Vector-Borne Disease Section

Annual Report

2022

California Department of PublicHealth

2022

ANNUAL REPORT

VECTOR-BORNE DISEASE SECTION

INFECTIOUS DISEASES BRANCH

DIVISION OF COMMUNICABLE DISEASE CONTROL

CENTER FOR INFECTIOUS DISEASES

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

Gavin Newsom
Governor
State of California

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Preface

I am pleased to present to you the 2022 Annual Report for the Vector-Borne Disease Section (VBDS) of the California Department of Public Health (CDPH). VBDS staff conducted prevention, surveillance, and control of existing and emerging vectors and vector-borne diseases throughout California in 2022.

In 2022, West Nile virus (WNV) activity was reported from 35 (60%) of 58 counties. Of the 207 human cases reported from 27 counties, 78% were the severe neuroinvasive form of the disease and there were 15 fatalities. West Nile virus continues to pose the greatest vector-borne disease threat in California, with over 7,500 cases (346 fatal) reported since 2003. In addition to WNV activity, St. Louis encephalitis virus (SLEV) activity was detected in 12 counties and there were 16 human cases, the highest number reported since the reemergence of SLEV in 2015.

The number of travel-associated human cases of dengue (130), chikungunya (24), and Zika (5) in 2022 increased relative to 2021, likely reflecting an increase in international travel following the peak of the COVID-19 pandemic. *Aedes aegypti* (yellow fever mosquito), the primary vector of dengue, Zika, and chikungunya viruses, expanded its range in California in 2022, and was detected in three new counties in northern California. The range of *Aedes albopictus* (Asian tiger mosquito) increased in southern California, but they were not detected in new counties. With *Aedes aegypti* and *Aedes albopictus* established in 25 and 5 counties, respectively, there is the ongoing threat of local virus transmission in some regions of the state.

In 2022, 225 human cases of flea-borne typhus, caused by *Rickettsia typhi*, were reported from five counties; 87% of the case-patients required hospitalization. Typhus is considered endemic in parts of southern California. Plague activity was detected in rodents or carnivores from four counties (El Dorado, Mariposa, Mono, and Sierra) in 2022, prompting enhanced outreach. Since 1980, hantavirus infection has been diagnosed in 90 California residents, with most cases exposed to Sin Nombre virus (SNV) in the interior mountain ranges of the state or eastern Sierra Nevada. There were no human cases reported in 2022, although SNV antibody-positive deer mice were found in 9 of 15 counties sampled.

Human cases of six tick-borne diseases were reported in California in 2022. Reports of Lyme disease (99) decreased slightly relative to 2021. Although Lyme disease is the most commonly reported tick-borne disease in California, there were also cases of anaplasmosis (16), Rocky Mountain spotted fever (9), tick-borne relapsing fever (7), babesiosis (5), and ehrlichiosis (2). In addition, in 2022, the first human case of *Borrelia miyamotoi* infection was confirmed. Genetic characterization of *B. miyamotoi* from the case-patient indicated the individual was exposed to infected *Ixodes pacificus* ticks in Marin County. In 2022, VBDS and collaborating agencies collected and tested thousands of ticks throughout California, including over 24,000 *Ixodes pacificus* (western blacklegged tick) from 37 counties, to aid in identifying areas at highest risk of tick-borne disease transmission.

In 2022, VBDS continued to expand public education through social media, digital and print materials, and the development of new web-based toolkits and interactive maps. VBDS continued to provide extensive consultation and training to United States Forest Service and National Park Service employees to reduce the risk of vector-borne disease exposure to park staff and visitors.

Many of you are our collaborators and colleagues, and I hope that you find the information contained in this annual report to be of value as we collectively strive to optimize the health and well-being of all Californians.

Vicki L. Kramer, PhD, Chief
Vector-Borne Disease Section

Acknowledgements

The California Department of Public Health, Vector-Borne Disease Section works with numerous local, state, and federal agencies, private and commercial organizations, and members of the medical community in its efforts to monitor, prevent, and control vector-borne diseases in California. Some of the Section's key collaborators in 2022 are listed here.

Rodent-borne Diseases

Alameda County Vector Control Services District (VCSD); County of San Diego Vector Control Program (VCP); Delta Mosquito and Vector Control District (MVCD); Museum of Vertebrate Zoology at University of California Berkeley; National Park Service (NPS); Northwest MVCD; Riverside County Department of Environmental Health VCP; San Bernardino County VCP; San Mateo County MVCD; Santa Clara County Vector Control District (VCD); Tulare County Public Health Branch; United States Forest Service (USFS); University of California Davis School of Veterinary Medicine, Department of Veterinary Medicine and Epidemiology; West Valley MVCD.

Flea-borne Diseases

Alameda County VCSD; Army Corps of Engineers; California Department of Fish and Wildlife (CDFW); County of Los Angeles Agricultural Commissioner; El Dorado County VCP; Los Angeles County Vector Management Program; Mono County Environmental Health; Mosquito and Vector Management District (MVMD) of Santa Barbara County; NPS; Orange County MVCD; Placer County MVCD; Riverside County VCP; San Bernardino County VCP; San Diego County VCP; San Mateo County MVCD; Sierra County Environmental Health Department; United States Department of Agriculture (USDA), United States Geological Survey, Fort Collins Science Center; USDA Animal and Plant Health Inspection Service, Wildlife Services; USFS; Ventura County Environmental Health Division (EHD).

Tick-borne Diseases

Alameda County Department of Environmental Health; Butte County MVCD; County of San Diego VCP; Delta MVCD; Los Angeles County West VCD: Marin County Health and Human Services; Marin-Sonoma MVCD; Mono County Environmental Health; MVMD of Santa Barbara County; NPS; Nevada County Environmental Health; Orange County MVCD; Placer County MVCD; Sacramento-Yolo County MVCD; San Bernardino County VCP; San Diego VCP; San Mateo County MVCD; Santa Clara County VCD; Santa Cruz County MVCD; Shasta MVCD; Sutter-Yuba MVCD; Tuolumne County EHD; USFS; Ventura County EHD; West Valley MVCD.

Mosquito-borne Diseases

CDFW; University of California Davis Arbovirus Research and Training (DART) Laboratory; Mosquito and Vector Control Association of California; participating local health departments, physicians and veterinarians, and local mosquito and vector control agencies.

California Department of Public Health Contributors

Infectious Diseases Branch
Duc Vugia, MD, MPH; Akiko Kimura, MD; Terry McIntire; Allyx Nicolici, MPH, CHES®.

Microbial Diseases Laboratory
Ryan Gabrio-Brannon, PHM; Kerry Padgett, PhD; Alyssa Poe; Jayakumar Poovassery, PHM, PhD; Mahtab Shahkarami, PHM, MS; Laura Smoot, PhD.

Surveillance and Statistics Section
Yanyi Djamba, PhD; Kirsten Knutson, MPH; Colleen McLellan; Alyssa Nguyen; Joseph Nguyen; Inderbir Sohi, MPH.

Vector-Borne Disease Section
Sacramento: Vicki Kramer, PhD; Naissem Andemel, MD, MPH; Mary Beth Danforth, PhD; Anne Kjemtrup, DVM, MPVM, PhD; Jesse Laxton; Michael Niemela, MS.

Northern Region: Mark Novak, PhD; Kim Fake, MS; Gehena Girish; Greg Hacker, MS; Christian Irian; Bryan Jackson, PhD; Tony Kovach, PhD.; Matthew Ward, PhD, MSPH.

Southern Region: Renjie Hu, PhD; Sarah Billeter, PhD; Joseph Burns; Marco Metzger, PhD.

Coastal Region: Tina Feiszli, MSPH; Ervic Aquino; Maryfer Esquivel Jacobo; Leslie Foss, MS; Margaret Kerrigan; Christopher Kilonzo, DVM, MPVM, PhD; Mary-Joyce Pakingan; Milciela Reyes; Hannah Romo, PhD; Megan Saunders, PhD, MSPH; Erin Trent MS.

Veterinary Public Health Section
Curtis Fritz, DVM, MPVM, PhD; Lisa Butler; Rebecca Campagna, DVM, MPH, DACVPM.

Viral and Rickettsial Disease Laboratory
Sutana Bethancourt; Teal Bullick; Summer Adams; Cynthia Bernas; Ricardo Berumen, PHM; Brandon Brown; Lyndsey Chaille; Yocelyn Cruz; Nick D'Angelo; Mojgan Deldari, MS, PHM; Alex Espinosa, MS, PHM; Bianca Gonzaga; Ydelita Gonzales; Melanie Greengard; Jill Hacker, PhD, MPH; Kim Hansard, PHM; Carl Hanson, PhD; Monica Haw, MPH, PHM; Susan Hepp, PhD; Chantha Kath, PHM; Deidra Lemoine; Maria Liu, MPH, PHM; Ruth Lopez, PHM; Sharon Messenger, PhD; Mary Kate Morris, PhD; Leo Oceguera, MPH, PHM; Nichole Osugi, MPH; Peter Patiris, MPH, PHM; Chris Preas, PHM; Will Probert, PhD, PHM; Alexa Quintana; Clarence Reyes; Maria Salas, MPH; Hilary Tamnanchit, PHM; Serena Ting; Maria Uribe-Fuentes; Maria Vu, PHM; Shigeo Yagi, PhD.

Annual Report Cover Art and Maps
Allyx Nicolici, MPH, CHES®; Daniela Muhawi; Greg Hacker, MS.

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https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/VBDSAnnualReports.aspx

Chapters

Many staff from the Vector-Borne Disease Section contribute to each chapter of the Annual Report. Lead author(s) for each chapter are listed below.

1 Rodent-borne Diseases
Jackson, B and Kjemtrup, A. Chapter 1: Rodent-borne Diseases. In: Vector-Borne Disease Section Annual Report, 2022. California Department of Public Health, Sacramento, California, 2023. pp 1-3.

2 Flea-borne Diseases
Hacker, G; Novak, M and Kjemtrup, A. Chapter 2: Flea-borne Diseases. In: Vector-Borne Disease Section Annual Report, 2022. California Department of Public Health, Sacramento, California, 2023. pp 4-6.

3 Tick-borne Diseases
Saunders, M and Kjemtrup, A. Chapter 3: Tick-borne Diseases. In: Vector-Borne Disease Section Annual Report, 2022. California Department of Public Health, Sacramento, California, 2023. pp 7-13.

4 Mosquito-borne Diseases
Romo, H; Danforth, ME and Metzger, M. Chapter 4: Mosquito-borne Diseases. In: Vector-Borne Disease Section Annual Report, 2022. California Department of Public Health, Sacramento, California, 2023. pp 14-21.

5 U.S. Forest Service Cost-Share Agreement
Burns, J. Chapter 5: U.S. Forest Service Cost-Share Agreement. In: Vector-Borne Disease Section Annual Report, 2022. California Department of Public Health, Sacramento, California, 2023. pp 22-25.

6 Vector Control Technician Certification Program
Niemela, M. Chapter 6: Vector Control Technician Certification Program. In: Vector-Borne Disease Section Annual Report, 2022. California Department of Public Health, Sacramento, California, 2023. pp 26-27.

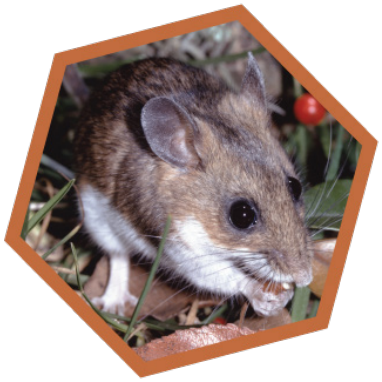
7 Public Information Materials, Publications
Nicolici, A and Kjemtrup, A. Chapter 7: Public Information Materials, Publications. In: Vector-Borne Disease Section Annual Report, 2022. California Department of Public Health, Sacramento, California, 2023. pp 28-29.

Program Overview

The mission of the California Department of Public Health, Vector-Borne Disease Section (CDPH-VBDS) is to protect the health and well-being of Californians from arthropod- and vertebrate-transmitted diseases and injurious pests. [Authorizing statutes: Health and Safety Code Sections (HSC) 116100-116108, 116110-116112; 116120; 116130; and 116180]. CDPH-VBDS provides leadership, information, and consultation on vector-borne diseases and vectors to the public and agencies engaged in disease prevention and vector control. CDPH-VBDS staff, located in three regional offices and headquartered in Sacramento, provide the following services:

- Develop and implement statewide vector-borne disease prevention, surveillance, and control programs
- Design and conduct scientific investigations to further knowledge of vector-borne diseases in California
- Coordinate preparedness activities for detection and response to introduced vector-borne diseases and vectors, such as West Nile virus disease, Zika, chikungunya, dengue, and invasive *Aedes* mosquitoes
- Conduct or coordinate emergency vector control when disease outbreaks occur
- Provide laboratory testing for vector-borne disease agents in arthropods and vertebrates
- Advise local agencies on public health issues related to vector-borne diseases
- Advise local agencies on regulatory issues pertaining to mosquito and other vector control
- Provide information, training, and educational materials to governmental agencies, the medical community, and the public
- Oversee a Cooperative Agreement (HSC 116180) between CDPH and local vector control agencies for pesticide applications
- Oversee the Vector Control Technician Certification and Continuing Education programs (HSC 116110(d))
- Provide consultation on issues related to the management of ticks, bed bugs, head lice, flies, kissing bugs, and other arthropods of public health importance
- Maintain the San Francisco Bay Area U.S. Army Corps of Engineers general permit, which allows local vector control agencies to conduct abatement activities

1 Rodent-borne Diseases



Hantavirus infection is the most important rodent-borne disease in California. Since the disease was first identified in 1993, the California Department of Public Health, Vector-Borne Disease Section has collaborated with county, state, and federal public health agencies to identify and investigate human cases of disease, to survey and study Sin Nombre virus infection in wild rodents, and to prepare and promote preventive information for the public.

Human disease surveillance

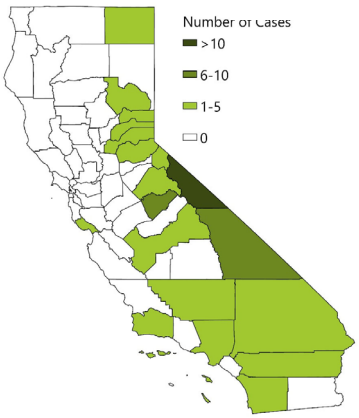
Human cases of hantavirus infection, which include both hantavirus pulmonary syndrome and non-pulmonary syndrome, are reported to the California Department of Public Health (CDPH) and are usually confirmed serologically and molecularly by the CDPH Viral and Rickettsial Disease Laboratory (CDPH-VRDL). When necessary, the CDPH Vector-Borne Disease Section (CDPH-VBDS) follows up human cases with environmental investigations, which may include trapping rodents and collaborating with CDPH-VRDL for testing for Sin Nombre virus (SNV) to evaluate unusual exposure circumstances or potential for additional exposures. In 2022, no cases of hantavirus infection were reported in California residents. Since 1980, hantavirus infection has been diagnosed in 90 California residents, with the majority of case-patients exposed to SNV in the interior mountain ranges of the state or eastern Sierra Nevada (Figure 1.1).

