixed because of the different sizes of districts, service area, and equipment inventory. It's important to note that each district's size, service area, and existing budget may or may not be able to withstand an emergency depending on the magnitude and length of the emergency.

Tables 4-6 explore each criterion in the RWA framework and the findings and implications from the document review and stakeholder interviews.

Table 4: Readiness Findings & Implications

Readiness		
Criteria	Findings	Implications
Process, Plans and Procedures	<p>Most districts cited the CDPH plans noted in the document review above as their guiding documents although some districts noted that their internal district-specific plans have lagged in updates.</p> <p>For example, San Gabriel Valley Mosquito and Vector Control District (SGVMVCD) noted an enhanced neighborhood support response plan in addition to the CDPH plan which was established at their district long before their human detection of dengue. This proactive response uses an escalating response model to ramp up response activities or proceed with business as usual. SGCMVCD cites this neighborhood support response model as what allowed them to respond quickly and efficiently to the locally transmitted dengue case in 2023.</p>	<p>The findings illustrate the need for more regularly updated district-specific plans or response models within districts that are based more specifically on geographic differences and impending risks as it varies from region to region rather than a statewide overarching plan.</p>
Collaboration	<p>All districts felt their relationships with partners were strong and they could contact important partners or other districts in the event of an emergency and were very aware of their specific roles.</p> <p>One district noted they have no written process or step-by-step information-sharing checklist in terms of who to contact and when. However, they feel confident in reaching out to local, state, and accessing the state for potential federal partners.</p> <p>All districts shared relationships with CDPH and CalOES and even the CDC.</p>	<p>Two districts agreed that communication at their districts and with outside partners and the public was one of the biggest barriers to a mosquito emergency response. A common emergency language was mentioned by one district to be an important part of communicating effectively during an emergency as well as a list of important contacts. Another district mentioned the quickness of being able to respond which is sometimes held up by the process of information and human cases coming from the county public health department. Some barriers also remain unknown as one stakeholder mentioned. Although they have responded to their first dengue case that was locally</p>

	<p>SGVMVCD shared a unique perspective in that they participated in a county-wide emergency response plan which was comprised of micro-meetings and created a large document of step-by-step processes for the county to follow. SGVMVCD shared that these meetings helped their leadership create personal relationships with important county departments and contacts which helped in their locally transmitted dengue response. The stakeholder shared that a big part of the plan was identifying who communicates with whom and when. So, for example, if the county has sensitive human information and sends it to a local district, what protections are in place, and who responds and initiates the response? Through this plan development, SGVMVCD met other emergency response contacts who connected them with a volunteer network that greatly supported their emergency response in 2023. Other districts did not formally meet with emergency response contacts, and this could be because they did not have as advanced of an invasive <i>Aedes</i> infestation as SGVMVCD, they do not have the contacts or do not find a partnership like this valuable.</p> <p>As for resource-sharing efforts and formal or informal relationships, most districts cited the cooperative agreement with CDPH and a formal MOU between Sac-Yolo and Placer for shared aerial treatments along with San Joaquin, East Side, Turlock and Merced districts. Most districts cited more informal relationships if the need for mutual aid occurred and felt comfortable with assisting neighboring districts. Some districts cited treating nearby or bordering counties in the past and under the health and safety code, districts can address public health issues even if it's not in their service area. One district cited preparing to send staff to another district not in a neighboring area that did not have mosquito services during an unusually high mosquito season, but the assistance never panned out however they are open to resource sharing in</p>	<p>transmitted the district anticipated more barriers in the future if there is another human case.</p> <p>Some districts feel confident in their neighboring districts (most interviewees are neighboring districts to each other) while others are concerned with their neighbors and their mosquito response. For example, Placer is neighbored by Nevada County which does not have an integrated vector management program. Although, so far in the history of the district, they have only assisted Nevada once with West Nile virus response but anticipate if invasive <i>Aedes</i> spread to the county that more services may need to be provided. This provides an opportunity for an MOU or even an annexation of the county into Placer's service area if the public is willing to pay for the district's services.</p> <p>Most districts did not have a documented communications model of how information is shared within the district or externally in the event of an emergency. SGVMVCD however had an enhanced neighborhood support model that was a process that included communications within their organized steps of mobilizing. Adding an organized communications model into emergency planning activities can greatly increase response time and streamline communication within the organization and externally to partners whether the correct contacts are documented in an order. This process is not only important internally at districts but also regionally to verify the correct contacts since some positions tend to change often.</p>
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	<p>similar events. The Sutter-Yuba district cited a mutual aid agreement developed in the outset of the pandemic with Butte, Colusa, and Glenn counties that allows for Sutter-Yuba to request manpower or equipment and it defines reimbursement policies in the case of a mosquito situation that exceeds their resources. As of February 2024, this agreement has not yet been exercised. San Gabriel Valley district has a cooperative agreement with our southern California districts in the southern region for resource sharing. The district has never had to use the agreement formally.</p>	
<p>Training/Mock Drill Scenarios</p>	<p>SGVMVCD was the only stakeholder that participated in a formal emergency preparedness training in the last five years. Sac-Yolo and Placer mentioned annual trainings before the start of the season while Sutter-Yuba agreed a formal emergency training would be helpful. SGVMVCD underwent intensive preparedness training and participated a mock run-through of a locally transmitted disease case which they found helpful to their response.</p>	<p>The findings illustrate the need for more formal training processes or mock drills since they can better prepare staff is response to an emergency.</p>

