Vector-Borne Disease Section

Annual Report

2021

California Department of PublicHealth

2021

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 2021 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 2021. Staff successfully adapted programs and procedures to address the challenges posed by the ongoing COVID-19 pandemic.

In 2021, West Nile virus (WNV) activity was less than in 2020, with 129 human cases reported from 28 counties; there were 12 fatalities. This is the lowest number of cases reported since 2010; however, WNV continues to pose the greatest vector-borne disease threat in California, with over 7,300 cases (332 fatal) reported since 2003. In addition to WNV activity, St. Louis encephalitis virus activity was detected in mosquitoes or sentinel chickens in eight counties and there were four human cases.

The number of travel-associated human cases of dengue (33), chikungunya (7), and Zika (2) continued to decline in California in 2021 relative to prior years, likely reflecting the reduction in international travel due to the COVID-19 pandemic. *Aedes aegypti* (yellow fever mosquito), the primary vector of dengue, Zika, and chikungunya viruses, slightly expanded its range in California in 2021. Although not detected in a new county, this species was found in 17 new cities or census designated places. In contrast, *Aedes albopictus* (Asian tiger mosquito) was not found in new cities in 2021. With *Aedes aegypti* and *Aedes albopictus* established in 22 and 3 counties, respectively, there is the ongoing threat of local virus transmission in some regions of the state.

In 2021, a record number (209) of human cases of flea-borne typhus, caused by *Rickettsia typhi*, were reported from five counties; 85% of the case-patients required hospitalization. Typhus is considered endemic in parts of southern California. Extensive plague activity was detected in animals and fleas in the South Lake Tahoe region (El Dorado County) prompting enhanced outreach and plague mitigation measures. Plague activity was also detected in Mono, Sierra, and San Bernardino counties. Since 1980, hantavirus infection has been diagnosed in 90 California residents, with the majority of cases exposed to Sin Nombre virus (SNV) in the interior mountain ranges of the state or eastern Sierra Nevada. In 2021, just one case of hantavirus pulmonary syndrome was reported in a resident of Riverside County, although SNV antibody-positive deer mice were found in five of nine counties sampled.

Human cases of seven tick-borne diseases were reported in California in 2021. Reports of Lyme disease (119) increased relative to 2020. Although Lyme disease is the most commonly reported tick-borne disease in California, there were also cases of anaplasmosis (15), tick-borne relapsing fever (10), Rocky Mountain spotted fever (5), babesiosis (4), Pacific Coast tick fever (3), and tularemia (1). In 2021, VBDS and collaborating agencies collected and tested thousands of ticks throughout California, including over 18,000 *Ixodes pacificus* (western blacklegged tick) from 30 counties, to aid in identifying areas at highest risk of tick-borne disease transmission.

In 2021, 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 2021 are listed here.

Rodent-borne Diseases

Alameda County Vector Control Services District (VCSD); Coachella Valley Mosquito and Vector Control District (MVCD); County of San Diego Vector Control Program (VCP); Museum of Vertebrate Zoology at University of California Berkeley; National Park Service (NPS); Northwest MVCD; Orange County MVCD; Riverside County Department of Environmental Health VCP; San Bernardino County VCP; San Mateo County MVCD; Santa Clara County Vector Control District (VCD); 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 Services; Mosquito and Vector Management District (MVMD) of Santa Barbara County; NPS; Placer County MVCD; San Bernardino County VCP; San Diego County VCP; San Mateo County MVCD; Sierra County Environmental Health Department; United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service, Wildlife Services; USFS; Ventura County Environmental Health Division (EHD).

Tick-borne Diseases

Alameda County VCSD; Butte County MVCD; CDFW; University of California Davis Arbovirus Research and Training (DART) Laboratory; Imperial County Public Health Department; Marin County Health and Human Services; Marin-Sonoma MVCD; Mono County Environmental Health; MVMD of Santa Barbara County; Napa County Mosquito Abatement District; 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; USFS; Ventura County EHD.

Mosquito-borne Diseases

CDFW; DART Laboratory; Mosquito and Vector Control Association of California; participating local health departments, physicians and veterinarians, and local mosquito and vector control agencies.

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Annual Report Cover Art and Maps
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Chapters

Many staff from the Vector-Borne Disease Section contribute to each chapter of the Annual Report; however, only the lead author(s) for each chapter is listed below.

1 Rodent-borne Diseases
Jackson, B; Kovach, T and Kjemtrup, A. Chapter 1: Rodent-borne Diseases. In: Vector-Borne Disease Section Annual Report, 2021. California Department of Public Health, Sacramento, California, 2022. pp 1-3.

2 Flea-borne Diseases
Hacker, G; Novak, M and Porse, C. Chapter 2: Flea-borne Diseases. In: Vector-Borne Disease Section Annual Report, 2021. California Department of Public Health, Sacramento, California, 2022. pp 4-7.

3 Tick-borne Diseases
Saunders, M and Kjemtrup, A. Chapter 3: Tick-borne Diseases. In: Vector-Borne Disease Section Annual Report, 2021. California Department of Public Health, Sacramento, California, 2022. pp 8-13.

4 Mosquito-borne Diseases
Feiszli, T; Danforth, M; Porse, C and Metzger, M. Chapter 4: Mosquito-borne Diseases. In: Vector-Borne Disease Section Annual Report, 2021. California Department of Public Health, Sacramento, California, 2022. 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, 2021. California Department of Public Health, Sacramento, California, 2022. 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, 2021. California Department of Public Health, Sacramento, California, 2022. pp 26-27.

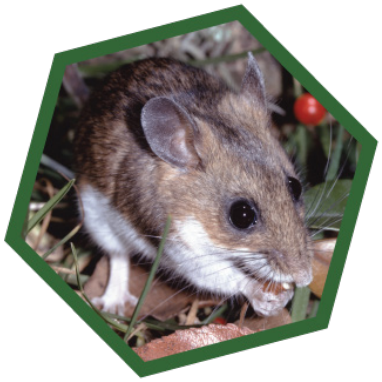
7 Public Information Materials, Publications
Nicolici, A. Chapter 7: Public Information Materials, Publications. In: Vector-Borne Disease Section Annual Report, 2021. California Department of Public Health, Sacramento, California, 2022. pp 28-29.

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, 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
- Oversee Special Local Need permits for restricted-use public health pesticides

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 includes 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 or potential for additional exposure.

In 2021, one case of hantavirus pulmonary syndrome was reported from a 70-year-old resident of Riverside County who survived. The month of illness onset was September.