Rodent surveillance

In 2022, 726 rodents (Genera: *Microtus*, *Neotoma*, *Peromyscus*, and *Reithrodontomys*) were tested for antibodies to SNV (Table 1.1). Of 679 *Peromyscus* spp. sampled, 34 (5.0%) were positive for SNV antibodies. Seroprevalence in deer mice (*P. maniculatus*), the primary reservoir for SNV, was 9.5% (Tables 1.1, 1.2). At least one deer mouse was SNV antibody-positive in nine of 15 counties sampled in 2022 (Table 1.2). SNV antibody has been detected in deer mice from 25 of 43 counties sampled in the last 10 years; prevalence ranged from 0.7% to 37.6% (average 12.6%) over that period (Table 1.2).

Additionally, three (8.6%) of 35 western harvest mice (*Reithrodontomys megalotis*) and one (33.3%) of three voles (*Microtus* spp.) demonstrated reactivity to SNV. None of nine woodrats (*Neotoma* spp.) demonstrated reactivity to SNV (Table 1.1). Seropositivity in these rodents may represent spillover of SNV from deer

County of Exposure for Reported Hantavirus Infections in California, 1980 - 2022*



*Represents cases where county of exposure could be determined by case-patient history, and epidemiologic and environmental evaluation: a total of 75 cases. Since 1980, hantavirus infection has been diagnosed in 90 California residents. Exposure location was not obtainable for all reported cases.

Figure 1.1. Likely county of exposure for reported hantavirus infections (1980 – 2022)

Over 40 years of rodent and human hantavirus data in California can be viewed on an interactive map on the CDPH-VBDS hantavirus webpage.

Table 1.1. Serologic evidence of hantavirus (Sin Nombre) infection in California rodents, 2013 - 2022

		2022			2013-2022		
Species	Common name	No. tested	No. reactive	Percent	No. tested	No. reactive	Percent
Peromyscus boylii	brush mouse	45	0		728	6	0.8
Peromyscus californicus	California mouse	122	0		1,342	15	1.1
Peromyscus crinitus	canyon mouse	3	0		37	2	5.4
Peromyscus eremicus	cactus mouse	118	0		1,063	8	0.8
Peromyscus fraterculus	northern Baja mouse	0	0		973	6	0.6
Peromyscus maniculatus	deer mouse	359	34	9.5	4,198	530	12.6
Peromyscus truei	piñon mouse	32	0		404	4	1.0
Peromyscus spp.	unspeciated *Peromyscus*	0	0		28	0	
Peromyscus spp. subtotal		679	34	5.0	8,773	571	6.5
Reithrodontomys megalotis	western harvest mouse	35	3	8.6	633	74	11.7
Neotoma spp.	woodrats	9	0		251	0	
Microtus spp.	voles	3	1	33.3	66	9	13.6

mice or infection with other hantaviruses, which cross react to the SNV assay. In California, no hantaviruses other than SNV have been shown to be pathogenic to humans.

National Park hantavirus prevention

In May 2013, Yosemite National Park (YOSE) of the National Park Service (NPS) and Heluna Health (HH, formerly Public Health Foundation Enterprises) began a cooperative agreement to decrease the risk of contracting vector-borne diseases through increased health education, vector surveillance, and public health research. CDPH-VBDS and HH worked with YOSE staff in 2022 on hantavirus prevention. Activities included rodent surveillance to estimate deer mouse abundance and SNV prevalence, facility evaluations, and improving employee training and public education. Deer mouse surveillance was conducted in two areas of Yosemite. The deer mouse trap success rate (25.4%) at Yosemite Valley locations in 2022 was higher compared to the overall Valley trap success of 12.3% for surveillance conducted from 2012 through 2021. Four (5.1%) of 78 deer mice from the Valley tested positive for SNV antibodies in 2022, compared to 21 (7.4%) of 284 deer mice sampled from 2012 to 2021. The trap success of 32.4% for deer mice in Tuolumne Meadows was also higher than the overall trap success of 13.4% for surveillance events in this area from 2013 to 2021. Similar to Yosemite Valley locations, the SNV seroprevalence of three (10.3%) of 29 deer mice at Tuolumne Meadows in 2022 was slightly lower than the overall SNV seroprevalence of 75 (13.5%) of 550 deer mice sampled in this area during 2013-2021. In addition to rodent surveillance and SNV testing, over 35 buildings were evaluated for rodent-borne disease risk. CDPH-VBDS and HH staff provided hantavirus prevention recommendations to YOSE and its associated partners based on surveillance results and facility evaluations.

Lassen Volcanic National Park (LAVO) renewed a task agreement with CDPH-VBDS in 2022 for services that included hantavirus risk reduction, including facility evaluations and deer mouse surveillance to estimate rodent abundance and SNV prevalence. Deer mouse surveillance was conducted in two areas of LAVO. At Manzanita Lake, one (5%) of 20 deer mice tested positive for SNV antibodies, while another 20 deer mice captured at Drakesbad Guest Ranch tested negative. In addition, over 25 buildings in LAVO were evaluated for vector-borne disease risks. HH staff provided hantavirus prevention recommendations to LAVO based on surveillance results and facility evaluations.

Table 1.2. Serologic evidence of hantavirus (Sin Nombre) infection in *Peromyscus maniculatus* in California, 2013-2022

	2022			2013-2022		
County	No. tested	No. reactive	Percent	No. tested	No. reactive	Percent
Alameda	10	0	0.0	73	0	0.0
Alpine				9	2	22.2
Amador				9	0	0.0
Butte				6	0	0.0
Calaveras				4	1	25.0
Contra Costa				16	0	0.0
Del Norte				1	0	0.0
El Dorado	42	15	35.7	242	60	24.8
Fresno				8	0	0.0
Glenn				5	1	20.0
Humboldt				69	0	0.0
Inyo				19	6	31.6
Kern				40	0	0.0
Lassen				26	8	30.8
Los Angeles				25	0	0.0
Marin	27	0	0.0	43	0	0.0
Mariposa	78	4	5.1	326	24	7.4
Modoc				38	3	7.9
Mono				367	138	37.6
Monterey	1	0	0.0	1	0	0.0
Napa				15	2	13.3
Nevada				85	15	17.6
Orange				59	6	10.2
Placer				32	2	6.3
Plumas	18	0	0.0	114	23	20.2
Riverside	1	0	0.0	194	29	14.9
San Bernardino	4	1	25.0	139	1	0.7
San Diego	78	6	7.7	1,259	56	4.4
San Joaquin				4	0	0.0
San Mateo				173	33	19.1
Santa Barbara				12	0	0.0
Santa Clara				1	0	0.0
Santa Cruz				18	5	27.8
Shasta	19	1	5.3	110	17	15.5
Sierra				22	0	0.0
Siskiyou	7	2	28.6	80	22	27.5
Sonoma	21	0	0.0	46	0	0.0
Sutter				9	0	0.0
Tehama	6	2	33.3	99	20	20.2
Trinity				3	0	0.0
Tulare	18	1	5.6	32	2	6.3
Tuolumne	29	2	6.9	330	53	16.1
Ventura				35	1	2.9
Total	**359**	**34**	**9.5**	**4,198**	**530**	**12.6**

2 Flea-borne Diseases

Flea-borne typhus and plague are the principal flea-borne diseases under surveillance in California. The California Department of Public Health collaborates with local, state, and federal agencies to conduct a statewide plague surveillance program. The California Department of Public Health, Vector-Borne Disease Section collects, collates, and analyzes information on suspect and confirmed plague activity among humans, domestic pets, and wild animals throughout California to evaluate the potential risk of plague to the public and, where necessary, implements preventive and control actions.

Human disease surveillance

Flea-borne typhus

Human testing for *Rickettsia typhi*, the causative agent of flea-borne typhus, is principally performed at commercial laboratories. The California Department of Public Health (CDPH) Viral and Rickettsial Disease Laboratory performs serology or PCR for samples requiring additional confirmation. Two hundred twenty-five of flea-borne typhus cases were reported to CDPH in 2022. Forty (18%) of these were classified as confirmed cases according to CDPH working surveillance case definition and 185 (82%) were probable. Median age of case-patients was 41 years (range 4 to 87 years); 125 (55%) were male, 98 (44%) were female, 1 (0.5%) was transfemale and 1 (0.5%) declined to state. One hundred ninety-three (87%) of the case-patients required hospitalization. Three (1%) cases were fatal. Case-patients were residents of Alameda(1), Los Angeles (189), Orange (29), Riverside (5), and San Bernardino (1) counties. Typhus is considered endemic in parts of southern California.

Plague

Human cases of plague are reportable to CDPH by local health jurisdictions. Presumptive positive test results for reported cases are typically confirmed by either the CDPH Microbial Diseases Laboratory (CDPH-MDL) or the U.S. Centers for Disease Control and Prevention. Environmental investigation in response to a human case of plague typically includes an evaluation and risk assessment of all potential exposure sites.

There were no human cases of plague reported to CDPH in 2022.

Animal disease surveillance (plague)

Rodent and flea surveillance is conducted to test for *Yersinia pestis* or the prevalence of antibodies in rodent blood samples, which provides evidence of *Y. pestis* transmission in local rodent populations. Recreational area closures for flea control may be initiated depending on surveillance results and estimated plague transmission risks. Domestic pet plague cases and antibody prevalence in carnivores (blood samples acquired via depredation programs) are used as indicators of regional plague activity and positive results are typically followed by local rodent and flea surveillance.

Domestic pets

No cases of plague in domestic pets were reported in 2022.

Wild animals

The CDPH Vector-Borne Disease Section plague surveillance program tested 539 wild rodents and 146 carnivores from 27 California counties in 2022 (Table 2.1, Figure 2.1). Serum antibodies to *Y. pestis* were observed in 25 rodents from three counties for an overall seroprevalence of 4.6% (Table 2.1, Figure 2.1). The 539 rodents tested for plague antibodies included: 332 chipmunks (*Tamias* spp.), 124 California ground squirrels (*Otospermophilus beecheyi*), 49 golden-mantled ground squirrels (*Callospermophilus lateralis*), 23 deer mice (*Peromyscus maniculatus*), 5 Belding's ground squirrels (*Urocitellus beldingi*), 3 bushy-tailed woodrats (*Neotoma cinerea*), and 3 Douglas squirrels (*Tamiasciurus douglasii*). Antibodies to *Y. pestis* were detected in 18 yellow-pine chipmunks (*Tamias amoenus*) from El Dorado, Mono, and Sierra counties, 5 shadow (Allen's)

chipmunks (*Tamias senex*) from El Dorado County, 1 California ground squirrel from El Dorado County, and 1 Belding's ground squirrel from Mono County (Table 2.1). One rodent carcass was submitted from Mono County and tested negative for *Y. pestis* by the CDPH-MDL reference bacteriology unit (Table 2.1). Of the 146 wild carnivores (and feral pigs) tested for serum antibodies to *Y. pestis*, one black bear (*Ursus americanus*) from Mariposa County was positive (Table 2.1). The 145 negative samples included: 105 coyotes (*Canis latrans*), 17 black bears, 9 feral pigs (*Sus scrofa*), 7 striped skunks (*Mephitis mephitis*), 4 raccoons (*Procyon lotor*), 2 mountain lions (*Puma concolor*), and 1 gray fox (*Urocyon cinereoargenteus*).

Table 2.1. CDPH-VBDS plague test results in wild rodents and carnivores, California, 2022

County				Positive specimens		
Location	Rodent blood tested by serology	Rodent carcasses tested by culture	Carnivore blood tested by serology	Species	Titer	Month
Butte	**1**		**19**			
El Dorado	**66**		**5**			
LTBMU: Fallen Leaf CG				*Tamias amoenus*	1:256	May
LTBMU: Fallen Leaf CG				*Tamias amoenus*	1:128	May
LTBMU: Fallen Leaf CG				*Tamias senex*	1:128	May
LTBMU: Tallac Historic Site				*Tamias amoenus*	1:64	May
LTBMU: Tallac Historic Site				*Tamias amoenus*	1:64	May
LTBMU: Tallac Historic Site				*Tamias amoenus*	1:128	May
LTBMU: Tallac Historic Site				*Tamias senex*	1:2048	September
LTBMU: Tallac Historic Site				*Tamias senex*	1:512	September
LTBMU: Tallac Point				*Otospermophilus beecheyi*	1:512	May
LTBMU: Tallac Point				*Tamias amoenus*	1:128	May
LTBMU: Tallac Point				*Tamias amoenus*	1:64	May
LTBMU: Tallac Point				*Tamias senex*	1:64	May
LTBMU: Taylor Creek Visitor Center				*Tamias amoenus*	1:256	May
LTBMU: Taylor Creek Visitor Center				*Tamias amoenus*	1:32	May
LTBMU: Taylor Creek Visitor Center				*Tamias amoenus*	1:128	May
LTBMU: Taylor Creek Visitor Center				*Tamias amoenus*	1:32	May
LTBMU: Taylor Creek Visitor Center				*Tamias amoenus*	1:32	May
LTBMU: Taylor Creek Visitor Center				*Tamias senex*	1:256	May
Inyo	**14**					
Kern	**8**		**39**			
Los Angeles	**23**		**9**			
Madera	**16**		**0**			
Mariposa	**0**		**5**			
Yosemite National Park: Yosemite Valley				*Ursus americanus*	1:64	July
Mendocino	**0**		**2**			
Modoc	**0**		**9**			
Mono	**113**	**1**	**0**			
Inyo NF: Oh Ridge CG				*Urocitellus beldingi*	1:128	June
Inyo NF: Sherwin Creek CG				*Tamias amoenus*	1:256	June
Inyo NF: Sherwin Creek CG				*Tamias amoenus*	1:128	June
Inyo NF: Sherwin Creek CG				*Tamias amoenus*	1:32	June
Inyo NF: Sherwin Creek CG				*Tamias amoenus*	1:128	June
Napa	**0**		**15**			
Orange	**2**		**0**			
Placer	**0**		**1**			
Plumas	**19**		**0**			
Riverside	**9**		**0**			
San Bernardino	**40**		**0**			
San Luis Obispo	**0**		**19**			
Santa Barbara	**27**		**15**			
Shasta	**22**		**0**			
Sierra	**26**		**0**			
Sierra NF: Logger CG				*Tamias amoenus*	1:64	June
Sierra NF: Logger CG				*Tamias amoenus*	1:64	June
Siskiyou	**37**		**0**			
Stanislaus	0		1			
Tehama	**5**		**0**			
Tulare	**40**		**1**			
Tuolumne	**50**		**0**			
Ventura	**21**		**4**			
Yuba	**0**		**2**			
Total	**539**	**1**	**146**			

CG: Campground
LTBMU: Lake Tahoe Basin Management Unit
NF: National Forest

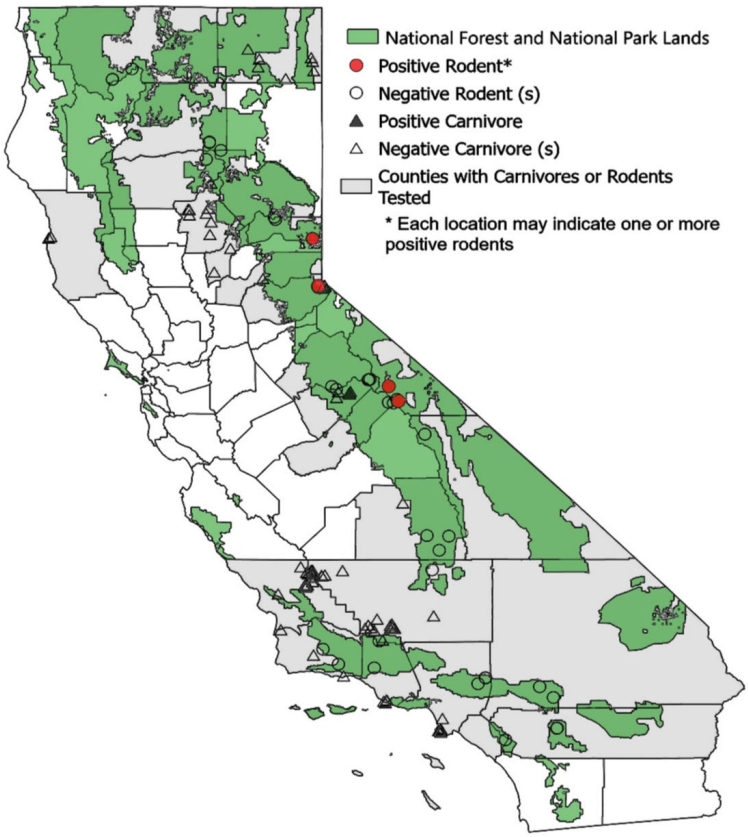


Figure 2.1. Approximate locations of carnivores or rodents that were tested by serology or culture for *Yersinia pestis*, California, 2022

In 2022, the San Diego County Department of Environmental Health-Vector Control Program conducted independent, county-wide surveillance and testing for plague in small mammals. None of 391 small mammals tested were positive for antibodies to *Y. pestis*. Data from San Diego County are not included in Table 2.1.