Table 5: Willingness Findings & Implications

Willingness		
Criteria	Findings	Implications
Motivation and Volunteering	<p>All districts felt confident in their staff's willingness and motivation to respond to an emergency both in volunteering to work outside of normal work hours and conditions to earn overtime hours. One district shared that although they have not been faced with an emergency like a locally transmitted dengue case yet, has always had staff step up to make early morning treatments or stayed after normal work hours to finish testing during peak West Nile virus seasons.</p> <p>All districts had established outreach and communication protocols in place. Most districts have already changed, updated, or streamlined protocols or resources to be prepared for an emergency. Some barriers identified in response included misinformation spreading or public pushback on aerial treatments, length of the outbreak, geographic barriers like a mountainous area making it hard to access mosquito development sites, and equipment shipping or supply and demand delays.</p>	<p>These findings show the importance of encouraging staff and assessing staff motivation in an ongoing fashion to keep motivation levels high.</p> <p>Communication protocols remain extremely necessary in emergency response and districts can benefit from keeping processes updated or streamlining. Reviewing these protocols with staff regularly is also important.</p>

Table 6: Ability Findings & Implications

Ability		
Criteria	Findings	Implications
Fiscal Health	<p>All districts have established emergency funds ranging in different sizes. Most districts raised concerns that if a disease threat lasted a long time, was in multiple locations, or was sustained - no end to positive cases, the impacts on their budgets might be devastating. At this point, one district noted accessing state or federal funds which is more difficult to access because of bureaucratic red tape or adjusting response to be normal operations rather than an emergency. One important note, San Gabriel mentioned is that funding in reserves is much harder to access than a budget line item, so they were able to move their emergency reserves into an accessible fund moving forward.</p>	<p>When districts were asked what other resources would enhance their emergency response, some districts responded with future funding opportunities with state partners, more cross-agency collaboration and a documented list that's updated on an ongoing basis of key point people so that when there is management turnover or succession on both ends, staff knows who to reach out to, more continuous coverage of mosquito services across the state, and training or coalition forming to build relationships further and respond quickly.</p>
Staffing & Skillset	<p>Most districts seem confident in their staffing skillsets and experience, and some feel somewhat adequately staffed in size. One district mentioned the district could always use more staff with important skills. SGVMVCD mentioned that response time to the threat is dependent on how many staff were allocated to the emergency response. How quickly they were able to respond depended on pulling staff off of other district activities or West Nile virus activities. It would depend on district to district on how many staff members would be moved over from regular operations to emergency response or an all-hands response to conduct 150 feet of the location of local transmission door-to-door inspections which is the recommended response for a locally transmitted dengue case. SGVMVCD and Sac-Yolo have experience partnering with volunteer organizations.</p>	<p>These findings show the need for ongoing training of staff in different skill areas. Assessing staffing levels in an ongoing review is also important to ensuring the district is adequately staff during an emergency event.</p>

	Most districts have had experience responding to the initial detection of invasive <i>Aedes</i> mosquitoes or high levels of West Nile virus cases that have offered them some preparation for a disease threat issue.	
Infrastructure Maintenance	Most districts felt confident in their equipment and maintenance upkeep processes and procedures. Two districts had on-site full-time maintenance and mechanic staff while others farm their maintenance outside of the district, especially for specialized equipment. No districts seemed concerned about their equipment in the event of an emergency.	These findings show the need to have a maintenance and replacement plan for equipment and a specific plan on equipment during emergency situations.