Since 1980, hantavirus infection has been diagnosed in 90 California residents, with the majority of cases exposed to SNV in the interior mountain ranges of the state or eastern Sierra Nevada (Figure 1.1).

Rodent surveillance

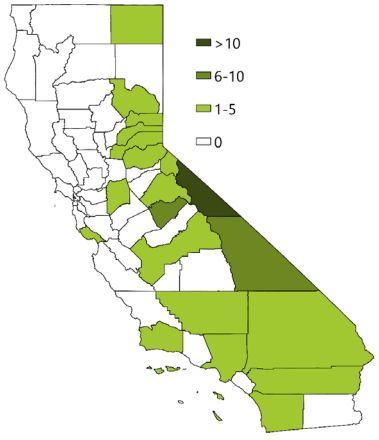
In 2021, 551 rodents (Genera: *Microtus*, *Neotoma*, *Peromyscus*, and *Reithrodontomys*) were tested for antibodies to SNV (Table 1.1). Of 551 *Peromyscus* spp. sampled, 22 (4.0%) were positive for SNV antibodies. Seroprevalence in deer mice (*Peromyscus maniculatus*), the primary reservoir for SNV, was 9.3% (Table 1.2). At least one deer mouse was SNV antibody-positive in 5 of 9 counties sampled in 2021 (Table 1.2). SNV antibody has been detected in deer mice from 24 of 43 counties sampled in the last 10 years; prevalence ranged from 2.9% to 35.5% (average 12.3%) over that period (Table 1.2).

Additionally, 1 (2.5%) of 40 western harvest mice (*Reithrodontomys megalotis*) demonstrated reactivity to SNV (Table 1.1). None of two woodrats (*Neotoma* spp.) nor 2 voles (*Microtus* spp.) demonstrated reactivity to SNV (Table 1.1). Seropositivity in these rodents may represent spillover of SNV from deer 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) and Public Health Foundation Enterprises (doing business as Heluna Health [HH]) entered into a cooperative agreement to help decrease the risk of contracting

County of Exposure for Reported Hantavirus Infections in California, 1980 - 2021*



*Represents cases where county of exposure could be determined by case-patient history, and epidemiologic and environmental evaluation: a total of 73 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 – 2021)

Table 1.1 Serologic evidence of hantavirus (Sin Nombre) infection in California rodents, 2012 - 2021

		2021			2012-2021		
Species	Common name	No. tested	No. reactive	Percent	No. tested	No. reactive	Percent
Peromyscus boylii	brush mouse	92	1	1.1	743	6	0.8
Peromyscus californicus	California mouse	115	0		1,390	19	1.4
Peromyscus crinitus	canyon mouse	0	0		32	2	6.3
Peromyscus eremicus	cactus mouse	90	0		1,550	10	0.6
Peromyscus fraterculus	northern Baja mouse	0	0		1,148	10	0.9
Peromyscus maniculatus	deer mouse	216	20	9.3	4,517	557	12.3
Peromyscus truei	piñon mouse	25	1	4.0	380	4	1.1
Peromyscus spp.	unspeciated *Peromyscus*	13	0		28	0	
Peromyscus spp. subtotal		551	22	4.0	9,788	608	6.2
Reithrodontomys megalotis	western harvest mouse	40	1	2.5	739	90	12.2
Neotoma spp.	woodrats	2	0		232	0	
Microtus spp.	voles	2	0		111	10	9.0

vector-borne diseases through increased health education, vector surveillance, and public health research.

CDPH-VBDS and HH worked with YOSE staff in 2021 on hantavirus prevention. Activities included rodent surveillance to estimate deer mouse abundance and SNV prevalence, facility evaluations, and improving employee training and public education. Rodent surveillance was conducted in Yosemite Valley and Tuolumne Meadows. Deer mouse trap success rates in 2021 were lower at Valley locations (6.4%) in comparison to an annual average of 15.7% (2012-2020). One (6.7%) of 15 deer mice tested positive for SNV antibodies. By comparison, 20 (7.2%) of 277 deer mice collected and tested from Yosemite Valley between 2012 and 2020 were seropositive to SNV. Trap success for deer mice in Tuolumne Meadows (11 captured out of 48 traps set or 22.9%) was higher than Valley locations (15 of 342 traps set or 4.4%). Three (27%) of the 11 deer mice trapped in Tuolumne Meadows were seropositive to SNV, compared to one (6.7%) of the 15 deer mice tested from Valley locations.

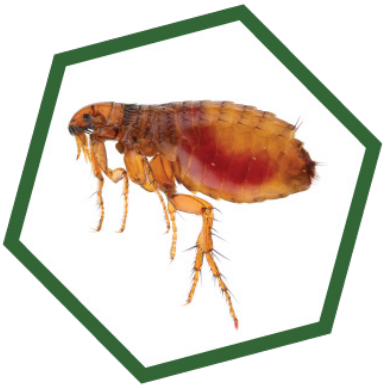
In addition to rodent surveillance and SNV testing, over 50 buildings were evaluated for rodent-borne disease risk. CDPH-VBDS and HH staff provided hantavirus prevention recommendations to YOSE and its associated partners based on surveillance results and facility evaluations.

Table 1.2. Serologic evidence of hantavirus (Sin Nombre) infection in *Peromyscus maniculatus* in California, 2012-2021

	2021			2012-2021		
County	No. tested	No. reactive	Percent	No. tested	No. reactive	Percent
Alameda				74	0	0.0
Alpine				9	2	22.2
Amador				8	0	0.0
Butte				6	0	0.0
Calaveras				4	1	25.0
Colusa				2	0	0.0
Contra Costa				16	0	0.0
Del Norte				1	0	0.0
El Dorado	19	7	36.8	249	56	22.5
Fresno				8	0	0.0
Glenn				5	1	20.0
Humboldt	43	0	0.0	69	0	0.0
Inyo				23	6	26.1
Kern	4	0	0.0	40	0	0.0
Lassen				42	10	23.8
Los Angeles				26	0	0.0
Marin				16	0	0.0
Mariposa	14	1	7.1	332	30	9.0
Modoc				47	4	8.5
Mono				403	143	35.5
Napa				20	3	15.0
Nevada				90	15	16.7
Orange				103	9	8.7
Placer				91	4	4.4
Plumas				101	24	23.8
Riverside	9	1	11.1	269	35	13.0
San Bernardino				137	0	0.0
San Diego	69	8	11.6	1,411	67	4.7
San Joaquin				4	0	0.0
San Mateo				174	33	19.0
Santa Barbara				12	0	0.0
Santa Clara				1	0	0.0
Santa Cruz				19	5	26.3
Shasta				91	16	17.6
Sierra				22	0	0.0
Siskiyou				73	20	27.4
Sonoma	25	0	0.0	25	0	0.0
Sutter				9	0	0.0
Tehama				93	18	19.4
Trinity				3	0	0.0
Tulare				14	1	7.1
Tuolumne	11	3	27.3	340	53	15.6
Ventura	22	0	0.0	35	1	2.9
Total	**216**	**20**	**9.3**	**4,517**	**557**	**12.3**