Rodent flea testing

A total of 1,037 fleas collected from sylvatic rodents in 15 counties were identified to species, combined into 368 pools, and tested for the presence of *Y. pestis* bacteria. No flea pools tested PCR-positive for *Y. pestis* in 2022 (Table 2.2).

Table 2.2. CDPH-VBDS plague test results in fleas from rodents, California, 2022

County	Total # Fleas (Flea Pools) Tested by PCR	Number Positive Pools
El Dorado	188 (57)	0
Kern	67 (17)	0
Los Angeles	33 (10)	0
Mariposa	8 (8)	0
Mono	15 (14)	0
Orange	5 (1)	0
Plumas	35 (14)	0
Riverside	13 (7)	0
Santa Barbara	146 (31)	0
Shasta	132 (82)	0
Sierra	33 (15)	0
Siskiyou	64 (26)	0
Tehama	2 (2)	0
Tuolumne	219 (71)	0
Ventura	77 (13)	0
Total	**1,037 (368)**	**0**

PCR: Polymerase Chain Reaction

3 Tick-borne Diseases

Ten tick-borne diseases have been documented in California. A goal of the California Department of Public Health, Vector-Borne Disease Section is to reduce human morbidity from tick-borne diseases in California through ongoing surveillance of the disease-causing agents and ticks, investigation of human cases, management of tick populations when appropriate, collation of state-wide tick data from participating agencies, and timely dissemination of findings and prevention messages to the public, medical and public health communities, and vector control agencies.

Human disease surveillance

Anaplasmosis

In 2022, 16 cases of anaplasmosis caused by *Anaplasma phagocytophilum* were reported to the California Department of Public Health (CDPH): 15 (94%) met national surveillance criteria for a confirmed case and one (6%) met the criteria for a probable case. Median age of case-patients was 68 years (range, 19 to 94 years); nine (56%) were male and seven (44%) were female. Of those self-reporting race and ethnicity, 12 (75%) were White, one (6%) was Asian, and three (19%) were Other or Unknown; two (13%) identified as Hispanic or Latino. Case-patients were residents of Butte, Los Angeles (2), Marin (8), San Diego, San Francisco, Santa Clara, Santa Cruz, and Sonoma counties. Seven (44%) case-patients reported exposure within California, including Marin (6) and Santa Cruz counties, eight (50%) reported exposure in the northeast or upper Midwest of the United States, and one (6%) reported exposure in Europe (Figure 3.1).

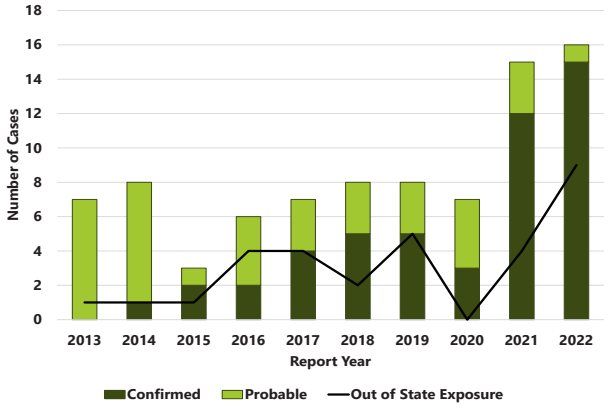


Figure 3.1. Confirmed and probable anaplasmosis cases, including cases reporting travel within incubation period, by report year 2013 - 2022

Since 2013, the median number of reported anaplasmosis cases in California has risen from one case per year to eight cases per year.

Babesiosis

In 2022, five cases of babesiosis caused by *Babesia microti* were reported to CDPH; all met national surveillance criteria for confirmed cases. Three (60%) case-patients were male; two (40%) were female. The median age of case-patients was 67 years (range, 22 to 78 years). Self-reported race and ethnicity were White (2), Asian, or Unknown (2); none reported Hispanic or Latino ethnicity. Case-patients were residents of Contra Costa, Los Angeles (2), Orange, and San Francisco counties. All case-patients had history of travel to the northeastern United States, an area endemic for *B. microti*.

Ehrlichiosis

Two cases of ehrlichiosis were reported to CDPH in 2022. Both case-patients were female residents of Los Angeles County, median age of 63.5 years, White, and non-Hispanic. Both had history of travel to midwestern United States where ehrlichiosis is endemic.

Lyme disease

A total of 99 cases of Lyme disease caused by *Borrelia burgdorferi* were reported in 2022; 61 (62%) of these met the surveillance case definition criteria for a confirmed case, 28 (28%) were probable, and 10 (10%) were suspect cases with erythema migrans (EM) rash with exposure in California (Figure 3.2). Of the 61 confirmed cases, case-patients were residents of 27 counties, with Los Angeles reporting the greatest number of cases (6) (Table 3.1).

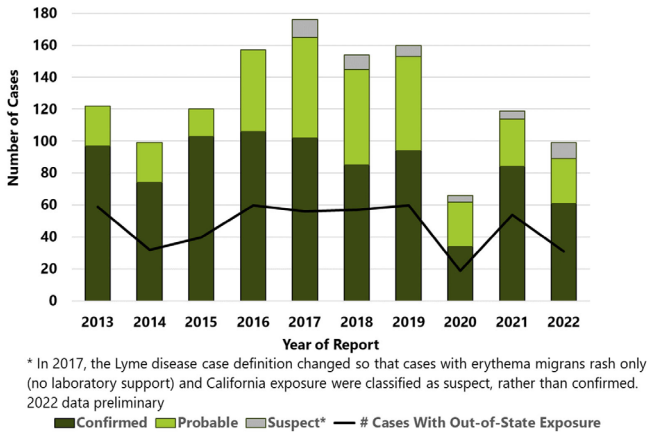


Figure 3.2. Confirmed, probable and suspect Lyme disease cases, including cases reporting travel within incubation period, by report year 2013 - 2022

The median age of confirmed Lyme disease case-patients was 34 years (range, 3 to 81 years). Thirty-four (56%) were male, 26 (43%) were female and 1 (1%) was unknown. Of the 40 confirmed case-patients for whom race and ethnicity were reported, 33 (82.5%) self-identified as White, 4 (10%) as Other, 1 (2.5%) as Asian, 1 (2.5%) as Black, and 1 (2.5%) as Multiple race. Four (10%) self-identified as Hispanic or Latino. Erythema migrans was identified in 15 (25%) confirmed case-patients, with onset of EM noted between March and November. Between 2013 and 2022, the highest incidence of Lyme disease was in the north to central coastal counties and some northern counties with western-facing Sierra slopes (Figure 3.3). Of the 35 (59%) confirmed and probable case-patients reporting travel history outside of their county of residence within the incubation period, 26 (74%) reported exposure outside of California, most commonly in the northeastern United States.

Spotted fever group rickettsiosis

Nine cases of spotted fever group rickettsiosis caused by *Rickettsia rickettsii*, the causative agent of Rocky Mountain spotted fever (RMSF), were reported to CDPH in 2022. Three (33%) met the surveillance criteria for a confirmed case and six (67%) were probable. Eight (89%) were male, one (11%) was female; median age was 54 years (range, 4 to 73 years). Of the eight case-patients self-reporting race and ethnicity, six (75%) were White and five (63%) were Hispanic or Latino. Case-patients were residents of Los Angeles (5), Orange, Riverside, and San Diego counties. Of the five (56%) case-patients reporting travel history outside of their county of residence within the incubation period, four (80%) reported exposure outside of California including to southeastern United States (2), northeastern United States, Mexico, and Central America.

Tick-borne relapsing fever

Seven cases of tick-borne relapsing fever (TBRF), caused by *Borrelia hermsii*, were reported to CDPH in 2022; four met CDPH working surveillance case definition criteria for a confirmed case and two met the criteria for a suspect case. Median age of case-patients was 55 years (range, 8 to 63 years); four (57%) were male and three (43%) were female. All case-patients self-reported race and ethnicity as White, Non-Hispanic/Latino. Case-patients were residents of Alameda, Marin, Fresno, Los Angeles, Tulare (2), and Placer counties; counties where case-patients were likely exposed in the three weeks prior to illness onset were Fresno, Mono (2), Tulare (2), and Tuolumne counties. One case-patient reported likely exposure in New Mexico.

In 2022, CDPH-VBDS worked with local county health and vector control agencies and the U.S. Centers for

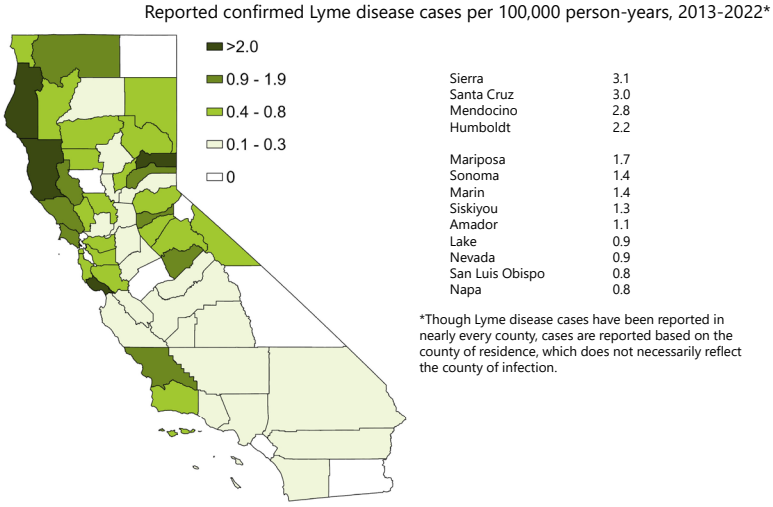


Figure 3.3. Incidence of reported confirmed Lyme disease, by county, California, 2013-2022

Table 3.1. Reported confirmed Lyme disease cases by county of residence, California, 2013-2022

County	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOTAL	Incidence per 100,000 person-years
Alameda	0	3	11	8	12	4	8	6	3	5	60	0.38
Alpine	0	0	0	0	0	0	0	0	0	0	0	0.00
Amador	1	0	2	0	0	0	0	1	0	0	4	1.06
Butte	0	1	0	2	0	0	1	0	0	0	4	0.19
Calaveras	0	0	1	0	1	0	1	0	0	0	3	0.66
Colusa	0	0	0	0	0	0	0	0	0	0	0	0.00
Contra Costa	5	2	4	6	12	10	2	2	5	2	50	0.45
Del Norte	0	0	0	0	0	0	0	0	0	1	1	0.36
El Dorado	0	2	2	1	2	0	0	0	1	4	12	0.64
Fresno	0	1	1	1	0	1	1	0	1	1	7	0.07
Glenn	0	1	0	0	0	0	1	0	0	0	2	0.69
Humboldt	4	4	6	4	3	1	2	1	0	4	29	2.17
Imperial	0	0	0	0	0	0	0	0	0	1	1	0.05
Inyo	0	0	0	0	0	0	0	0	0	0	0	0.00
Kern	0	0	1	1	0	0	1	0	0	0	3	0.03
Kings	1	0	0	1	0	0	0	0	0	0	2	0.13
Lake	0	0	1	1	0	0	3	1	0	0	6	0.93
Lassen	0	0	0	1	0	0	0	0	0	0	1	0.31
Los Angeles	17	6	6	1	3	2	3	0	6	6	50	0.05
Madera	0	0	0	0	0	0	0	1	0	1	2	0.13
Marin	6	5	5	3	0	1	8	0	5	3	36	1.40
Mariposa	1	1	1	0	0	0	0	0	0	0	3	1.66
Mendocino	0	1	0	1	1	1	10	1	6	4	25	2.84
Merced	0	0	0	0	0	0	0	0	0	0	0	0.00
Modoc	0	0	0	0	0	0	0	0	0	0	0	0.00
Mono	1	0	0	0	0	0	0	0	0	0	1	0.73
Monterey	1	0	0	1	0	0	1	0	2	1	6	0.14
Napa	0	2	2	2	0	1	0	1	1	2	11	0.80
Nevada	1	1	1	2	0	2	1	0	0	1	9	0.92
Orange	0	0	0	1	0	0	0	0	0	0	1	0.00
Placer	1	0	0	2	3	0	0	0	0	1	7	0.19
Plumas	0	1	0	0	0	0	0	0	0	0	1	0.52
Riverside	2	1	1	3	1	1	2	2	2	0	15	0.06
Sacramento	0	0	0	1	1	3	2	0	0	1	8	0.05
San Benito	0	0	1	0	0	0	0	0	0	0	1	0.17
San Bernardino	1	0	1	0	0	0	2	0	3	0	7	0.03
San Diego	8	8	9	7	1	8	0	2	6	2	51	0.16
San Francisco	5	0	0	0	11	14	10	3	12	2	57	0.67
San Joaquin	0	1	0	1	0	1	3	0	0	0	6	0.08
San Luis Obispo	4	3	3	1	1	1	3	2	2	2	22	0.80
San Mateo	3	6	5	5	4	0	2	1	0	0	26	0.35
Santa Barbara	6	0	4	7	3	3	2	1	2	1	29	0.66
Santa Clara	13	5	10	11	7	5	2	3	4	5	65	0.35
Santa Cruz	5	6	8	7	15	10	11	3	13	3	81	3.03
Shasta	0	0	0	0	0	0	0	1	1	0	2	0.11
Sierra	0	0	0	0	0	1	0	0	0	0	1	3.11
Siskiyou	1	0	1	1	1	1	0	0	0	1	6	1.34
Solano	0	0	0	3	2	2	0	1	1	0	9	0.21
Sonoma	7	11	12	11	8	8	5	0	3	4	69	1.41
Stanislaus	0	0	1	1	3	2	0	0	0	0	7	0.13
Sutter	0	0	0	0	0	0	0	0	1	0	1	0.10
Tehama	0	0	0	3	1	0	0	0	0	0	4	0.62
Trinity	0	1	0	0	0	0	0	0	0	0	1	0.73
Tulare	0	0	1	1	0	0	4	0	0	0	6	0.13
Tuolumne	0	0	1	0	0	0	1	0	0	0	2	0.36
Ventura	2	0	0	3	3	2	2	0	3	1	16	0.19
Yolo	1	0	1	1	3	0	0	0	1	1	8	0.38
Yuba	0	1	0	0	0	0	0	1	0	1	3	0.40
TOTAL	**97**	**74**	**103**	**106**	**102**	**85**	**94**	**34**	**84**	**61**	**840**	**0.22**

Disease Control and Prevention (CDC) to follow up on a human case of *Borrelia miyamotoi*, causative agent of hard tick-borne relapsing fever, in a Marin County resident. Disease onset was in October 2021 and compatible travel history was restricted to California. Tick-flagging around the case-patient's place of residence in 2022 netted a total of 19 *Ixodes pacificus* ticks (12 adults, 7 nymphs) from the patient's yard and nearby trails. While none of the collected ticks tested positive for *B. miyamotoi*, molecular characterization of the agent from the case-patient by CDC matched a previous *B. miyamotoi* sequence from a tick previously collected in Marin County. This is the first documented human case of tick-borne relapsing fever caused by *B. miyamotoi* acquired in California.