Overall, all districts feel prepared for an emergency disease threat but have identified different areas for improvement and preparation but whether they are truly prepared or not is all dependent on the size, amplitude, and length of a disease threat emergency. SGVMVCD mentioned their experience with their locally transmitted case of dengue was somewhat of a perfect storm. They were given a potentially locally transmitted case information early from their county public health department, they were in an all-staff meeting when receiving the news, and they had just done all-hands training and practiced the response on a small scale which was flexible and scalable for a bigger emergency. The district did imply that if the emergency was any bigger - meaning multiple cases of locally acquired dengue, the district most likely would have hit a wall or run out of resources.

V. Recommendations

Although Sacramento-area mosquito and vector control districts feel in theory adequately prepared in many ways for an emergency mosquito-borne disease threat, they can benefit from more planning, preparing, and practicing for an emergency to close preparedness gaps. Through their interviews in the RWA analysis, I was able to identify some gaps in their efforts or areas that could use improvement. Even SGVMVCD, which had many different preparedness efforts in place before their emergency, offered a wealth of learning experiences from their emergency response in fall 2023. Moreover, their district foresees challenges with the length and amplification of a future emergency on funding, staffing and materials. Below, I outline different areas and preparedness gaps that Sacramento-region districts can focus their preparedness efforts on to better prepare their district, management, their staff, and their funding mechanism or reserves for future emergencies.

Improvement Area 1: Planning and Collaboration

Most districts cited that they rely on CDPH's invasive *Aedes* response plan to prepare for an emergency and within their districts have not regularly updated their plans or scheduled trainings to review the plan. Developing a region and district-specific emergency plan based on the CDPH recommendations, can help districts apply the recommendations to nuances at their district since they are different in terms of their services, equipment, sizes, and potential threats. In addition, regionally, a plan developed collaboratively between like districts and geographically close partners has multiple benefits not only for mosquito control providers but also other partners like the county department, office of emergency services, and other private or public partners. This activity and deliverable created together would not only bring together partners, but it can also improve relationships and integrate districts into designing a response

plan that better suits their region and is a unified agreed-upon approach for moving forward that districts nearby to one another can feel good about.

Meeting together to review plans or network collaboratively on an ongoing basis can have its benefits in an emergency especially as there might be turnover, retirements, and new faces in the group. Local partner meetings quarterly can help with communications processes, plan updates, and building effective relationships. Something we can learn from emergencies before us include the 2009 H1N1 pandemic which offered a collaboration opportunity between the Office of Emergency Services and the local public health agency to create a National Incident Management System organization which combined public and private partners together and these groups were continuing to meet once a week to work on mutual issues and maintain important relationships formed during the emergency (Barishansky, et al., 2012). Also to note is the DHS Homeland Security Grant Program which encouraged collaboration in training and exercises between the public health and emergency response communities (Barishansky, et al., 2012). It also permits sharing of operational assets. In March 2024, the Nevada County Public Health Emergency Preparedness team facilitated a hospital evacuation workshop at Tahoe Forest Hospital with representatives of Nevada County (CA) and Washoe County (NV) including hospital staff, law enforcement, emergency management, public health, fire partners and more to initiate a partnership amongst neighboring counties across state lines to become more disaster ready and know how to work together during a disaster. At the end of their workshop, the consensus was reached amongst the group that relationships were the greatest asset during emergencies.

Improvement Area 2: Annexations & MOUs

I anticipate that areas of the region and counties without local mosquito and vector control districts will eventually increase the chance of a disease outbreak and the need for more collaboration or possible Memorandum of Understandings like one of the district notes in its interview across county borders. Districts may consider analyzing existing cooperative agreements and MOUs as well as annexation opportunities to provide more consistent mosquito and vector control coverage across their region and eventually the entire state. Annexations of land into public agency service areas is one of the oldest and most common methods of adjusting municipal boundaries and for mosquito districts, establishing or expanding their districts service area (Coe, 1983). This improvement would allow for more help from neighboring districts and an opportunity better stack resources in the event of an emergency. For example, if the Tulare Lake area - the refilled lake that was causing a mosquito emergency issue and not in a districts border - was in a mosquito and vector control district, we could anticipate that the emergency response would have been faster. Districts should exercise agreements, if necessary, to have better emergency and overall public health outcomes. All districts were open to assisting each other and it's important to provide a continuum of services in the event of an emergency.