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. In 2021, 209 cases of typhus fever were reported to CDPH. Three (1%) of these were classified as confirmed cases according to CDPH working surveillance definition and 206 (99%) were probable. Median age was 44 years (range 2 to 87 years); 125 (59.8%) were male, 83 (39.7%) were female, and 1 (0.5%) was transmale. One hundred seventy-eight (85%) of the case-patients required hospitalization. Case-patients were residents of Los Angeles (172), Orange (25), Riverside (7), San Bernardino (4), and San Mateo counties. Typhus is considered endemic in parts of southern California. The case-patient from San Mateo County reported travel to an endemic area during the incubation period.

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. Rodent and flea surveillance are 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 and flea control may be initiated depending on surveillance results and estimated plague transmission risks.

One human case of plague was reported to CDPH in July 2021. The case-patient was a resident of Santa Clara County who was hospitalized and survived. The case-patient had travel and recreational exposure history to a plague-endemic area of Colorado one week prior to disease onset where it was determined that exposure most likely occurred.

A rodent carcass was collected and tested positive for plague at Taylor Creek Visitor Center (El Dorado County, Lake Tahoe Basin Management Unit, United States Forest Service [USFS]). Rodent and flea surveillance (Table 2.1) provided additional evidence of plague transmission and a 2020 human plague case was likely exposed in the vicinity. For these reasons, the area was temporarily closed in early September, and CDPH Vector-Borne Disease Section (CDPH-VBDS), El Dorado County Vector Control Program, and USFS staff applied deltamethrin insecticide to control rodent fleas. Follow-up surveillance at Taylor Creek indicated that flea control did not reduce flea densities below pre-treatment levels. Risk reduction recommendations were provided to local and federal agencies and the public was notified of potential risk of transmission in the area.

Animal disease surveillance (Plague)

Domestic pets

No cases of plague in domestic pets were reported in 2021.

Wild animals

The CDPH-VBDS plague surveillance program tested 309 wild rodents and 127 carnivores and wild pigs from 31 California counties in 2021 (Figure 2.1, Table 2.1). Serum antibodies to *Y. pestis* were observed in 26 rodents from four counties for an overall seroprevalence of 8.4% (Figure 2.1, Table 2.1). The 309 rodents tested for plague antibodies included: 190 chipmunks (*Tamias* spp.), 83 California ground squirrels (*Otospermophilus beecheyi*), 31 golden-mantled ground squirrels (*Callospermophilus lateralis*), 3 bushy-tailed woodrats (*Neotoma cinerea*), and 2 Douglas squirrels (*Tamiasciurus douglasii*). Antibodies to *Y. pestis* were detected in 11 yellow-pine chipmunks (*Tamias amoenus*) from El Dorado, Mono, and Sierra counties, 6 shadow (Allen's) chipmunks (*Tamias senex*) from El Dorado County, 5 California ground squirrels from El Dorado County, 2 least chipmunks (*Tamias minimus*) from Mono County, and 2 lodgepole chipmunks (*Tamias speciosus*) from Mono and San Bernardino counties (Table 2.1). Eight rodent carcasses were submitted from five counties (including three from Washoe County, Nevada) and tested by the CDPH-MDL reference bacteriology unit (Table 2.1). One yellow-pine chipmunk from El Dorado County (Taylor Creek Visitor Center, Lake Tahoe Basin Management Unit, USFS) tested positive for *Y. pestis* bacteria. Of the 127 wild carnivores and wild pigs tested for serum antibodies to *Y. pestis*, one black bear (*Ursus americanus*) from El Dorado County was positive (Table 2.1). The 126 negative samples included: 89 coyotes (*Canis latrans*), 31 black bears, 3 mountain lions (*Puma concolor*), 2 feral pigs (*Sus scrofa*), and 1 bobcat (*Lynx rufus*).

In 2021, 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 241 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 605 fleas collected from sylvatic rodents in eight counties were identified to species, combined into 151 pools, and tested for the presence of *Y. pestis* bacteria. Three pools of *Eumolpianus eumolpi* fleas collected from yellow-pine chipmunks in El Dorado County tested PCR-positive for *Y. pestis* (Table 2.2).

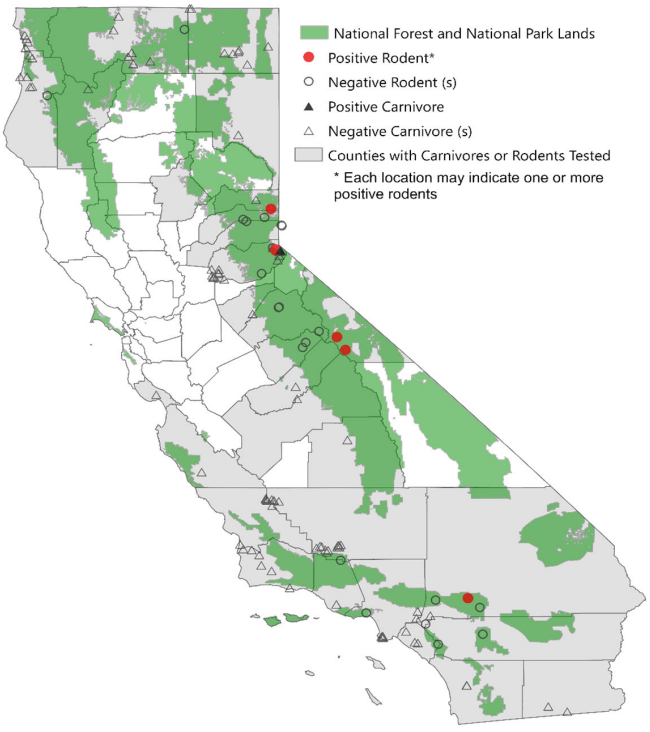


Figure 2.1. Approximate locations of carnivores or rodents that were tested by serology or culture for *Yersinia pestis*, California, 2021

Table 2.1. CDPH-VBDS plague test results in wild rodents and carnivores, California, 2021