Tularemia

One case of tick-associated transmission of tularemia, caused by the bacteria *Francisella tularensis*, was reported to CDPH in 2022. The case fit the national surveillance definition for a probable case. The case-patient was a resident of Marin County and tick-exposure exposure was reported from Sonoma County.

Tick surveillance

Anaplasma phagocytophilum

In 2022, a total of 11,010 adult, 2,343 nymphal, and 94 larval western blacklegged ticks (*Ixodes pacificus*) were collected and tested for the presence of *Anaplasma phagocytophilum*, the causative agent of anaplasmosis. Of these ticks, the CDPH Vector-Borne Disease Section (CDPH-VBDS) individually tested 5,640 adult and 1,249 nymphal western blacklegged ticks from 34 counties (Table 3.2). Additionally, 94 larval western blacklegged ticks from Contra Costa, Humboldt, Marin, and Mendocino counties were tested in 10 pools at CDPH-VBDS; all tested negative. Thirty-three (0.6%) adult and 14 (1.1%) nymphal western blacklegged ticks tested positive by real-time polymerase chain reaction (RT-PCR) at the CDPH-VBDS laboratory (Table 3.2). Alameda County Department of Environmental Health and San Mateo Mosquito and Vector Control District (MVCD) share *A. phagocytophilum* tick testing data with CDPH-VBDS. In 2022, collectively their agencies collected and tested 5,370 adult western blacklegged ticks in 1,124 pools and 1,094 nymphal ticks in 551 pools from sites in their counties. Twenty-eight (0.5%) adult tick pools tested positive; no nymphal pools tested positive (Table 3.2). Statewide minimum infection prevalence (MIP – defined as the number of positive pools divided by the number of ticks tested multiplied by 100) in adult western blacklegged ticks was 0.5% and 0.6% in nymphal ticks (Table 3.2).

Francisella tularensis

In 2022, CDPH-VBDS tested a total of 156 adult American dog ticks (*Dermacentor variabilis*) and 612 adult Pacific coast ticks (*Dermacentor occidentalis*) from Colusa, El Dorado, Humboldt, Mendocino, Napa, Nevada, San Diego, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Cruz, and Yolo counties for *Francisella tularensis*, the causative agent of tularemia. All ticks tested negative. Reported to CDPH-VBDS, San Diego Environmental Health tested 3,813 adult Pacific coast ticks and 127 adult American dog ticks for *F. tularensis* by RT-PCR. All ticks tested negative. Additionally, San Mateo MVCD reported to CDPH-VBDS that they tested 681 adult Pacific coast ticks and 133 adult American dog ticks for *F. tularensis* in 142 and 30 pools, respectively. One pool of adult Pacific coast ticks tested positive for *F. tularensis* by RT-PCR for an MIP of 0.1%.

Spotted fever group rickettsiosis

In 2022, CDPH-VBDS tested 2,501 adult Pacific coast ticks from Calaveras, Contra Costa, Humboldt, Kern, Lake, Los Angeles, Marin, Mendocino, Merced, Orange, Riverside, San Bernardino, San Diego, San Joaquin, and Ventura counties for spotted fever group *Rickettsia* spp. (SFGR), including the *R. philipii* 364D strain, causative agent of Pacific coast tick fever, and *R. rickettsii*, the causative agent of Rocky Mountain spotted fever. DNA from all ticks was extracted by CDPH-VBDS and tested by RT-PCR by the CDPH Viral and Rickettsial Disease Laboratory. All ticks tested negative for *R. rickettsii*. Sixty-six (2.6%) adult Pacific coast ticks tested positive for *R. philipii* 364D, with positive ticks detected from Contra Costa (1 of 36=2.8%), Los Angeles (27 of 1,098=2.5%), Marin (1 of 9=11.1%), Orange (4 of 141=2.8%), Riverside (6 of 111=5.4%), San Diego (25 of 696=3.6%), and Ventura (2 of 195=1.0%) counties. Orange County MVCD tested 244 adult Pacific coast ticks in 60 pools and 2 adult American dog ticks for SFGR at their laboratory. One pool of adult Pacific coast ticks tested positive for *R. philipii* 364D for an MIP of 0.4%.

Table 3.2. Infection prevalence and minimum infection prevalence of *Anaplasma phagocytophilum* in *Ixodes pacificus* ticks, California, 2022

Non-pooled testing	No. Ticks Tested		Positive *A. phagocytophilum*			
County	**Adults**	**Nymphs**	**Adults (IP[a])**	**Nymphs (IP[a])**	**Collected by**	**Laboratory**
Amador	35				CDPH, VBDS	CDPH, VBDS
Calaveras	16				CDPH, VBDS	CDPH, VBDS
Colusa	42				CDPH, VBDS	CDPH, VBDS
Contra Costa	249	17	1 (0.4)	1 (5.9)	CDPH, VBDS	CDPH, VBDS
Del Norte	3				CDPH, VBDS	CDPH, VBDS
El Dorado	562	50	3 (0.5)		CDPH, VBDS	CDPH, VBDS
Humboldt	192	91	3 (1.6)	4 (4.4)	CDPH, VBDS	CDPH, VBDS
Kern	18				CDPH, VBDS	CDPH, VBDS
Lake	80				CDPH, VBDS	CDPH, VBDS
Los Angeles	373				CDPH, VBDS	CDPH, VBDS
Madera	3				CDPH, VBDS	CDPH, VBDS
Marin	510	433	6 (1.2)	8 (1.9)	CDPH, VBDS; Marin-Sonoma MVCD	CDPH, VBDS
Mendocino	8	38			CDPH, VBDS	CDPH, VBDS
Merced	7				CDPH, VBDS	CDPH, VBDS
Napa	101		3 (3.0)		CDPH, VBDS	CDPH, VBDS
Nevada	186	12			CDPH, VBDS	CDPH, VBDS
Orange	103				CDPH, VBDS	CDPH, VBDS
Placer	222		1 (0.5)		CDPH, VBDS	CDPH, VBDS
Riverside	14				CDPH, VBDS	CDPH, VBDS
Sacramento	1				CDPH, VBDS	CDPH, VBDS
San Bernardino	206				CDPH, VBDS	CDPH, VBDS
San Diego	364				CDPH, VBDS	CDPH, VBDS
San Luis Obispo	828		3 (0.4)		CDPH, VBDS	CDPH, VBDS
San Mateo	43		1 (2.3)		CDPH, VBDS; San Mateo MVCD	CDPH, VBDS
Santa Barbara	134				CDPH, VBDS	CDPH, VBDS
Santa Cruz	20	7			Santa Cruz County MVCD	CDPH, VBDS
Solano	18				CDPH, VBDS	CDPH, VBDS
Sonoma	1,088	601	12 (1.1)	1 (0.2)	CDPH, VBDS	CDPH, VBDS
Stanislaus	4				CDPH, VBDS	CDPH, VBDS
Sutter	6				CDPH, VBDS	CDPH, VBDS
Tulare	148				CDPH, VBDS; Delta MVCD	CDPH, VBDS
Ventura	40				CDPH, VBDS	CDPH, VBDS
Yolo	16				CDPH, VBDS	CDPH, VBDS
Non-pooled totals	**5,640**	**1,249**	**33 (0.6)**	**14 (1.1)**		
Pooled testing	**No. Ticks Tested**		**Positive *A. phagocytophilum* pools**			
County	**Adults (pools)**	**Nymphs (pools)**	**Adults (MIP[b])**	**Nymphs (MIP[b])**	**Collected by**	**Laboratory**
Alameda	1,340 (288)	670 (336)	12 (0.9)		Alameda County DEH	Alameda County DEH
San Mateo	4,030 (836)	424 (215)	16 (0.4)		San Mateo MVCD	San Mateo MVCD
Pooled totals	**5,370 (1,124)**	**1,094 (551)**	**28 (0.5)**	**0**		
All tick totals	**11,010**	**2,343**	**61 (0.5)**	**14 (0.6)**		

Abbreviations:
IP, Infection prevalence; MIP, Minimum infection prevalence; CDPH-VBDS, California Department of Public Health, Vector-Borne Disease Section; MVCD, Mosquito and Vector Control District; DEH, Department of Environmental Health.

[a] Infection prevalence is the number of individually tested ticks positive divided by the number of ticks tested multiplied by 100.

[b] Minimum infection prevalence is the number of positive pools divided by the number of ticks tested multiplied by 100.

Table 3.3. Infection prevalence of *Borrelia burgdorferi* sensu lato and *Borrelia miyamotoi* spirochetes in *Ixodes pacificus* ticks, California, 2022

County	No. Ticks Tested			Positive *B. burgdorferi*		Positive *B. miyamotoi*		Collected by	Laboratory
	Adults	Nymphs	Larvae[a]	Adults (IP)[b]	Nymphs (IP)[b]	Adults (IP)[b]	Nymphs* (IP)[b]		
Amador	35							CDPH, VBDS	CDPH, VBDS
Butte		1						Butte County MVCD	Placer MVCD
Calaveras	16							CDPH, VBDS	CDPH, VBDS
Colusa	42					1 (2.4)		CDPH, VBDS	CDPH, VBDS
Contra Costa	249	17	78	2 (0.8)	1 (5.9)			CDPH, VBDS	CDPH, VBDS
Del Norte	3							CDPH, VBDS	CDPH, VBDS
El Dorado	584	50	1	21 (3.6)	19 (38.0)	14 (2.4)		CDPH, VBDS	CDPH, VBDS
Humboldt	192	90		2 (1.0)	3 (3.3)	1 (0.5)		CDPH, VBDS	CDPH, VBDS
Kern	18							CDPH, VBDS	CDPH, VBDS
Lake	80							CDPH, VBDS	CDPH, VBDS
Los Angeles	373							CDPH, VBDS	CDPH, VBDS
Madera	3							CDPH, VBDS	CDPH, VBDS
Marin	515	612	14	20 (3.9)	26 (4.2)	9 (1.7)	14 (2.3)	CDPH, VBDS; Marin-Sonoma MVCD	CDPH, VBDS; Marin-Sonoma MVCD
Mendocino	8	38	1	1 (12.5)				CDPH, VBDS	CDPH, VBDS
Merced	7							CDPH, VBDS	CDPH, VBDS
Napa	102			1 (1.0)				CDPH, VBDS	CDPH, VBDS
Nevada	186	12		1 (0.5)	1 (8.3)	2 (1.1)	1 (8.3)	CDPH, VBDS	CDPH, VBDS
Orange	103			3 (2.9)				CDPH, VBDS	CDPH, VBDS
Placer	222			2 (0.9)		4 (1.8)		CDPH, VBDS	CDPH, VBDS
Riverside	41							CDPH, VBDS	CDPH, VBDS
Sacramento	1	3			2 (66.7)			CDPH, VBDS; Sacramento-Yolo MVCD	CDPH, VBDS; Sacramento-Yolo MVCD
San Bernardino	206							CDPH, VBDS	CDPH, VBDS
San Diego	364							CDPH, VBDS	CDPH, VBDS
San Luis Obispo	828			4 (0.5)		6 (0.7)		CDPH, VBDS	CDPH, VBDS
San Mateo	43							CDPH, VBDS; San Mateo MVCD	CDPH, VBDS
Santa Barbara	134							CDPH, VBDS	CDPH, VBDS
Santa Clara		176			1 (0.6)		1 (0.6)	Santa Clara VCD	Santa Clara VCD
Santa Cruz	142	7				1 (0.7)		Santa Cruz County MVCD	CDPH, VBDS; Santa Cruz County MVCD
Solano	18							CDPH, VBDS	CDPH, VBDS
Sonoma	1,085	722		16 (1.5)	25 (3.5)	19 (1.8)	18 (2.5)	CDPH, VBDS; Marin-Sonoma MVCD	CDPH, VBDS; Marin-Sonoma MVCD
Stanislaus	4							CDPH, VBDS	CDPH, VBDS
Sutter	6							CDPH, VBDS	CDPH, VBDS
Tulare	148			14 (9.5)				CDPH, VBDS; Delta MVCD	CDPH, VBDS
Ventura	40							CDPH, VBDS	CDPH, VBDS
Yolo	16							CDPH, VBDS	CDPH, VBDS
Total	**5,814**	**1,728**	**94**	**87 (1.5)**	**78 (4.5)**	**57 (1.0)**	**34 (2.0)**		

Abbreviations:

CDPH-VBDS, California Department of Public Health, Vector-Borne Disease Section; MVCD, Mosquito and Vector Control District; VCD, Vector Control District

All *Ixodes pacificus* ticks tested at CDPH-VBDS are tested by multiplex real-time polymerase chain reaction (RT-PCR) for *Borrelia burgdorferi* sensu lato and *Borrelia miyamotoi*.

*1,725 nymphs tested for *B. miyamotoi,* Sacramento-Yolo MVCD does not test for *B. miyamotoi*.

[a] No larvae tested positive for *B. burgdorferi* sensu lato or *B. miyamotoi*, so IP was not calculated.

[b] IP: Measure of prevalence. IP (infection prevalence) is equal to the number of positive ticks divided by the number of ticks tested multiplied by 100.

[c] Only nymphs included from Marin-Sonoma MVCD, Sacramento-Yolo MVCD (Sacramento County), and Santa Clara VCD; adults can be found in MIP table.