Improvement Area 3: Training & Mock Drills

Districts could benefit from participating in a county-specific or district-specific emergency response training. Both CalOES and FEMA offer emergency training programs that review important emergency terminology and structures that are followed universally statewide if an emergency becomes declared. The California Specialized Training Institute (CSTI) provides training for emergency management including preparedness, response, recovery, and mitigation (*Emergency Management Program*, 2024). This training is important because it reviews emergency operation center training and levels of the California Standardized Emergency Management System and Incident Command System. None of the districts other than SGVMVCD referenced these trainings. FEMA's program, the Emergency Management Institute (EMI) offers the Emergency Management Professional Program (EMPP) which provides a framework for acquiring the knowledge, skills, and abilities to enter and progress through the field and to meet the challenges of a dynamic and complex environment (*Emergency management professional program*, 2024). Sending management or staff to these trainings can greatly increase preparedness levels.

Participating in mock drills either at the trainings listed above or as a district or county also has benefits to preparedness. Mock drills can improve emergency response time, check plan efficiency and effectiveness and if policies make sense or need updating, and clarifies roles and responsibilities. Districts should consider incorporating mock drills into emergency preparedness training procedures.

Improvement Area 4: Funding Mechanisms

Most districts had emergency reserves set aside ranging in amounts and whether they were accessible in their budgets or locked in their reserves. However, when local resources become overwhelmed the process of applying to receive state or federal funds can be arduous and an emergency declaration is often needed to access funds (Katz, et al., 2017) which makes it even more important for districts to set aside emergency funding that is accessible. How much is the right amount for an emergency is a tough question to answer but ongoing and timely planning for future emergencies and adjusting emergency funds annually is important although cannot guarantee sufficient funds. District should assess funds by analyzing spending habits at the district, average costs for certain emergency response efforts, and estimated staffing to adequately develop an emergency fund that makes sense for their district's size, service area and staff. Although there is not a formula established for mosquito and vector control emergencies to build an emergency fund based on percentages (this might be something to investigate further), districts could lean on the Government Finance Officers Association for fund balance guidelines.

This may not be feasible anytime soon with California's current budget in a deficit, but if invasive *Aedes* mosquitoes continue to spread and introduce more opportunities for local disease transmission, California mosquito and vector control districts financially will head toward the red. Regardless of emergency funds, Districts would not be able to continue other services like West Nile virus prevention if continually responding to local transmission cases. This is concerning because keeping Californians safe from mosquito-borne diseases is important to protecting public health. Districts can continue to shore away emergency funds for future emergencies, but there is still the risk of an emergency funds dwindling and resources being scarce, especially at smaller districts. Districts should look into future potential state and federal

funding opportunities to prepare for mosquito-borne disease emergencies and risks that are inevitable due to climate change and the proliferation of invasive mosquitoes. In the past, federal emergency planning guidance expects state and local authorities to lead the initial response of a disaster or emergency, with federal measures available only under certain conditions.

There are only four routes to access emergency funds: a presidential declaration under the Stafford Act, a presidential declaration under the National Emergencies Act (NEA), a declaration of a public health emergency by the secretary of the HHS, or congressional action to enact legislation for supplemental appropriations. This process occurred in 2000 during the West Nile virus outbreak with a Presidential Emergency Declaration under the Stafford Act with \$2.44 million in Public Assistance grants and \$2.44 million in Emergency Work. The process was initiated again in 2016 during the Zika outbreak and with the Health and Human Services secretary declaring a public health emergency in Puerto Rico under section 319 of the Public Health Service Act and a Presidential Emergency Funding request for \$1.9 billion with \$1.1 billion granted as part of Continuing Resolution. This illustrates the limited options for federal funding although not impossible to access, but the conditions need to be just right (Katz, et al., 2017).

VI. Conclusion

Are Sacramento-region mosquito and vector control districts prepared for a mosquito-borne disease emergency? The answer is multi-faceted. With the spread of invasive *Aedes* mosquitoes on the rise throughout California and the Sacramento region, paired with climate change creating habitats year-round for invasive mosquitoes to stay active, the risk of locally transmitted mosquito-borne diseases is on the rise and inevitable in many cases. Overall, districts felt prepared for a mosquito-borne disease outbreak although there were many ways to improve preparedness, planning, and practicing and opportunities to adjust organizationally to improve public health outcomes with MOUs or potential annexations of California areas not in a mosquito or vector control districts service area. According to the research, emergency readiness can be dependent on the length and magnitude of the emergency.