County / Location	Rodent blood tested by serology	Rodent carcasses tested by culture	Carnivore blood tested by serology	Positive Specimens		
				Species	Titer or Pos	Month
Butte	**0**		**2**			
Calaveras	**0**		**1**			
Del Norte	**0**		**5**			
El Dorado	**85**	**2**	**23**			
LTBMU: Fallen Leaf CG				*Otospermophilus beecheyi*	1:4096	May
LTBMU: Fallen Leaf CG				*Tamias senex*	Pos (No titer)	May
LTBMU: Tallac Historic Site				*Tamias amoenus*	1:512	August
LTBMU: Tallac Historic Site				*Tamias senex*	1:32	August
LTBMU: Tallac Point				*Otospermophilus beecheyi*	1:1024	May
LTBMU: Tallac Point				*Otospermophilus beecheyi*	1:2048	May
LTBMU: Tallac Point				*Tamias amoenus*	1:512	May
LTBMU: Tallac Point				*Tamias senex*	1:64	May
LTBMU: Taylor Creek Visitor Center				*Tamias amoenus*	Pos (Carcass)	July
LTBMU: Taylor Creek Visitor Center				*Otospermophilus beecheyi*	1:1024	August
LTBMU: Taylor Creek Visitor Center				*Otospermophilus beecheyi*	1:32	August
LTBMU: Taylor Creek Visitor Center				*Tamias amoenus*	Pos (No titer)	August
LTBMU: Taylor Creek Visitor Center				*Tamias amoenus*	1:32	August
LTBMU: Taylor Creek Visitor Center				*Tamias amoenus*	1:64	August
LTBMU: Taylor Creek Visitor Center				*Tamias amoenus*	1:512	August
LTBMU: Taylor Creek Visitor Center				*Tamias amoenus*	1:256	August
LTBMU: Taylor Creek Visitor Center				*Tamias amoenus*	1:512	August
LTBMU: Taylor Creek Visitor Center				*Tamias senex*	1:2048	August
LTBMU: Taylor Creek Visitor Center				*Tamias senex*	1:256	August
LTBMU: Taylor Creek Visitor Center				*Tamias senex*	1:512	August
South Lake Tahoe				*Ursus americanus*	1:64	October
Fresno	**0**		**1**			
Humboldt	**2**		**6**			
Imperial	**0**		**4**			
Kern	**0**		**15**			
Klamath	**0**		**2**			
Lassen	**0**		**1**			
Los Angeles	**0**	**1**	**11**			
Madera	**0**		**1**			
Mariposa	**10**		**0**			
Modoc	**0**		**10**			
Mono	**55**		**0**			
Inyo NF: Oh Ridge CG				*Tamias minimus*	1:1024	June
Inyo NF: Oh Ridge CG				*Tamias minimus*	1:512	June
Inyo NF: Sherwin Creek CG				*Tamias speciosus*	1:256	June
Inyo NF: Sherwin Creek CG				*Tamias amoenus*	1:256	June
Monterey	**0**		**1**			
Nevada	**8**	**1**	**0**			
Orange	**5**		**5**			
Placer	**10**		**0**			
Riverside	**5**		**0**			
San Bernardino	**81**		**2**			
San Bernardino NF: Hanna Flat CG				*Tamias speciosus*	1:32	July
San Diego	**0**		**2**			
San Luis Obispo	**0**		**8**			
Santa Barbara	**0**		**13**			
Santa Cruz	**0**		**1**			
Sierra	**22**		**1**			
Sierra NF: Logger CG				*Tamias amoenus*	1:128	June
Sierra NF: Logger CG				*Tamias amoenus*	1:256	June
Siskiyou	**0**	**1**	**8**			
Trinity	**0**		**1**			
Tulare	**0**		**1**			
Tuolumne	**22**		**0**			
Ventura	**4**		**2**			
Washoe (Nevada)	**0**	**3**	**0**			
Total	**309**	**8**	**127**			

CG: Campground
LTBMU: Lake Tahoe Basin Management Unit
NF: National Forest
Pos (No Titer): Antibodies to *Yersinia pestis* found but no obtainable titer
Pos (Carcass): Rodent positive for *Yersinia pestis* bacteria by culture and PCR

Table 2.2. CDPH-VBDS plague test results in fleas from rodents, California, 2021						
County			**PCR-Positive Pools**			
Location	**Total # Fleas (Flea Pools) Tested by PCR**	**Number Positive Pools**	**Rodent Host**	**Flea Species**	**Total Fleas in Pool**	**Collection Date**
El Dorado	**228 (65)**	**3**				
LTBMU: Tallac Historical Site			*Tamias amoenus*	*Eumolpianus eumolpi*	**4**	8/5/2021
LTBMU: Taylor Creek Visitor Center			*Tamias amoenus*	*Eumolpianus eumolpi*	**10**	7/18/2021
LTBMU: Taylor Creek Visitor Center			*Tamias amoenus*	*Eumolpianus eumolpi*	**5**	8/5/2021
Mariposa	**98 (14)**	**0**				
Nevada	**146 (20)**	**0**				
Orange	**14 (3)**	**0**				
Placer	**14 (5)**	**0**				
Riverside	**11 (6)**	**0**				
Sierra	**22(12)**	**0**				
Tuolumne	**53 (23)**	**0**				
Total	**605 (151)**	**3**				

LTBMU: Lake Tahoe Basin Management Unit
PCR: Polymerase Chain Reaction

3 Tick-borne Diseases

Nine 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 2021, 15 cases of anaplasmosis caused by *Anaplasma phagocytophilum* were reported to the California Department of Public Health (CDPH); 12 (80%) met national surveillance criteria for a confirmed case and 3 (20%) met the criteria for a probable case. Case-patients were residents of Alameda, Contra Costa (2), Lake, Marin (6), Mendocino, Santa Clara, Santa Cruz, and Sonoma (2) counties. Median age was 68 years (range, 27 to 81 years) and 11 (73%) were male. Eleven (73%) case-patients reported exposure within California, including Contra Costa, Lake, Marin (5), Mendocino, and Sonoma (3) counties, and 4 (27%) reported exposure in the northeast or upper Midwest of the United States.

Babesiosis

In 2021, four cases of babesiosis were reported to CDPH; two met national surveillance criteria for confirmed cases caused by *Babesia microti*; two were probable cases caused by *B. duncani*. Case-patients were residents of Marin, Orange, Santa Cruz, and San Francisco counties. Median age was 58 years (range 16 to 75 years) and two (50%) were female. Both *B. microti*-infected patients had history of travel to the northeast United States, an area endemic for *B. microti*. The probable *B. duncani* case-patients did not have recent travel history out of their county of residence (Marin and Orange counties).