Table 3.4. Minimum infection prevalence of *Borrelia burgdorferi* sensu lato and *Borrelia miyamotoi* in *Ixodes pacificus* ticks, California, 2022

County	No. Ticks Tested		Positive Pools, *B. burgdorferi*		Positive Pools, *B. miyamotoi*[c]		Collected by	Laboratory
	Adults (pools)	Nymphs (pools)	Adults (MIP)[b]	Nymphs (MIP)[b]	Adults (MIP)[b]	Nymphs (MIP)[b]		
Alameda	1,340 (288)	670 (336)	25 (1.9)	34 (5.1)	15 (1.1)	12 (1.8)	Alameda County DEH	Alameda County DEH
Butte	788 (166)		11 (1.4)		11 (1.4)		Butte County MVCD	Placer MVCD
Los Angeles[a]	363 (59)						Los Angeles County West VCD	Los Angeles County West VCD
Orange	40 (12)						Orange County MVCD	Orange County MVCD
Placer	4,702 (1,010)		44 (0.9)		21 (0.4)		Placer MVCD	Placer MVCD
Sacramento	1,219 (375)		16 (1.3)				Sacramento-Yolo MVCD	Sacramento-Yolo MVCD
San Bernardino	92 (47)						West Valley MVCD	West Valley MVCD
San Diego	1,108 (163)						County of San Diego VCP	County of San Diego VCP
San Mateo	4,030 (836)	424 (215)	28 (0.7)	9 (2.1)	35 (0.9)	15 (3.5)	San Mateo MVCD	San Mateo MVCD
Santa Clara	1,009 (378)		2 (0.2)		12 (1.2)		Santa Clara VCD	Santa Clara VCD
Shasta	1,230 (279)		7 (0.6)		5 (0.4)		Shasta MVCD	Placer MVCD
Yolo	104 (34)	3 (1)					Sacramento-Yolo MVCD	Sacramento-Yolo MVCD
Total	**16,025 (3,647)**	**1,097 (552)**	**133 (0.8)**	**43 (3.9)**	**99 (0.7)**	**27 (2.5)**		

Abbreviations:

DEH, Department of Environmental Health; MVCD, Mosquito and Vector Control District; VCD, Vector Control District; VCP, Vector Control Program.

[a] Tested by IFA.

[b] MIP: Measure of prevalence. MIP (minimum infection prevalence) is equal to the number of positive pools divided by the number of ticks tested multiplied by 100.

[c] 14,702 (3,238) adult ticks and 1,094 (551) nymphs tested for *Borrelia miyamotoi.*

Borrelia spirochetes

Borrelia burgdorferi sensu lato

In 2022, local, state, and federal agencies, in collaboration with CDPH-VBDS, collected 21,839 adult, 2,825 nymphal, and 94 larval western blacklegged ticks from 37 counties to test for *Borrelia burgdorferi*, the causative agent of Lyme disease. Collection and testing data for western blacklegged ticks are collated by CDPH-VBDS. From the counties where ticks were tested individually by RT-PCR, 87 of 5,814 (1.5%) adult and 78 of 1,728 (4.5%) nymphal ticks tested positive for *B. burgdorferi* sensu lato (Table 3.3). Ticks tested by local vector control agencies in pools were tested by RT-PCR or IFA. In the counties where ticks were tested in pools, 133 adult tick pools out of 16,025 (0.8% MIP) collected and 43 nymphal pools out of 1,097 (3.9% MIP) collected, tested positive for *B. burgdorferi* sensu lato (Table 3.4). All larval ticks tested negative.

Borrelia miyamotoi

In 2022, of the western blacklegged ticks collected, 20,516 adult, 2,819 nymphal, and 94 larval ticks were tested for *Borrelia miyamotoi*, a relapsing fever-type spirochete implicated in human disease in the United States and Europe. Of the 5,814 individually tested adults and 1,725 individually tested nymphs, 57 (1.0%) and 34 (2.0%), respectively, tested positive (Table 3.3). Of the 14,702 adult ticks tested in 3,238 pools and 1,094 nymphs tested in 551 pools, 99 (0.7% MIP) and 27 (2.5% MIP), respectively, tested positive (Table 3.4).

Borrelia hermsii (tick-borne relapsing fever)

CDPH-VBDS tested 45 *Ornithodoros hermsi* from Tuolumne County for *Borrelia hermsii* following a human case of tick-borne relapsing fever (TBRF). All ticks tested negative for *B. hermsii* by RT-PCR.

Borrelia spp. coinfection

- *Borrelia burgdorferi* sensu lato and *Anaplasma phaocytophilum*

  In 2022, eight adult *I. pacificus* from El Dorado (1), Humboldt (2), Marin (2), Napa (1), and Sonoma (2) counties tested positive for both *B. burgdorferi* sl and *A. phagocytophilum*, for a statewide adult infection prevalence of 0.1% (8 positive out of 5,640 adults tested). Five *I. pacificus* nymphs from Contra Costa (1), Humboldt (1), Marin (2), and Sonoma (1) counties tested positive for both *B. burgdorferi* sl and *A. phagocytophilum*, for a statewide nymphal infection prevalence of 0.4% (5 positive out of 1,246 nymphs tested).

- *Borrelia miyamotoi* and *Anaplasma phagocytophilum*

  Two adult *I. pacificus* from El Dorado (1) and Sonoma (1) counties tested positive for both *B. miyamotoi* and *A. phagocytophilum*, for a statewide adult infection prevalence of 0.04% (2 positive out of 5,640 adults tested).

- *Borrelia burgdorferi* sensu lato and *Borrelia miyamotoi*

  Four adult tick pools from Butte (1) and Shasta (3) counties, collected by Butte County MVCD and Shasta MVCD, tested positive for both *B. burgdorferi* sl and *B. miyamotoi* by RT-PCR, for a statewide MIP of 0.02% (4 out of 14,702 ticks in 3,238 pools).

Mammal surveillance

Francisella tularensis

CDPH-VBDS collaborates with the CDPH Microbial Diseases Laboratory to test mammals for *Francisella tularensis*, the agent of tularemia, by serology, DFA, PCR, and culture. Mammals may be tested for tularemia in response to reported human cases or for environmental risk assessment including specific carcass testing requests. In 2022, one small mammal carcass tested negative for *F. tularensis* from Mono County.

4 Mosquito-borne Diseases

Mosquito-borne diseases under surveillance in California include the endemic arboviral diseases caused by West Nile virus, St. Louis encephalitis virus, and western equine encephalitis virus, as well as travel-associated diseases caused by *Plasmodium* spp. (malaria), dengue, chikungunya, and Zika viruses. The California Department of Public Health, Vector-Borne Disease Section monitors and consults with local agencies regarding invasive mosquito species including *Aedes aegypti* (yellow fever mosquito) and *Aedes albopictus* (Asian tiger mosquito). Endemic arbovirus surveillance is performed under the California Arbovirus Surveillance program, a cooperative effort of multiple state and local entities.

Human disease surveillance

West Nile virus

Serological diagnosis of human infection with West Nile virus (WNV) and other arboviruses was performed at the California Department of Public Health (CDPH) Viral and Rickettsial Disease Laboratory (VRDL), local public health laboratories, and commercial laboratories. Local and commercial laboratories tested for WNV using an IgM enzyme immunoassay (EIA) and/or an IgM immunofluorescence assay (IFA). Specimens from the first case of the year from each county, as well as specimens from all cases from counties with enzootic St. Louis encephalitis virus (SLEV) activity, were forwarded to CDPH-VRDL for further testing with plaque reduction neutralization tests (PRNT). Additional WNV infections were identified through nucleic acid test screening performed by blood donation centers.

In 2022, a total of 207 symptomatic and 14 asymptomatic infections with WNV were identified; a 60% increase compared to the number of total symptomatic infections (119) reported in 2021, but close to the 2017-2021 5-year median of 225 cases (Table 4.1). Of the 207 symptomatic cases, 162 (78%) were classified as West Nile neuroinvasive disease (e.g., encephalitis, meningitis, acute flaccid paralysis, or other neurologic dysfunction) and 45 (22%) were classified as West Nile non-neuroinvasive disease. There were 15 fatal cases for a case-fatality rate of 7.2%. Case-patients were residents of 27 counties and 129 (62%) were male. Incidence was highest (4.6 cases per 100,000 persons) in Tehama County (Table 4.1, Figure 4.1). The median age for neuroinvasive case-patients was 65 years (range, 9 to 91 years), and among non-neuroinvasive case-patients, the median age was 60 years (range, 14 to 93 years). The median age of the 15 WNV-associated fatalities was 81 years (range, 45 to 88 years). Dates of symptom onset for all reported cases ranged from April 11 to December 8.

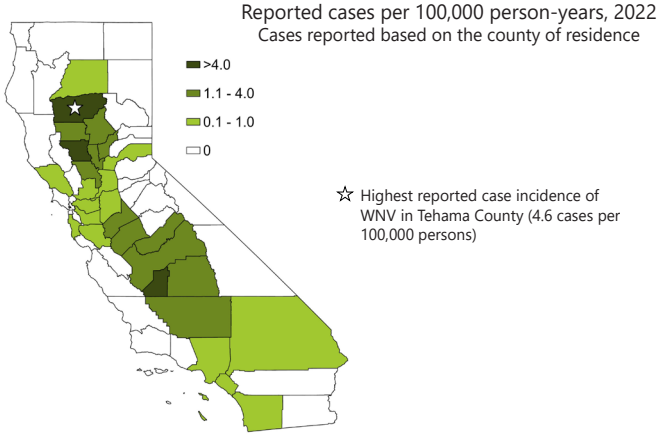


Figure 4.1. Incidence of reported human cases of West Nile virus, by county, California, 2022

St. Louis encephalitis virus

Sixteen symptomatic cases of SLEV infection were identified in 2022. Fourteen (88%) case-patients presented with neuroinvasive disease, and two (13%) with non-neuroinvasive disease; one fatality was reported. Case-patients were residents of eight counties (Table 4.5) and ten (63%) were male. The median age was 66 years (range, 21 to 83 years) and dates of symptom onset ranged from May 31 to December 2.

Table 4.1. Reported West Nile virus human cases by county of residence, California, 2013-2022

County	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2022 incidence per 100,000 person-years	10 year incidence per 100,000 person-years
Alameda	0	1	0	0	1	0	1	0	0	1	0.06	0.02
Alpine	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Amador	0	0	0	1	0	1	1	0	0	0	0.00	0.74
Butte	24	24	53	21	4	12	5	4	13	3	1.49	8.08
Calaveras	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Colusa	2	3	1	2	0	0	1	0	0	1	4.59	4.59
Contra Costa	5	5	1	4	4	4	1	4	2	1	0.09	0.27
Del Norte	0	0	0	0	0	0	0	0	0	0	0.00	0.00
El Dorado	1	0	0	1	0	0	0	1	1	0	0.00	0.21
Fresno	8	43	8	14	13	14	51	10	14	30	2.97	2.03
Glenn	9	10	19	6	0	2	0	1	2	1	3.48	17.39
Humboldt	0	0	0	0	0	1	0	0	0	0	0.00	0.07
Imperial	0	1	1	0	3	0	3	1	0	0	0.00	0.50
Inyo	0	0	0	0	4	0	0	0	0	0	0.00	2.11
Kern	25	11	11	17	30	13	28	8	8	22	2.42	1.90
Kings	1	4	0	8	5	0	3	2	8	7	4.60	2.50
Lake	0	1	2	1	0	1	0	2	0	0	0.00	1.04
Lassen	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Los Angeles	151	253	286	151	277	43	31	90	16	61	0.62	1.38
Madera	3	3	4	6	2	4	3	6	3	3	1.91	2.35
Marin	2	0	1	0	0	0	0	0	0	0	0.00	0.12
Mariposa	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Mendocino	0	1	2	0	0	0	0	0	0	0	0.00	0.33
Merced	0	1	1	0	10	2	10	12	6	7	2.46	1.72
Modoc	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Mono	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Monterey	0	0	0	1	0	1	0	0	0	0	0.00	0.05
Napa	1	0	0	0	0	1	0	0	0	0	0.00	0.15
Nevada	0	0	2	0	0	1	0	0	0	0	0.00	0.30
Orange	10	263	92	32	33	9	5	17	3	9	0.29	1.50
Placer	6	7	0	7	0	9	1	2	2	2	0.49	0.88
Plumas	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Riverside	35	14	127	11	32	15	12	10	3	0	0.00	1.06
Sacramento	11	10	4	25	6	15	4	7	6	5	0.32	0.59
San Benito	0	0	0	0	0	0	0	0	0	0	0.00	0.00
San Bernardino	13	21	54	8	57	9	7	3	1	4	0.18	0.81
San Diego	0	11	42	20	2	2	3	1	3	3	0.09	0.26
San Francisco	1	0	0	0	1	0	0	0	1	0	0.00	0.04
San Joaquin	8	9	2	13	14	14	7	2	7	4	0.51	1.02
San Luis Obispo	0	0	0	0	0	0	2	0	2	0	0.00	0.14
San Mateo	0	0	0	0	0	0	0	0	1	1	0.13	0.03
Santa Barbara	1	0	0	0	0	0	0	0	2	0	0.00	0.07
Santa Clara	2	10	8	1	0	1	1	0	3	1	0.05	0.14
Santa Cruz	0	0	0	0	0	0	0	0	1	0	0.00	0.04
Shasta	1	2	3	1	1	1	0	2	3	1	0.55	0.83
Sierra	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Siskiyou	0	0	1	0	0	0	0	0	0	0	0.00	0.23
Solano	1	5	1	4	1	0	1	1	2	2	0.45	0.40
Sonoma	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Stanislaus	17	33	13	26	28	15	16	35	5	15	2.73	3.69
Sutter	10	8	2	12	3	1	1	1	0	1	1.01	3.93
Tehama	5	4	5	5	2	2	0	2	0	3	4.61	4.30
Trinity	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Tulare	5	21	13	10	12	8	24	7	8	15	3.16	2.59
Tuolumne	0	0	0	0	0	1	0	0	0	0	0.00	0.18
Ventura	2	1	6	7	1	2	2	0	0	0	0.00	0.25
Yolo	6	15	8	16	6	11	1	4	3	3	1.36	3.30
Yuba	13	6	10	11	1	2	0	0	0	1	1.22	5.35
Total WNV disease	**379**	**801**	**783**	**442**	**553**	**217**	**225**	**235**	**129**	**207**	**0.52**	**1.01**
Asymptomatic Infections[a]	54	91	77	41	47	26	18	28	19	14		
Total WNV infections	**433**	**892**	**860**	**483**	**600**	**243**	**243**	**263**	**148**	**221**		

[a] WNV infections detected through blood bank screening; no associated illness reported

In 2022,16 confirmed human cases of St. Louis encephalitis virus (SLEV) infections were reported in California. This is the highest number of human cases reported since SLEV reemerged in 2015. Despite this number of cases, the number of SLEV-positive mosquito pools was less than the median number detected during the previous six years.

Malaria

In 2022, 118 confirmed cases of malaria were reported to CDPH. Case-patients were residents of 22 California counties and 78 (66%) were male. The median age was 37 years (range, 1 to 81 years). Of the 84 cases for which the *Plasmodium* species was determined, 67 were *P. falciparum*, 11 *P. vivax,* 4 *P. ovale,* and 2 *P. malariae*. One hundred seventeen case-patients reported compatible travel history to malaria-endemic areas including Sub-Saharan Africa (93), Central and South Asia (17), Central and South America (5), and Southeast Asia (2). Exposure information for one case-patient was not available.

Chikungunya

Twenty-four cases of chikungunya were reported to CDPH in 2022; four met the criteria for a confirmed case and 20 were probable (Table 4.2). Case-patients were residents of nine California counties, 11 (46%) were male, and the median age was 43 years (range, 15 to 89 years). No locally acquired cases were reported. All case-patients reported travel to chikungunya-endemic or outbreak areas including South Asia (10), South and Central America (8), North America/Caribbean (3), Southeast Asia (2), and Africa (1).

Dengue

In 2022, 130 cases of dengue were reported to CDPH; 44 (34%) of these met the criteria for a confirmed case and 86 (66%) were probable (Table 4.2). Case-patients were residents of 23 California counties, 73 (56%) were male, and the median age was 45 years (range, 1 to 85 years). No locally acquired cases were reported. Travel region history included South Asia (45), Central and South America (31), Southeast Asia and Pacific Islands (27), Caribbean (24), and Africa (2). Exposure information for one case-patient was not available.