With only one detailed plan from CDPH for districts to lean on in an emergency, there is room for more geographically specific emergency plan documentation and communication organization to lead mosquito and vector control districts through an emergency event. Training can only better prepare district leadership and staff to respond to an emergency more qualified and experienced. Preparing financially for an emergency is key to a district's longevity to withstand an emergency and although all districts had emergency funds set aside, the sufficiency of these funds is dependent on the type of emergency and its length and magnitude. There are more opportunities for districts to exercise cooperative agreements and MOUs as well as to annex more unrepresented areas of California into their service area which could with a funding mechanism increase public health outcomes and budgets while also better preparing the state for a mosquito emergency. Lastly, districts should consider future funding opportunities or

mechanisms from the state or federal government to help sustain operations during an unpredictable emergency event.

Mosquito and vector control districts in the Sacramento region are organized, hard-working, and scientifically driven organizations that are passionate about protecting public health in California regardless of county borders. Mosquitoes continue to proliferate throughout the state and the Sacramento region and being prepared for a mosquito-borne disease outbreak or emergency is important. Improvements to preparedness planning will only increase public health outcomes in the Sacramento region. Whether or not Sacramento region mosquito and vector control districts are prepared for an emergency matters because they have the ability to respond with control methods to keep residents more safe, aware and limit local transmission of a potentially deadly disease. This analysis can offer local districts insights into areas where they can enhance their internal preparedness and empower districts to take the next steps in improving their preparedness efforts. This, in turn, can improve public health outcomes for their service areas and for California.

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Appendix A

Stakeholder Interview Questionnaire

These questions are open-ended and meant to be answered at length to get a sense of the sentiment of district managers if a disease outbreak happened at the border of their service area with another county or within their district.

Readiness

1. What emergency protocols, procedures, or response plans does your district have in place in preparation for a disease outbreak? When were these last updated or reviewed?
2. What established processes do you have in place to collaborate with neighboring districts, counties, or state departments during a disease outbreak within your district or a neighboring district? Please note the questions below are probes to draw out more information.
 - a. Do you have an established communications channel or a step-by-step checklist of people who need to be informed?
 - b. Do you have a relationship with (local, state or federal) partners like CalOES, NACCHO or FEMA? Do you have a relationship with your County public health officer?
 - c. What resource-sharing efforts do you have in place with other districts? (e.g. personnel, equipment, funding, surveillance data, etc.)
 - d. Do you have any established partnerships or agreements in place with neighboring districts or agencies to support emergency response efforts like MOUs, mutual aid agreements or cooperative agreements?

3. Has your district or in collaboration with a neighboring district or partner organization conducted a training, drill, or emergency preparedness exercise together?

Willingness

4. Is your District willing to take on new responsibilities during an emergency for your service area or a neighboring district's service area?
5. How motivated is staff to actively participate in emergency mosquito surveillance and control activities?
6. What programs does the district, and its staff have to engage the community in emergency mosquito control efforts? How responsive is the district to feedback from the community?
7. Has your district identified challenges or barriers that prevent the district from effectively implementing emergency mosquito control measures? Have you addressed any of these gaps? If so, what actions have been taken?

Ability

8. Does your district have emergency funding set aside in your budget for an emergency disease outbreak? Would a disease threat and an appropriate response to limit risk to people put your budget in the red or sink operations?
9. What expertise and skills do staff members possess in mosquito surveillance, identification, control, or communication that would be valuable during an emergency response to a disease outbreak?
10. Can you provide examples of successful mosquito control interventions or responses to an emergency at your district in the past that effectively show your district can respond efficiently in an emergency?

11. What measures does the district have in place to ensure the ongoing maintenance and upkeep of mosquito control equipment and infrastructure? What equipment and resources are readily available for emergency mosquito control activities like larviciding or adulticiding?
12. Are staff members equipped with the necessary tools and resources to carry out emergency mosquito control activities efficiently and effectively?
13. Do you have adequate staffing for an emergency or disease threat? Have you partnered with a volunteer organization to mobilize more people in the event of a disease outbreak?

Other

14. What are the most challenging barriers to effective collaboration during a disease outbreak?
15. Does a neighboring county without mosquito and vector control services or limited services affect your ability to protect public health in your county or collaborate effectively?
 - a. How does this impact your district's operations?
16. What other resources, funding, cross-county district collaboration or partnerships would be beneficial to enhance collaborations with neighboring districts, counties, or state departments during a disease outbreak and protect public health?
17. Overall, do you feel your District is prepared for an emergency disease outbreak in your county or a neighboring county?

Any questions? Or anything you would like to add?