Ehrlichiosis

No cases of ehrlichiosis were reported to CDPH in 2021.

Lyme disease

A total of 119 cases of Lyme disease caused by *Borrelia burgdorferi* were reported in 2021; 85 (71%) of these met the surveillance case definition criteria for a confirmed case, 29 (25%) were probable, and 5 (4%) were suspect cases with erythema migrans (EM) rash with exposure in California (Figure 3.1).

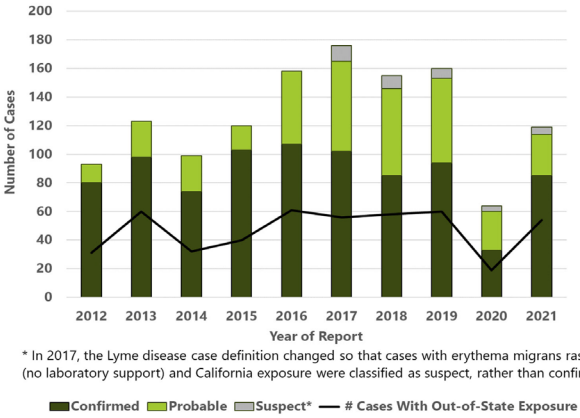
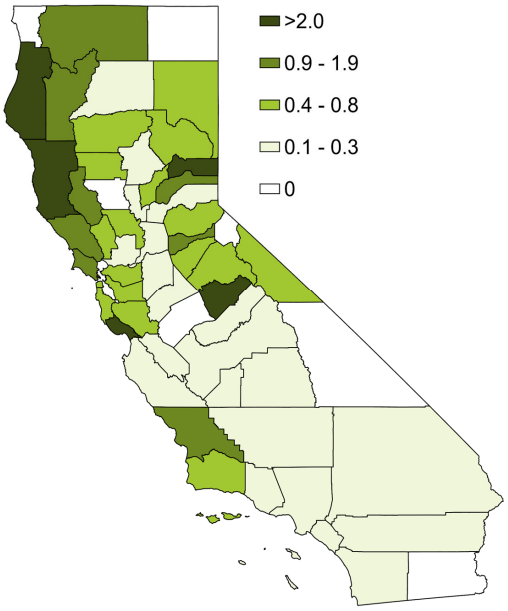


Figure 3.1. Confirmed and probable Lyme disease cases, including cases reporting travel within incubation period, by report year 2012 - 2021

Of the 85 confirmed cases, case-patients were residents of 23 counties, with Santa Cruz County reporting the greatest number of cases (13) (Table 3.1). The median age of confirmed Lyme disease case-patients was 44 years (range, 4 to 83 years) and 50 (59%) were male. Of the 61 confirmed case-patients for whom race or ethnicity was reported, 55 (90%) self-identified as White, 3 (5%) as Asian, and 3 (5%) as other; 6 (10%) self-identified as Hispanic or Latino. Erythema migrans was identified in 34 (40%) confirmed case-patients, with onset of EM noted between February and September, and the greatest number (13) reported with onset in July. Between 2012 and 2021, the highest incidence of Lyme disease

Reported confirmed cases per 100,000 person-years, 2012-2021*



Sierra	6.2
Santa Cruz	3.1
Mendocino	3.0
Mariposa	2.2
Humboldt	2.1
Sonoma	1.6
Trinity	1.5
Marin	1.4
Siskiyou	1.3
Amador	1.1
Nevada	1.0
Lake	0.9

*Though Lyme disease cases have been reported in nearly every county, cases are reported based on the county of residence, which does not necessarily reflect the county of infection.

Figure 3.2. Incidence of reported confirmed Lyme disease, by county, California, 2012-2021

was in northern California, particularly northwestern coastal counties and those with western-facing Sierra slopes (Figure 3.2). Of the 60 (53%) confirmed and probable case-patients reporting travel history outside of their county of residence within the incubation period, 54 (90%) reported exposure outside of California (Figure 3.1), most commonly in the northeastern United States.

Spotted fever group rickettsiosis

Eight cases of spotted fever group rickettsiosis were reported to CDPH in 2021. One fit the national surveillance criteria for a confirmed Rocky Mountain spotted fever (RMSF) case, four were classified as probable RMSF cases, and three were classified as probable cases of Pacific Coast tick fever (PCTF).

Of the five RMSF cases, case-patients were residents of Fresno, Los Angeles (2), Orange, and San Diego counties. Three (60%) were male and the median age was 58 years (range 7 to 72 years). Three cases reported travel outside of their counties of residence within the exposure period (to Los Angeles [2], San Diego), and two cases reported exposure to out-of-state RMSF-endemic areas including Mexico and Tennessee.

Of the PCTF cases, case-patients were residents of Alameda, El Dorado, and Santa Clara counties; the Alameda case-patient reported an associated tick-bite in Sonoma County, the other two case-patients did not report travel nor a tick-bite. Two were male and median age was 72 years. Case-patients presented with eschars (dark scab lesions) typical of PCTF.

Tick-borne relapsing fever

Ten cases of tick-borne relapsing fever (TBRF), caused by *Borrelia hermsii*, were reported to CDPH in 2021; seven met CDPH working surveillance case definition criteria for a confirmed case and three met the criteria for a suspect case. The median age for case patients was 60 years (range 4 to 78 years), and seven (70%) were female. Case-patients were residents of El Dorado (2), Fresno, Los Angeles (3), Mono, San Diego, San Mateo, and Ventura counties; counties where case-patients were likely exposed in the three weeks prior to illness onset were El Dorado (3), Fresno, and Mono (6) counties.

Tularemia

One case of tick-associated transmission of tularemia, caused by the bacteria *Francisella tularensis*, was reported to CDPH in 2021. The case fit the national surveillance definition for a probable case. The case-patient was a resident of Santa Cruz County and exposure was in San Mateo County.