Table 4.2. Reported confirmed and probable *Aedes*-transmitted diseases in humans by county, California, 2022

County	Chikungunya	Dengue	Zika	TOTAL
Alameda	4	12	1	17
Alpine	0	0	0	0
Amador	0	0	0	0
Butte	0	0	0	0
Calaveras	0	0	0	0
Colusa	0	0	0	0
Contra Costa	0	3	0	3
Del Norte	0	0	0	0
El Dorado	0	0	0	0
Fresno	0	2	0	2
Glenn	0	0	0	0
Humboldt	0	0	0	0
Imperial	0	0	0	0
Inyo	0	0	0	0
Kern	0	2	0	2
Kings	0	0	0	0
Lake	0	0	0	0
Lassen	0	0	0	0
Los Angeles	8	35	2	45
Madera	0	0	0	0
Marin	1	0	0	1
Mariposa	0	0	0	0
Mendocino	0	0	0	0
Merced	0	0	0	0
Modoc	0	0	0	0
Mono	0	1	0	1
Monterey	0	0	0	0
Napa	0	1	0	1
Nevada	0	0	0	0
Orange	1	6	0	7
Placer	0	1	0	1
Plumas	0	0	0	0
Riverside	0	4	0	4
Sacramento	2	7	0	9
San Benito	0	0	0	0
San Bernardino	0	1	0	1
San Diego	2	13	1	16
San Francisco	0	6	1	7
San Joaquin	0	1	0	1
San Luis Obispo	0	1	0	1
San Mateo	1	7	0	8
Santa Barbara	0	2	0	2
Santa Clara	4	17	0	21
Santa Cruz	0	0	0	0
Shasta	0	1	0	1
Sierra	0	0	0	0
Siskiyou	0	0	0	0
Solano	1	2	0	3
Sonoma	0	0	0	0
Stanislaus	0	0	0	0
Sutter	0	0	0	0
Tehama	0	0	0	0
Trinity	0	0	0	0
Tulare	0	0	0	0
Tuolumne	0	0	0	0
Ventura	0	1	0	1
Yolo	0	4	0	4
Yuba	0	0	0	0
TOTAL	**24**	**130**	**5**	**159**

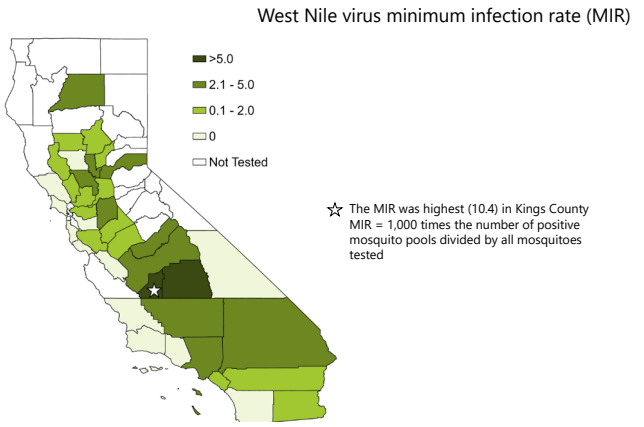


Figure 4.2. West Nile virus minimum infection rate of *Culex* spp. mosquitoes, by county, California, 2022

Zika

In 2022, five infections of Zika virus were reported to CDPH; all met the criteria for a confirmed infection. Counties of residence for the case-patients were Alameda, Los Angeles (2), San Diego, and San Francisco (Table 4.2). Four were exposed in North America or the Caribbean and one in South Asia.

Mosquito surveillance

In 2022, a total of 1,261,191 mosquitoes (47,687 pools) collected in 38 counties were tested at the University of California, Davis Arbovirus Research and Training (DART) Laboratory or at one of 13 local agencies by a real-time (TaqMan) reverse transcriptase-polymerase chain reaction (RT-qPCR) for SLEV, western equine encephalitis virus (WEEV), and/or WNV viral RNA (Table 4.3). WNV was detected in 3,165 mosquito pools from 26 counties, and SLEV was detected in 152 mosquito pools from nine counties (Tables 4.3, 4.5, 4.8). Statewide, the minimum infection rate (MIR)— defined as the number of infected mosquito pools divided by the total number of mosquitoes tested multiplied by 1,000— of WNV in all mosquitoes tested was 2.5; the MIR was highest (10.4) in Kings County (Table 4.3, Figure 4.2). Since 2003, the MIR of WNV in California has ranged from a low of 0.08 (2003) to a high of 3.9 (2014). WNV was identified from two *Aedes* species and six *Culex* species (*Ae. aegypti*, *Ae. nigromaculis*, *Cx. erythrothorax*, *Cx. pipiens*, *Cx. quinquefasciatus*, *Cx. stigmatosoma*, *Cx. tarsalis*, and *Cx. thriambus*) (Table 4.4), and SLEV was identified from three *Culex* species (*Cx. pipiens*, *Cx. quinquefasciatus*, and *Cx. tarsalis*).

Table 4.3. West Nile virus (WNV) positive mosquito pools and minimum infection rate, by county, California, 2022

County	No. mosquitoes tested[a]	No. mosquito pools tested	WNV positive pools[a]	WNV Minimum Infection Rate[b]
Alameda	17,093	734	0	0.0
Alpine	0	0	0	0.0
Amador	0	0	0	0.0
Butte	19,787	424	38	1.9
Calaveras	0	0	0	0.0
Colusa	450	9	0	0.0
Contra Costa	9,791	307	2	0.2
Del Norte	0	0	0	0.0
El Dorado	0	0	0	0.0
Fresno	60,708	1,848	296	4.9
Glenn	852	18	1	1.2
Humboldt	0	0	0	0.0
Imperial	2,852	164	1	0.4
Inyo	699	15	0	0.0
Kern	26,560	803	99	3.7
Kings	10,065	232	105	10.4
Lake	10,779	461	7	0.6
Lassen	0	0	0	0.0
Los Angeles	140,115	3,800	578	4.1
Madera	35,088	880	132	3.8
Marin	1,736	87	0	0.0
Mariposa	0	0	0	0.0
Mendocino	0	0	0	0.0
Merced	10,787	549	20	1.9
Modoc	0	0	0	0.0
Mono	0	0	0	0.0
Monterey	0	0	0	0.0
Napa	1,803	117	1	0.6
Nevada	0	0	0	0.0
Orange	132,610	4,347	39	0.3
Placer	31,295	1,942	89	2.8
Plumas	0	0	0	0.0
Riverside	256,713	7,656	125	0.5
Sacramento	39,563	3,719	42	1.1
San Benito	64	14	0	0.0
San Bernardino	43,136	2,707	100	2.3
San Diego	24,839	1,929	0	0.0
San Francisco	0	0	0	0.0
San Joaquin	69,031	2,338	208	3.0
San Luis Obispo	1,374	59	0	0.0
San Mateo	2,887	156	0	0.0
Santa Barbara	3,093	130	0	0.0
Santa Clara	17,540	2573	23	1.3
Santa Cruz	2,697	125	0	0.0
Shasta	15,851	580	39	2.5
Sierra	0	0	0	0.0
Siskiyou	0	0	0	0.0
Solano	13,281	480	12	0.9
Sonoma	4,253	192	0	0.0
Stanislaus	38,719	1,216	70	1.8
Sutter	9,194	282	31	3.4
Tehama	0	0	0	0.0
Trinity	0	0	0	0.0
Tulare	172,580	4,917	1,030	6.0
Tuolumne	0	0	0	0.0
Ventura	3,265	67	0	0.0
Yolo	23,389	1,625	65	2.8
Yuba	6,652	185	12	1.8
Total	**1,261,191**	**47,687**	**3,165**	**2.5**

[a] Tested by University of California Davis Arbovirus Research and Training Laboratory or local mosquito/vector control agency.

[b] Minimum Infection Rate = (No. pools positive/No. mosquitoes tested) X 1,000

Table 4.4. West Nile virus (WNV) positive mosquito pools and minimum infection rate, by mosquito species, California, 2022

Mosquito Species	No. Pools Tested	No. Mosquitoes	WNV positive pools	Minimum Infection Rate[a]
***Culex* species**				
Cx. erythrothorax	1,607	54,020	2	0
Cx. pipiens	8,415	119,518	181	2
Cx. quinquefasciatus	20,719	628,053	2,059	3
Cx. restuans	4	10	0	0
Cx. stigmatosoma	454	4,403	31	7
Cx. tarsalis	15,415	441,665	888	2
Cx. territans	2	43	0	0
Cx. thriambus	55	99	1	10
Culex species	2	4	0	0
All *Culex*	**46,673**	**1,247,815**	**3,162**	**2.5**
***Anopheles* species**				
An. franciscanus	143	3,801	0	0.0
An. freeborni	3	72	0	0.0
An. hermsi	3	26	0	0.0
All *Anopheles*	**149**	**3,899**	**0**	**0.0**
***Aedes* species**				
Ae. aegypti	543	4,200	2	0.5
Ae. melanimon	17	381	0	0.0
Ae. nigromaculis	9	316	1	3.2
Ae. squamiger	1	28	0	0.0
Ae. taeniorhynchus	5	161	0	0.0
Ae. vexans	12	370	0	0.0
All *Aedes*	**587**	**5,456**	**3**	**0.5**
Other species				
Culiseta incidens	243	3,443	0	0
Culiseta inornata	15	149	0	0
Culiseta particeps	16	340	0	0
Psorophora columbiae	3	39	0	0
Unknown	1	50	0	0
All other	**278**	**4,021**	**0**	**0.0**

[a] Minimum Infection Rate = (No. pools positive/No. mosquitoes tested) X 1,000

Chickens attract the same mosquitoes that can transmit WNV and SLEV to humans and therefore are useful for surveillance when placed at strategic locations and then tested for infection.

In 2022, the first detection of WNV in mosquitoes was from a *Cx. tarsalis* pool collected in Riverside County on January 5, and the last detection was from a *Cx. quinquefasciatus* pool collected in Los Angeles County on November 16. The first detection of SLEV in mosquitoes was from a *Cx. tarsalis* pool collected in Kings County on June 21, and the last detection was from a *Cx. tarsalis* pool collected in Riverside County on November 1.

Animal surveillance

Chicken serosurveillance

In 2022, 24 local mosquito and vector control agencies in 20 counties maintained 79 sentinel chicken flocks (Table 4.6). Blood samples were collected from chickens every other week and tested for antibodies to WNV, SLEV, and WEEV by an EIA at the CDPH Vector-Borne Disease Section (CDPH-VBDS) laboratory and one local agency. Positive samples were confirmed at the CDPH-VBDS laboratory by IFA or western blot. Samples with inconclusive results were tested by PRNT at CDPH-VRDL. Of 5,292 chicken blood samples tested, 145 seroconversions to WNV were detected among 35 flocks in 13 counties

Table 4.5. Infections with St. Louis encephalitis virus in humans, mosquito pools, and sentinel chickens, by county, California, 2022

County	Humans	Mosquito Pools[a]	Sentinel Chickens
Fresno	2	14	NT
Imperial	0	6	NT
Kern	3	12	NT
Kings	0	27	NT
Los Angeles	3	1	NT
Madera	0	18	NT
Orange	1	0	NT
Riverside	0	57	0
Sacramento	1	0	NT
Sonoma	1	0	0
Stanislaus	1	1	NT
Tulare	4	16	0
State Totals	**16**	**152**	**0**

NT= no samples tested

[a]Positive mosquito pools included *Culex tarsalis* (103 pools), *Cx. quinquefasciatus* (45 pools), *Cx. pipiens* (4 pools)

Table 4.6. Results of testing sentinel chickens for West Nile virus (WNV), by county, California, 2022

County	No. flocks	No. chickens[a]	No. WNV positive flocks	WNV positive sera
Alameda	3	18	0	0
Butte	7	46	6	27
Calaveras	1	10	0	0
Colusa	1	10	1	3
Contra Costa	4	23	1	5
Lake	2	12	1	3
Los Angeles	21	120	9	33
Merced	8	47	4	16
Nevada	2	12	0	0
Sacramento	3	19	2	6
San Benito	1	8	0	0
San Mateo	2	14	0	0
Shasta	5	34	1	3
Solano	3	20	0	0
Sutter	5	35	4	16
Tehama	3	30	2	6
Tulare	1	10	1	10
Ventura	3	29	0	0
Yolo	2	14	1	4
Yuba	2	14	2	13
Total	**79**	**525**	**35**	**145**

[a] Reflects planned standard number of chickens per flock. Actual number may vary due to mortality or replacement of seroconverted chickens.

(Tables 4.6, 4.8). Statewide, 28% of sentinel chickens seroconverted to WNV. Since 2003, the percentage of WNV seroconversions in chickens has ranged from a low of 3.2% (2003) to a high of 37% (2015). In 2022, the first and last WNV seroconversions were detected in Merced County on July 1 and in Butte County October 15, respectively. No SLEV seroconversions were detected in any chicken flocks (Table 4.5).

Dead bird surveillance for West Nile virus

In 2022, the California WNV and Dead Bird Call Center and website received 4,996 dead bird reports from the public in 49 counties (Table 4.7). Oral swabs or other samples (e.g., brain, kidney, ocular) from dead bird carcasses were tested either at the DART Laboratory or at one of 13 local agencies by RT-qPCR. Of the 1,330 carcasses deemed suitable for testing, WNV was detected in 189 (14%) carcasses from 23 counties (Tables 4.7, 4.8, Figure 4.3). Since 2003, the prevalence of WNV-positive dead birds has ranged from a low of 5% (2003) to a high of 60% (2014). In 2022, the first WNV-positive dead bird was an American Crow reported from Contra Costa County on May 4, and the last WNV-positive dead bird was an American Crow reported from Los Angeles County on November 9.

Horses

Serum or brain tissue specimens from horses displaying neurological symptoms were tested for WNV at the California Animal Health and Food Safety Laboratory. In 2022, WNV infection was detected in 16 horses from 10 counties (Table 4.8). Five of the horses died or were euthanized as a result of their infection.

Invasive mosquito surveillance

Three species of invasive *Aedes* mosquitoes became established in California between 2011 and 2014: the Asian tiger mosquito, *Ae. albopictus* (2011), the yellow fever mosquito, *Ae. aegypti* (2013), and the Australian backyard mosquito, *Ae. notoscriptus* (2014). All three species have similar biology and behavior, live in close association with human-made environments, and are container breeders. *Aedes aegypti* is the primary worldwide vector of chikungunya, dengue, yellow fever, and Zika viruses, and *Ae. albopictus* can also serve as a vector of these arboviruses. In Australia, *Ae. notoscriptus* is an important urban vector of dog heartworm and has been found infected with Ross River and Barmah Forest viruses. None of these viruses are currently present in California.