Table 3.1. Reported confirmed Lyme disease cases by county of residence, California, 2012-2021

County	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTAL	Incidence per 100,000 person-years
Alameda	4	0	3	11	8	12	4	8	6	3	59	0.37
Alpine	0	0	0	0	0	0	0	0	0	0	0	0.00
Amador	0	1	0	2	0	0	0	0	1	0	4	1.06
Butte	0	0	1	0	2	0	0	1	0	0	4	0.19
Calaveras	0	0	0	1	0	1	0	1	0	0	3	0.66
Colusa	0	0	0	0	0	0	0	0	0	0	0	0.00
Contra Costa	4	5	2	4	6	12	10	2	2	5	52	0.47
Del Norte	0	0	0	0	0	0	0	0	0	0	0	0.00
El Dorado	2	0	2	2	1	2	0	0	0	1	10	0.53
Fresno	4	0	1	1	1	0	1	1	0	1	10	0.10
Glenn	0	0	1	0	0	0	0	1	0	0	2	0.69
Humboldt	4	4	4	6	4	3	1	2	0	0	28	2.09
Imperial	0	0	0	0	0	0	0	0	0	0	0	0.00
Inyo	0	0	0	0	0	0	0	0	0	0	0	0.00
Kern	0	0	0	1	1	0	0	1	0	0	3	0.03
Kings	0	1	0	0	1	0	0	0	0	0	2	0.13
Lake	0	0	0	1	1	0	0	3	1	0	6	0.93
Lassen	0	0	0	0	1	0	0	0	0	0	1	0.31
Los Angeles	2	17	6	6	1	3	2	3	0	6	46	0.05
Madera	0	0	0	0	0	0	0	0	1	0	1	0.06
Marin	3	6	5	5	3	0	1	8	0	5	36	1.40
Mariposa	1	1	1	1	0	0	0	0	0	0	4	2.21
Mendocino	4	0	1	0	1	1	1	10	1	7	26	2.96
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	0	1	0	0	0	0	0	0	0	0	1	0.73
Monterey	1	1	0	0	1	0	0	1	0	2	6	0.14
Napa	1	0	2	2	2	0	1	0	1	1	10	0.73
Nevada	2	1	1	1	2	0	2	1	0	0	10	1.02
Orange	0	0	0	0	1	0	0	0	0	0	1	0.00
Placer	2	1	0	0	2	3	0	0	0	0	8	0.21
Plumas	0	0	1	0	0	0	0	0	0	0	1	0.52
Riverside	0	2	1	1	3	1	1	2	2	2	15	0.06
Sacramento	2	0	0	0	1	1	3	2	0	0	9	0.06
San Benito	0	0	0	1	0	0	0	0	0	0	1	0.17
San Bernardino	0	1	0	1	0	0	0	2	0	3	7	0.03
San Diego	7	8	8	9	7	1	8	0	2	6	56	0.17
San Francisco	2	5	0	0	0	11	14	10	3	12	57	0.67
San Joaquin	1	0	1	0	1	0	1	3	0	0	7	0.10
San Luis Obispo	1	5	3	3	1	1	1	3	2	2	22	0.80
San Mateo	1	3	6	5	5	4	0	2	1	0	27	0.36
Santa Barbara	0	6	0	4	8	3	3	2	1	2	29	0.66
Santa Clara	4	13	5	10	11	7	5	2	3	4	64	0.34
Santa Cruz	5	5	6	8	7	15	10	11	3	13	83	3.11
Shasta	1	0	0	0	0	0	0	0	1	1	3	0.17
Sierra	1	0	0	0	0	0	1	0	0	0	2	6.22
Siskiyou	1	1	0	1	1	1	1	0	0	0	6	1.34
Solano	0	0	0	0	3	2	2	0	1	1	9	0.21
Sonoma	12	7	11	12	11	8	8	5	0	3	77	1.58
Stanislaus	0	0	0	1	1	3	2	0	0	0	7	0.13
Sutter	0	0	0	0	0	0	0	0	0	1	1	0.10
Tehama	0	0	0	0	3	1	0	0	0	0	4	0.62
Trinity	1	0	1	0	0	0	0	0	0	0	2	1.46
Tulare	1	0	0	1	1	0	0	4	0	0	7	0.15
Tuolumne	0	0	0	1	0	0	0	1	0	0	2	0.36
Ventura	3	2	0	0	3	3	2	2	0	3	18	0.22
Yolo	1	1	0	1	1	3	0	0	0	1	8	0.38
Yuba	2	0	1	0	0	0	0	0	1	0	4	0.53
TOTAL	**80**	**98**	**74**	**103**	**107**	**102**	**85**	**94**	**33**	**85**	**861**	**0.22**

Tick surveillance

Anaplasma phagocytophilum

In 2021, a total of 6,376 adult, 968 nymphal, and 9 larval western blacklegged ticks (*Ixodes pacificus*) were collected and tested for the presence of *A. phagocytophilum*, the agent of anaplasmosis (Table 3.2). Of these ticks, the CDPH Vector-Borne Disease Section (CDPH-VBDS) collected and individually tested 2,678 adult, 748 nymphal, and 9 larval western blacklegged ticks from Contra Costa, Del Norte, El Dorado, Humboldt, Lake, Los Angeles, Marin, Mariposa, Mendocino, Napa, Placer, Sierra, Solano, Sonoma, Tehama, and Yolo counties. Fifteen (0.6%) adult and 4 (0.5%) nymphal western blacklegged ticks tested positive by real-time polymerase chain reaction (RT-PCR) at the CDPH-VBDS laboratory (Table 3.2). San Mateo Mosquito and Vector Control District (MVCD) shares data with CDPH-VBDS and reported that their agency collected and tested 3,698 adult western blacklegged ticks in 764 pools, and 220 nymphal ticks in 113 pools from sites in San Mateo County. The minimum infection prevalence (MIP- defined as the number of positive tick pools divided by the total number of ticks tested multiplied by 100) was 0.2% and 0.9% of adult and nymphal ticks, respectively. (Table 3.2). San Mateo MVCD also tested 28 *Ixodes spinipalpis* (a nest-dwelling tick of rodents and lagomorphs) nymphs in 14 pools for *A. phagocytophilum*. Three (10.7% MIP) nymphal *I. spinipalpis* tested positive by RT-PCR.

Colorado tick fever virus

In 2020 and 2021, CDPH-VBDS collected 90 adult Rocky Mountain wood ticks (*Dermacentor andersoni*) from Alpine and Nevada counties for Colorado tick fever virus testing. Forty-five ticks were tested by RT-PCR at the CDPH Viral and Rickettsial Disease Laboratory (CDPH-VRDL). All ticks tested negative.