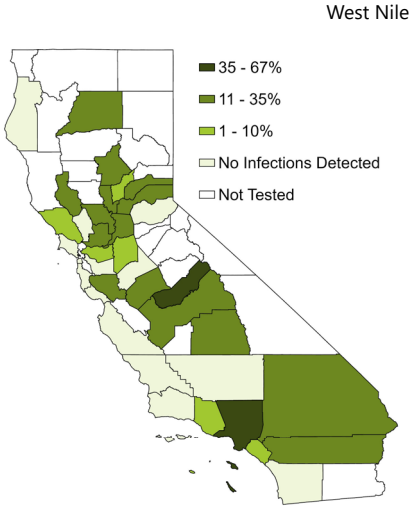


Figure 4.3. Prevalence of West Nile virus infection in dead birds, California, 2022

Table 4.7. Dead birds reported, tested, and positive for West Nile virus, by county, California, 2022

County	Reported	Tested[a]	Positive	%
Alameda	230	38	0	0
Alpine	0	0	0	0
Amador	6	0	0	0
Butte	38	7	2	29
Calaveras	3	0	0	0
Colusa	4	0	0	0
Contra Costa	373	42	1	2
Del Norte	0	0	0	0
El Dorado	27	9	0	0
Fresno	124	8	2	25
Glenn	4	0	0	0
Humboldt	5	1	0	0
Imperial	0	0	0	0
Inyo	0	0	0	0
Kern	23	1	0	0
Kings	11	0	0	0
Lake	12	6	2	33
Lassen	1	0	0	0
Los Angeles	783	115	49	43
Madera	8	3	2	67
Marin	56	4	0	0
Mariposa	0	0	0	0
Mendocino	5	0	0	0
Merced	44	7	2	29
Modoc	0	0	0	0
Mono	0	0	0	0
Monterey	18	4	0	0
Napa	20	9	0	0
Nevada	11	4	1	25
Orange	411	284	1	0
Placer	93	47	5	11
Plumas	3	0	0	0
Riverside	93	21	5	24
Sacramento	617	270	40	15
San Benito	3	0	0	0
San Bernardino	101	24	7	29
San Diego	127	47	0	0
San Francisco	44	8	0	0
San Joaquin	124	29	1	3
San Luis Obispo	16	2	0	0
San Mateo	262	64	0	0
Santa Barbara	25	5	0	0
Santa Clara	463	83	26	31
Santa Cruz	57	10	0	0
Shasta	28	6	1	17
Sierra	0	0	0	0
Siskiyou	1	0	0	0
Solano	143	33	9	27
Sonoma	98	19	1	5
Stanislaus	121	5	0	0
Sutter	47	13	4	31
Tehama	5	0	0	0
Trinity	0	0	0	0
Tulare	33	9	2	22
Tuolumne	3	0	0	0
Ventura	67	10	1	10
Yolo	177	73	24	33
Yuba	28	10	1	10
Totals	**4,996**	**1,330**	**189**	**14**

[a] Tested by the University of California Davis Arboviral Research and Training Laboratory or local mosquito/vector control agency

Table 4.8. Infections with West Nile virus in humans, horses, dead birds, mosquito pools, and sentinel chickens, by county, California, 2022

County	Humans[a]	Horses	Dead Birds	Mosquito Pools	Sentinel Chickens
Alameda	1	0	0	0	0
Alpine	0	0	NT	NT	NT
Amador	0	0	NT	NT	NT
Butte	3	0	2	38	27
Calaveras	0	0	NT	NT	0
Colusa	1	0	NT	0	3
Contra Costa	1	0	1	2	5
Del Norte	0	0	NT	NT	NT
El Dorado	0	0	0	NT	NT
Fresno	33	0	2	296	NT
Glenn	1	0	NT	1	NT
Humboldt	0	0	0	NT	NT
Imperial	0	0	NT	1	NT
Inyo	0	0	NT	0	NT
Kern	23	3	0	99	NT
Kings	7	1	NT	105	NT
Lake	0	0	2	7	3
Lassen	0	0	NT	NT	NT
Los Angeles	68	1	49	578	33
Madera	3	0	2	132	NT
Marin	0	0	0	0	NT
Mariposa	0	0	NT	NT	NT
Mendocino	0	0	NT	NT	NT
Merced	7	0	2	20	16
Modoc	0	0	NT	NT	NT
Mono	0	0	NT	NT	NT
Monterey	0	0	0	NT	NT
Napa	0	0	0	1	NT
Nevada	0	1	1	NT	0
Orange	11	0	1	39	NT
Placer	2	0	5	89	NT
Plumas	0	0	NT	NT	NT
Riverside	0	0	5	125	NT
Sacramento	5	2	40	42	6
San Benito	0	0	NT	0	0
San Bernardino	4	0	7	100	NT
San Diego	3	0	0	0	NT
San Francisco	0	0	0	NT	NT
San Joaquin	5	1	1	208	NT
San Luis Obispo	0	1	0	0	NT
San Mateo	1	0	0	0	0
Santa Barbara	0	0	0	0	0
Santa Clara	1	0	26	23	NT
Santa Cruz	0	0	0	0	NT
Shasta	1	0	1	39	3
Sierra	0	0	NT	NT	NT
Siskiyou	0	0	NT	NT	NT
Solano	3	0	9	12	0
Sonoma	1	0	1	0	NT
Stanislaus	15	1	0	70	NT
Sutter	1	0	4	31	16
Tehama	3	2	NT	NT	6
Trinity	0	0	NT	NT	NT
Tulare	15	3	2	1,030	10
Tuolumne	0	0	NT	NT	NT
Ventura	0	0	1	0	0
Yolo	3	0	24	65	4
Yuba	1	0	1	12	13
State Totals	**223**	**16**	**189**	**3,165**	**145**

[a]Includes asymptomatic infections detected through blood bank screening

NT= no samples tested

Since 2011, local vector control agencies have detected *Ae. aegypti* and *Ae. albopictus* mosquitoes in 382 cities or census-designated places (CDP) in 27 counties; populations of *Ae. aegypti* and *Ae. albopictus* have become established within urbanized areas of 25 and 5 counties, respectively. (Figure 4.4). *Aedes notoscriptus* are established in parts of Los Angeles, Orange, and San Diego counties, and since 2014, have been detected in over 45 cities and CDP.

In 2022, *Ae. aegypti* mosquitoes were discovered for the first time in ten new cities, 22 CDP, and three counties: Contra Costa, Santa Clara, and Santa Cruz. *Aedes albopictus* were discovered in one new city and one CDP. *Aedes notoscriptus* were not detected in any new locations. Local vector control agencies with invasive *Aedes* worked to improve the efficacy and efficiency of *Aedes*-specific surveillance, expanded public education and outreach programs to encourage residents to minimize mosquito larval habitats on their properties, and explored potential future *Aedes* control options including exclusion from public utilities vaults and sterile insect techniques. Agencies responded to travel-associated human cases of *Aedes*-borne arboviruses, such as dengue, following U.S. Centers for Disease Control and Prevention recommended guidelines to minimize the potential for local transmission in areas with established populations of *Ae. aegypti* or *Ae. albopictus*. In 2022, a total of 30,778 *Ae. aegypti* mosquitoes were tested for chikungunya, dengue, and Zika viruses; all were negative. In addition, 4,200 *Ae. aegypti* were tested for WNV, SLEV, and WEEV; two were positive for WNV (Table 4.4).

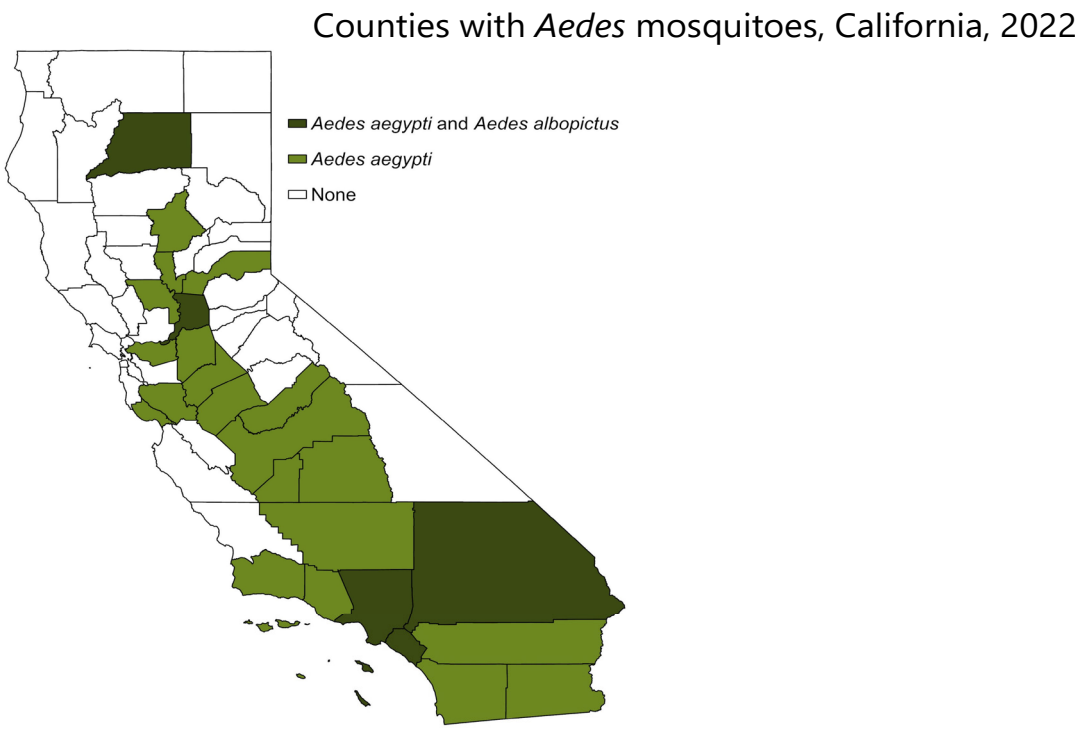


Figure 4.4. Invasive *Aedes* mosquito detections, by county, California, 2022

5 U.S. Forest Service Cost-Share Agreement

In 1992, the California Department of Public Health, Vector-Borne Disease Section, entered into a Challenge Cost-Share Agreement with the Pacific Southwest Region (Region 5) of the United States Department of Agriculture Forest Service. The agreement maintains cooperative surveillance and control of vector-borne diseases within the National Forests.

Major objectives and activities related to the United States Department of Agriculture Forest Service (USFS) Region 5 (R5) cost-share agreement include:

- Surveillance of and response to vector-borne diseases (VBD) including visual campground assessment, small mammal trapping and testing, and tick collection and testing
- Flea treatment of campgrounds if plague risk deemed elevated
- Forest Service facility and campground evaluations and recommendations for VBD risk reduction
- Education of personnel, concessionaires, and the public in the 18 National Forests in California through safety presentations, videos, and social media
- Provision of public health educational materials to concessionaires, USFS offices, and public information displays
- Response to other insect and vector-related queries from USFS personnel

This report briefly reviews activities carried out under the agreement by the California Department of Public Health, Vector-Borne Disease Section (CDPH-VBDS) and local collaborators in 2022. For each National Forest, activities and test results for selected vector-borne diseases are summarized in Tables 5.1 through 5.3, and highlights are described below.

2022 U.S. Forest Service Highlights

- Nearly 36% (15 of 42) *Peromyscus maniculatus* (deer mice) from two locations on the Eldorado National Forest tested positive for serum antibodies to Sin Nombre virus, the causative agent of hantavirus pulmonary syndrome (Tables 5.2, 5.3).
- Bacterial and/or serological evidence of plague activity continues to be documented annually on the Lake Tahoe Basin Management Unit without interruption since 2012, including a human case in 2020, and 18 (27%) of 66 of rodents testing positive in 2022 (Tables 5.2, 5.3).
- Tick surveillance and testing on the Sequoia National Forest showed an unusually high number (14 [9%] of 156) adult *Ixodes pacificus* ticks infected with *Borrelia burgdorferi*, the causative agent of Lyme disease (Tables 5.2, 5.3).
- Tick testing for human pathogens has expanded to include *Anaplasma phagocytophilum*, an intracellular bacterial pathogen found in *Ixodes* spp. ticks and causative agent of anaplasmosis. Two positive ticks were found on the Six Rivers National Forest in 2022 including one with co-infection of *B. burgdorferi* (Table 5.3).
- In response to a human case of tick-borne relapsing fever, 45 soft ticks (*Ornithodoros hermsi*), collected from Camp Jack Hazard on the Stanislaus National Forest, tested negative for *Borrelia hermsii* (Tables 5.2, 5.3).

Table 5.1. Summary of United States Forest Service Activities (Region 5)
Performed by the California Department of Public Health Under the USFS-CDPH Cost-Share Agreement, 2022