Francisella tularensis

In 2021, CDPH-VBDS tested a total of 20 adult American dog ticks (*D. variabilis*) from Los Angeles and San Diego counties for *F. tularensis*, the causative agent of tularemia. All ticks tested negative. As reported to CDPH-VBDS, San Diego Environmental Health tested 4,676 adult Pacific coast ticks (*D. occidentalis*), 517 adult American dog ticks, and 1 adult rabbit tick (*Haemaphysalis leporispalustris*) for *F. tularensis* by RT-PCR. All ticks tested negative. Additionally, San Mateo MVCD reported to CDPH-VBDS that they tested 779 adult Pacific coast ticks (*D. occidentalis*) and 171 adult American dog ticks for *F. tularensis* in 172 and 43 pools, respectively. Four (0.5% MIP) adult Pacific coast ticks and two (1.2% MIP) American dog ticks tested positive for *F. tularensis* by RT-PCR.

Spotted fever group rickettsiosis

In 2021, CDPH-VBDS tested 2,618 adult and 1 nymphal Pacific coast ticks from Butte, Contra Costa, Humboldt, Kern, Los Angeles, Marin, Nevada, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, Sonoma, Stanislaus, Tulare, and Ventura counties for spotted fever group

Table 3.2. Infection prevalence and minimum infection prevalence of *Anaplasma phagocytophilum* in *Ixodes pacificus* ticks, California, 2021

Non-pooled testing	No. Ticks Tested			Positive *A. phagocytophilum*				
County	Adults	Nymphs	Larvae	Adults (IP[a])	Nymphs (IP[a])	Larvae (IP[a])	Collected by	Laboratory
Contra Costa	208						CDPH, VBDS	CDPH, VBDS
Del Norte	11						CDPH, VBDS	CDPH, VBDS
El Dorado	204	99					CDPH, VBDS	CDPH, VBDS
Humboldt	10						CDPH, VBDS	CDPH, VBDS
Lake	80	7					CDPH, VBDS	CDPH, VBDS
Los Angeles	121						CDPH, VBDS	CDPH, VBDS
Marin	630	593		9 (1.4)	4 (0.7)		CDPH, VBDS	CDPH, VBDS
Mariposa	41						CDPH, VBDS	CDPH, VBDS
Mendocino	441	7		2 (0.5)			CDPH, VBDS	CDPH, VBDS
Napa	71		9				CDPH, VBDS	CDPH, VBDS
Placer	86	9		2 (2.3)			CDPH, VBDS	CDPH, VBDS
Sierra	20						CDPH, VBDS	CDPH, VBDS
Solano	22						CDPH, VBDS	CDPH, VBDS
Sonoma	620	33		2 (0.3)			CDPH, VBDS	CDPH, VBDS
Tehama	86						CDPH, VBDS	CDPH, VBDS
Yolo	27						CDPH, VBDS	CDPH, VBDS
Non-pooled totals	**2,678**	**748**	**9**	**15 (0.6)**	**4 (0.5)**	**0**		

Pooled testing	No. Ticks Tested			Positive *A. phagocytophilum* pools				
County	Adults (pools)	Nymphs (pools)	Larvae	Adults (MIP[b])	Nymphs (MIP[b])	Larvae (MIP[b])	Collected by	Laboratory
San Mateo	3,698 (764)	220 (113)	0	7 (0.2)	2 (0.9)	0	San Mateo MVCD	San Mateo MVCD

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

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

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

Rickettsia spp. (SFGR), including the *Rickettsia* 364D strain, causative agent of Pacific coast tick fever, and *Rickettsia rickettsii*, the causative agent of Rocky Mountain spotted fever. All ticks were tested by RT-PCR by CDPH-VBDS and CDPH-VRDL. All ticks tested negative for *R. rickettsii*. Fifty-two (2.0%) adult Pacific coast ticks tested positive for *Rickettsia* 364D, with positive ticks detected from Contra Costa (1 of 108 or 0.9%), Los Angeles (26 of 954 or 2.7%), Orange (7 of 289 or 2.4%), Riverside (4 of 144 or 2.8%), San Bernardino (3 of 24 or 2.4%), San Diego (4 of 124 or 3.2%), San Luis Obispo (1 of 97 or 1.0%), Santa Barbara (1of 91 or 1.1%), and Ventura (5 of 315 or 1.6%) counties. Orange County MVCD tested 1,427 adult Pacific coast ticks, 138 adult American dog ticks, and 2 brown dog ticks (*Rhipicephalus sanguineus*) for *R. rickettsii*, at their laboratory. All ticks tested negative.

Borrelia **spirochetes**

Borrelia burgdorferi sensu lato

In 2021, local, state, and federal agencies in collaboration with CDPH-VBDS, collected 18,092 adult, 2,038 nymphal, and 23 larval western blacklegged ticks from 30 counties to test for *B. burgdorferi* sensu lato (Tables 3.3, 3.4). The causative agent of Lyme disease, *B. burgdorferi* sensu stricto, is part of this genetic complex. Collection and testing data for western blacklegged ticks are collated by CDPH-VBDS. In counties where ticks were tested individually, ticks were tested either by RT-PCR only or by direct fluorescent antibody (DFA) followed by RT-PCR. Seventy-eight (1.8%) of 4,344 adult and 36 (7.3%) of 1,190 nymphal ticks tested positive for *B. burgdorferi* sensu lato (Table 3.3). One *I. spinipalpus* nymph from Santa Cruz County also tested positive at the CDPH-VBDS laboratory for *B. burgdorferi* sensu lato. Ticks tested by local vector control agencies in pools were tested by RT-PCR. In these counties, of the 13,748 adult and 848 nymphs tested, 125 adult tick pools (0.9% MIP) and 32 nymphal pools (3.8% MIP) were positive for *B. burgdorferi* sensu lato (Table 3.4). All larval ticks tested negative. In addition, 28 nymphal *I. spinipalpis* were tested in 14 pools for *B. burgdorferi* sensu lato at the San Mateo MVCD laboratory. Nine pools (32.1% MIP) tested positive for *B. burgdorferi* sensu lato.

Borrelia miyamotoi

In 2021, of the western blacklegged ticks collected, 16,241 adult, 2,038 nymphal, and 23 larval ticks were tested for *B. miyamotoi*, a relapsing fever-type spirochete implicated in human disease in the eastern United States and Europe. Of the 4,344 individually tested adults and 1,190 individually tested nymphs, 36 (0.8%) and 18 (1.5%), respectively, tested positive (Table 3.3). Of the 11,897 adult ticks tested in 2,725 pools and 848 nymphs tested in 450 pools, 117 adult tick pools (1.0% MIP) and 10 nymphal tick pools (1.2% MIP) tested positive (Table 3.4).