National Forest	Disease Risks/Services Addressed	Facility Evaluation	Presentation Audiences	Forest Locations Visited/Contacted[a]
Angeles/ San Gabriel Mountain National Monument	Plague; Tick-borne diseases			Supervisor's Office; Gateway Ranger District, North Lodge (concessionaire HQ), Apple Tree, Buckhorn, Crystal Lake, Horse Flats, Little Pines, Manzanita, Mountain Oak, Peavine, and Table Mountain campgrounds; Jackson Lake Picnic Area; Crystal Lake and Windy Gap trails
Cleveland	Plague; Tick-borne diseases			Supervisor's Office; Descanso, Palomar, and Trabuco Ranger District Offices; Blue Jay, Bobcat Meadow, Boulder Oaks, Burnt Rancheria, Cibbet Flat, Corral Canyon OHV, El Prado Group, Fry Creek, Horse Haven Group, and Laguna, Observatory, campgrounds; Inaja, San Juan, Maple Springs trails; Corral Canyon OHV
Eldorado	Hantavirus; Plague; Tick-borne diseases	Lumberyard Fire Station, Leek Springs Lookout		Supervisor's Office; Amador, Georgetown, Pacific, and Placerville Ranger District and Nursery Offices; Northwind, Strawberry Point and Sunset campgrounds
Inyo	Plague; Tick-borne diseases	Private residences (tick-borne relapsing fever cases) on long-term leased lands in Glass Creek Recreation Residence, Pine Glade Residence, and Twin Lakes Residence tracts	Safety presentation via internet, new employee orientation	Supervisor's Office; Mammoth Lakes, Mono Lake, Mt. Whitney and White Mountain Ranger District Offices; Agnew Meadows, Aspen, Big Bend, Coldwater, Ellery Lake, Four Jeffrey, Junction, Kennedy Meadows, Lake George, Lake Mary, Lower Gray's Meadow, Minaret Falls, New Shady Rest, North Lake, Pine City, Sherwin Creek, Oh Ridge, Old Shady Rest, Red's Meadow, Tioga Lake, Twin Lakes, and Upper Soda Springs campgrounds; Cottonwood Canyon Trail.
Klamath	Hantavirus; Plague			Supervisor's Office; Goosenest and Happy Camp/Oak Knoll Ranger District Offices; Carter Meadows Horse, Hidden Horse Group, Kangaroo Lake campgrounds.
Lake Tahoe Basin Management Unit	Hantavirus; Plague			LTBMU Supervisors Office; Tallac Historical Site and Tallac Point; Taylor Creek Visitor Center; Fallen Leaf Campground.
Lassen	Hantavirus; Plague	Mineral Work Station		Supervisor's Office; Almanor, Eagle Lake, Hat Creek District Offices.
Los Padres	Plague; Tick-borne diseases			Supervisor's Office; Monterey, Mt. Pinos, Ojai, Santa Barbara, and Santa Lucia Ranger District Offices; Arroyo Seco, Camp Alto, Figueora, Upper Oso, Wheeler Gorge campgrounds; Aliso, Romero Canyon, Cerro Alto, Cozy Dell, Deal, Jesuita, Potrero John, and San Carpoforo trails.
Mendocino	Tick-borne diseases			Supervisors Office; Grindstone and Upper Lake Ranger District Offices; Alder Springs Fire Station; Dixie Glade and Middle Creek campgrounds.
Modoc	Plague			Supervisor's Office; Big Valley, Devil's Garden, Doublehead, and Warner Mountain Ranger Districts.
Plumas	Plague			Supervisor's Office; Beckwourth and Mt. Hough Ranger District Offices; Gold Lake, Goose Lake, Haven Lake, and Lakes Basin campgrounds; Gray Eagle Creek trail.
San Bernardino	Hantavirus; Plague; Tick-borne diseases			Supervisor's Office, Front Country, Mountaintop, and San Jacinto Ranger District Offices; Desert Water Agency (Snow Creek); Mormon Rocks Station; Apple White, Barton Flats, Buttercup Group, Fern Basin, Green Valley, Hanna Flat, Heart Bar Family, Heart Bar Equestrian Group, Holcomb Valley, Horse Springs, Lake Hemet, Marion Mountain, North Shore, Oso-Lobo Group, Pine Knot, Serrano, Skyline Group, South Fork, Wildhorse Equestrian campgrounds; Apple White and Meadows Edge picnic areas; Big Falls, Middle Fork, Momyer Creek, Pacific Crest (Swarthout Canyon area) trails; Penstock and San Sevaine (1N34) roads.
Sequoia	Hantavirus; Plague; Tick-borne diseases	Peppermint Work Station	Safety presentation via MS Teams to the Kern River Ranger District	Supervisor's Office; Hume Lake, Kern River, and Western Divide Ranger District Offices; Hot Springs Work Center; Cannell Meadow Cabin; Belknap, Boulder Gulch, Camp 9 Recreation Area, Fairview, Fish Creek, French Gulch, Goldledge, Headquarters, Holey Meadow, Horse Meadow, Hospital Flat, Leavis Flat, Limestone, Long Meadow Group, Paradise Cove, Quaking Aspen, Quaking Aspen Group, Redwood Meadow, Tillie Creek, Troy Meadow, and Wishon campgrounds; South Fork Wildlife Area; Kern River (Johnsondale Bridge), Mill Creek, Pack Saddle, Remington Ridge, and Rincon trails.
Shasta-Trinity				Supervisor's Office; Mount Shasta McCloud, Mount Shasta, South Fork, and Trinity Management Units; McCloud and Mount Shasta Ranger Stations.
Sierra	Plague; Tick-borne diseases			Supervisor's Office; Bass Lake and High Sierra Ranger Districts; Dorabell Campground; Lewis Creek National Recreation and Willow Creek trails.
Six Rivers	Tick-borne diseases			Supervisor's Office; Lower Trinity and Orleans Ranger District Offices; Smith River National Recreation Area Office; Aiken's Creek and Boise Creek campgrounds; Paradise Trail.
Stanislaus	Hantavirus; Plague; Tick-borne diseases	Camp Jack Hazard	Safety presentation via MS Teams to the Forest Staff	Supervisor's Office; Calaveras, Groveland, Mi-Wok, and Summit Ranger District Offices; Baker Historical Station; High Sierra Institute; Baker, Brightman Flat, Camp Liahona Alp, Cascade Creek, Cherry Valley, Clark Fork, Clark Fork Horse Camp, Dardanelles, Deadman Eureka Valley, Meadowview Niagara Creek, Peaceful Pines, Pigeon Flat, Sand Flat campgrounds; Cottonwood and Douglas Picnic Areas; Donnell Vista Point; Alp, Arnot Creek, Clark Fork, Columns of the Giants, Disaster Creek, Kennedy Meadows, Saint Mary's Pass, and Sonora Pass trailheads; Cascade Creek OHV Registration Sign; Niagara ORV.
Tahoe	Plague; Tick-borne diseases		American River, Sierraville, Truckee, and Yuba River Ranger Districts	Supervisor's Office; American River, Sierraville, Truckee, and Yuba River Ranger District Offices; Cold Creek, Hampshire Rocks, Logger, Lower Little Truckee, Silver Creek, and Upper Little Truckee campgrounds; Donner Camp Picnic Site and Ralston Picnic Area; Circle Bridge and Sagehen trails.

[a] Locations visited or contacted not already listed under Facility Evaluations.

Table 5.2. Vector-Borne Disease Related Services and Findings, USFS-CDPH Cost-Share Agreement, 2022

National Forest	Unique Services/ Unusual Findings
Angeles / San Gabriel Mountain National Monument	Plague and tick surveillance and sample testing were conducted in the Crystal Lake recreation area of the San Gabriel Mountain National Monument.
Cleveland	Three (4%) of 68 adult *Ixodes pacificus* ticks collected during routine surveillance on Maple Springs Trail on the Trabuco Ranger District were positive for *Borrelia burgdorferi* sensu lato (Bbsl), a possible human pathogen.Forest and District leadership were notified of the test results.
Eldorado	Seven (35%) of 20, and eight (36%) of the 22 deer mice collected from Lumberyard Fire Station and Leek Springs Lookout, respectively, tested positive for antibodies to Sin Nombre virus (SNV) causative agent for hantavirus pulmonary syndrome (HPS). Test results and recommendations were communicated to Ranger District and Forest leadership.
Inyo	Thirty and 26 rodents collected from Sherwin Creek and Oh Ridge campgrounds, respectively, were tested for plague antibodies. Two (7%) from Sherwin Creek and two (8%) from Oh Ridge were seropositive. Campgrounds remained open with Plague Warning signage and VBDS plague disease prevention brochures made available to campers. Follow-up testing at Sherwin Creek Campground found no additional seropositive samples.
Klamath	Two (27%) of seven deer mice from recreation sites on the Salmon River Ranger District tested positive for antibodies to SNV.
Lake Tahoe Basin Management Unit	Eighteen (27%) of 66 rodents tested from recreation sites on the Management Unit tested positive for antibodies to *Yersinia pestis*, causative agent for plague. Significantly, none of the fleas collected and tested were positive for plague bacteria.
Lassen	Two (33%) of six deer mice tested positive for antibodies to SNV. Staff provided a facility hantavirus risk evaluation to leadership.
Los Padres	One (0.4%) of 270 adult *I. pacificus* ticks collected from the Forest tested positive for *Borrelia burgdorferi* sensu lato.None of the 270 ticks tested positive for *Anaplasma phagocytophilum*, another human pathogen.
Modoc	None of the four carnivore samples from lands on or adjacent to the Forest tested positive for antibodies to *Y.pestis*.
Plumas	None of the 18 chipmunks or their associated flea pools were positive for evidence of plague infection.
San Bernardino	None of the 14 *Peromyscus* spp. mice from Forest lands adjacent to the HPS case in Snow Creek tested positive for antibodies to SNV.
Sequoia	A high proportion of adult *I. pacificus* ticks (11 [19%] of 57) tested positive for the presence of *B. burgdorferi* sensu stricto, causative agent for Lyme disease, from lands around the Hot Springs Work Center. Overall, from sites on the Forest, 14 (8%) of 166 adult *I. pacificus* ticks were positive for *B. burdgorferi* bacteria, the highest seen on any Forest in R5.
Sierra	None of the adult *I. pacificus* ticks collected from trails surveyed on the Forest were positive for *Borrelia* or *Anaplasma* organisms. One (6%) of 18 deer mice collected on Forest land tested positive to antibodies to SNV.
Six Rivers	An adult *I. pacificus* tick collected from Boise Creek Campground was co-infected with *B. burgdorferi* sensu lato and *A. phagocytophilum,* both known human pathogens.
Stanislaus	Forty-five *Ornithodoros hermsi* (soft ticks) tested negative for *Borrelia hermsii,* the causative agent for tick-borne relapsing fever, at the VBDS laboratory. Ticks were collected from a private summer camp in relation to a confirmed case of tick-borne relapsing fever.
Tahoe	Four *I. pacificus* ticks infected with B. *miyamotoi* bacteria were collected from two different locations on the Forest.
R5 (District Level)	Held a virtual annual meeting with Region 5 (R5) Safety Officer. Provided a pre-season letter for distribution throughout R5. Provided the R5 Public Affairs Officer vector-borne disease prevention and education materials in Visalia. Notified the R5 Safety Officer with reports of significant findings from sampling test results or human cases with probable exposure from USFS lands.

Table 5.3. Testing results for selected vector-borne disease agents in U.S. National Forests, California, 2022

National Forest	Sin Nombre virus (hantavirus pulmonary syndrome)		*Yersinia pestis* (plague)						*Borrelia spp.*		*Anaplasma phagocytophilum*		Tularemia	
	Peromyscus mice		rodents		flea pools[a]		carnivore[b]		*Ixodes* spp. or *Ornithodoros*[c] ticks		*Ixodes pacificus* ticks		*Dermacentor* ticks	
	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested
Angeles			0	23	0	10			0	17	0	17		
Cleveland			0	2	0	1			3	68	0	68		
Eldorado	15	42												
Inyo			5	143	0	14								
Klamath	2	7	0	37	0	26								
Lake Tahoe BMU			18	66	0	57	0	3						
Lassen	2	6	0	5	0	2								
Los Padres			0	36	0	44	0	9	1[d]	270	0	270	0	2
Mendocino									0	8	0	8		
Modoc							0	4						
Plumas			0	18	0	14	0	1						
San Bernardino	0	14	0	49	0	7			0	206	0	206		
Sequoia	1	18	0	48	0	17			14	166	0	166		
Sierra							0	1	0	3	0	3		
Six Rivers									2	186	2	186	0	1
Stanislaus							1	1	0	45[c]				
Tahoe			2	18	0	7			4[d]	106	0	106		
Total, all forests	**20**	**87**	**25**	**445**	**0**	**199**	**1**	**19**	**24**	**1,075**	**2**	**1,030**	**0**	**3**

[a] Flea pools may contain 1 to 10 fleas; a single rodent may have more than one flea pool associated with it.

[b] Carnivore specimens taken directly from or adjacent to USFS lands. Because of the broad home range of some carnivores, results obtained can be inferred to a large area, including both USFS and adjacent lands.

[c] Investigation of a tick-borne relapsing fever case caused by *Borrelia hermsii* and transmitted by *Onrithodorous hermsi* (soft) ticks.

[d] *B. miyamotoi*, a relapsing fever-type spirochete and emerging pathogen.

6 Vector Control Technician Certification Program

The California Health and Safety Code, § 106925, requires every government agency employee who handles, applies, or supervises the use of any pesticide for public health purposes to be certified by the California Department of Public Health. The Vector-Borne Disease Section administers the Public Health Vector Control Technician certification examination twice each year (May and November) to certify the competence of government agency personnel to control vectors for the health and safety of the public.

To become certified in a control category, applicants must pass the Core section and at least one Specialty section of the examination. Each applicant to the examination pays a fee for each section requested on the application. The Core section consists of questions about the safe and effective use of pesticides. Specialty sections of the examination include the Biology and Control of Mosquitoes in California, Arthropods of Public Health Significance in California, and Vertebrates of Public Health Importance in California (Table 6.1). Successful examinees are issued a gold certification card that is valid for up to two years in the qualified categories specified on the card. To maintain full certification status in subsequent two-year cycles, Certified Technician employees must pay annual renewal fees and fulfill minimum continuing education requirements. The California Department of Public Health (CDPH) Vector-Borne Disease Section approved 112 continuing education events in 2022. Successful examinees that elect not to participate in continuing education are issued parchment certificates in the categories in which they qualified. These Certified Technicians (Limited) employees may use pesticides only under the direct supervision of a Certified Technician.

Through 2022, 1,192 Vector Control Technicians employed at 104 local public health agencies and CDPH held 2,861 certificates (Table 6.2). The agencies include special districts, departments of county government, departments of city government, and CDPH. Of these agencies, 73 are signatory to a cooperative agreement with CDPH.

In 2022, 920 individuals employed at 72 agencies held full certification status. In addition, 272 employees from 52 agencies held limited status. Many agencies employ technicians with both full and limited status.

Vector Control Technicians can view their certification records and the approved Vector Control continuing education courses at: http://ce.calsurv.org. For information on Vector Control Technician exam applications, training manuals, practice exam questions and the Continuing Education Guide, please refer to https://www.cdph.ca.gov/ and then and search for "Vector Control Technician Certification Program".

Table 6.1. Results of certification examinations administered in 2022

Exam section	No. Exams Given	No. Passed (%)
Core	174	109 (63)
Mosquito Control	173	108 (62)
Terrestrial Invertebrate Control	139	82 (59)
Vertebrate Vector Control	114	74 (65)
Totals	**600**	**373 (62)**

Table 6.2. Vector Control Technician certificates in effect as of December 2022

	No. Certificates		
Certification Category	**Full Status**	**Limited Status**	**Total**
Mosquito Control	910	188	1,098
Terrestrial Invertebrate Vector Control	716	145	861
Vertebrate Vector Control	714	188	902
Totals	**2,340**	**521**	**2,861**

7 Public Information Materials, Publications

A goal of the California Department of Public Health, Vector-Borne Disease Section is to provide clear and effective information on disease prevention. This goal is pursued through approaches including presentations, development and distribution of printed and digital materials, and maintenance of websites with up-to-date information. Research projects in which the California Department of Public Health, Vector-Borne Disease Section was a principal or collaborating investigator are published in peer-reviewed scientific literature.

New public information materials in 2022

- *Help Track Plague in California* (flyer)
- *Got Lice? Here's What You Need to Know About Head Lice* (flyer)

Expanded resources in 2022

- *Westnile.ca.gov social media toolkit* (webpage and digital resources)
- *Don't Let the Ticks Bite! Educational Toolkit for Youth* (PowerPoint presentation and printable resources)
- *Head lice* (Spanish webpage)

Help Track Plague in California!

Report and submit dead rodents to the CA Department of Public Health

What is plague?

Plague is a disease caused by *Yersinia pestis* bacteria that can infect humans, rodents, and other animals. Humans and their pets can get plague through the bite of infected fleas that live on wild rodents or in rodent burrows. The California Department of Public Health (CDPH) works with National Forest, Park Service, and State Park personnel and campground staff in recreation areas to monitor commonly visited recreation areas for signs of plague.

CDPH

Areas of increased plague risk

Why monitor recreation areas?

The best way to protect people from plague is to proactively monitor popular recreation areas where rodents are common. In these areas, people can be very close to rodents and their fleas in the environment. Rodents can die from plague, which can be a sign that plague is active in the area. If signs of plague are identified early, preventative steps can be taken to protect the public, such as notifying residents/visitors and conducting flea control.

How you can help!

If you find a dead rodent with no visible injury, or notice a large die-off or sudden absence of rodents in your area, contact CDPH right away:

(916) 552-9730

- CDPH will ask for additional information and may ask for your help in safely collecting the dead rodent for testing.
- After reporting, continue to look for signs of plague in the area, and caution visitors to avoid contact with rodents and fleas.

Rodents to look out for:

How to Submit a Dead Rodent to CDPH:

1. Use gloves to collect dead rodent in clear bag. Or turn bag inside out to pick up carcass. One carcass per bag.
2. Seal and label bag with:
   - Date/time
   - Collection location
   - Collector's name/ agency

   LABEL
3. Double-bag and freeze or put on ice ASAP.
4. Contact CDPH for shipping instructions:

(916) 552-9730
VBDS@cdph.ca.gov

Publications*

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*Bolded names are members of VBDS staff at time research was conducted

California Department of Public Health, Vector-Borne Disease Section
1616 Capitol Avenue, MS 7307, P.O. Box 997377, Sacramento, CA 95899-7377
VBDS@cdph.ca.gov, (916) 552-9730
https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/VBDS.aspx

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