Borrelia spp. coinfection

In 2021, one adult *I. pacificus* adult from Placer County tested positive for both *B. miyamotoi* and *A. phagocytophilum* for a statewide infection prevalence of 0.04% (one positive out of 2,678 adults tested statewide).

Borrelia hermsii (tick-borne relapsing fever)

CDPH-VBDS conducted an environmental assessment of a cabin in El Dorado County in collaboration with El Dorado Vector Control Program (VCP), following a report of potential soft tick (*Ornithodoros hermsi*) infestation. At initial investigation, El Dorado VCP collected 102 *O. hermsi*, and a follow-up visit with CDPH-VBDS yielded another 62 *O. hermsi* ticks. Of the initial 102 ticks collected, 54 were sent to the U.S. Centers for Disease Control and Prevention in Fort Collins for *B. hermsii* testing. Four (7.4%) were positive either by PCR (1) or culture (3). CDPH-VBDS tested the second collection of ticks at the CDPH-VBDS laboratory, where 2 (3.2%) of the 62 ticks tested positive for *B. hermsii* by RT-PCR.

Mammal surveillance

Francisella tularensis

CDPH-VBDS collaborates with the CDPH Microbial Disease Laboratory (CDPH-MDL) to test mammals for *F. 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 2021, six small mammals were tested from El Dorado (2), Los Angeles, Nevada, and Siskiyou counties. CDPH-VBDS and CDPH-MDL additionally tested three small mammals from Washoe County, Nevada for tularemia. All mammals tested negative.

Table 3.3. Infection prevalence of *Borrelia burgdorferi* sensu lato and *Borrelia miyamotoi* spirochetes in *Ixodes pacificus* ticks, California, 2021

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]		
Butte	15			2 (13.3)				CDPH, VBDS	CDPH, VBDS
Calaveras	11			1 (9.1)				CDPH, VBDS	CDPH, VBDS
Contra Costa	240			2 (0.8)		1 (0.4)		CDPH, VBDS	CDPH, VBDS
Del Norte	11							CDPH, VBDS	CDPH, VBDS
El Dorado	292	98		10 (3.4)	11 (11.2)			CDPH, VBDS	CDPH, VBDS
Humboldt	33					2 (6.1)		CDPH, VBDS	CDPH, VBDS
Kern	4							CDPH, VBDS	CDPH, VBDS
Lake	80	7		1 (1.3)	1 (14.3)			CDPH, VBDS	CDPH, VBDS
Los Angeles	334							CDPH, VBDS	CDPH, VBDS
Marin	648	806		24 (3.7)	71 (8.8)	12 (1.9)	14 (1.7)	CDPH, VBDS; Marin-Sonoma MVCD[c]	CDPH, VBDS; Marin-Sonoma MVCD
Mariposa	41							CDPH, VBDS	CDPH, VBDS
Mendocino	441	7		6 (1.4)	1 (14.3)	11 (2.5)		CDPH, VBDS	CDPH, VBDS
Merced	4							CDPH, VBDS	CDPH, VBDS
Napa	71		9	3 (4.2)				CDPH, VBDS	CDPH, VBDS
Nevada	202	2		3 (1.5)		2 (1.0)		CDPH, VBDS	CDPH, VBDS
Orange	68							CDPH, VBDS	CDPH, VBDS
Placer	186	9		5 (2.7)		1 (0.5)		CDPH, VBDS	CDPH, VBDS
Riverside	3							CDPH, VBDS	CDPH, VBDS
San Bernardino	90							CDPH, VBDS	CDPH, VBDS
San Diego	346							CDPH, VBDS	CDPH, VBDS
Santa Cruz	21	17	14	1 (4.8)	1 (5.9)		2 (11.8)	CDPH, VBDS	CDPH, VBDS
Sierra	48							CDPH, VBDS	CDPH, VBDS
Solano	22							CDPH, VBDS	CDPH, VBDS
Sonoma	724	229		16 (2.2)	2 (0.9)	6 (0.8)	2 (0.9)	CDPH, VBDS; Marin-Sonoma MVCD[c]	CDPH, VBDS; Marin-Sonoma MVCD
Tehama	201	15						CDPH, VBDS	CDPH, VBDS
Ventura	64							CDPH, VBDS	CDPH, VBDS
Yolo	27							CDPH, VBDS	CDPH, VBDS
Yuba	117			3 (2.6)		1 (0.9)		CDPH, VBDS	CDPH, VBDS
Total	**4,344**	**1,190**	**23**	**78 (1.8)**	**87 (7.3)**	**36 (0.8)**	**18 (1.5)**		

Abbreviations:

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

All *Ixodes pacificus* ticks tested at CDPH-VBDS are subject to a two step process, unless otherwise noted. Step 1: direct fluorescent antibody test (DFA) for genus *Borrelia*. Positive DFA ticks are subject to step 2. Step 2: multiplex real-time polymerase chain reaction (RT-PCR) for *Borrelia burgdorferi* sensu lato and *Borrelia miyamotoi*.

[a] No larvae tested positive for *B. burgdorferi* sensu lato or *Borrelia 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, 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, 2021

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	825 (183)	552 (277)	19 (2.3)	24 (4.3)	15 (1.8)	5 (0.9)	Alameda County DEH	Alameda County DEH
Butte	2,335 (467)		24 (1.0)		34 (1.5)		Butte County MVCD	Placer MVCD
Marin	306 (79)		5 (1.6)		6 (2.0)		Marin-Sonoma MVCD	Marin-Sonoma MVCD
Orange	244 (244)						Orange County MVCD	Orange Conty MVCD
Placer	1,165 (345)	76 (60)	16 (1.4)	2 (2.6)	24 (2.1)	1 (1.3)	Placer MVCD	Placer MVCD
Sacramento[a]	1,650 (378)		18 (1.1)				Sacramento-Yolo MVCD	Sacramento-Yolo MVCD
San Diego	1,082 (144)						County of San Diego VCP	County of San Diego VCP
San Mateo	3,698 (764)	220 (113)	34 (0.9)	6 (2.7)	26 (0.7)	4 (1.8)	San Mateo MVCD	San Mateo MVCD
Shasta	1,719 (380)		6 (0.3)		10 (0.6)		Shasta MVCD	Placer MVCD
Sonoma	523 (119)		3 (0.6)		2 (0.4)		Marin-Sonoma MVCD	Marin-Sonoma MVCD
Yolo[a]	201 (55)						Sacramento-Yolo MVCD	Sacramento-Yolo MVCD
Total	**13,748 (3,158)**	**848 (450)**	**125 (0.9)**	**32 (3.8)**	**117 (1.0)**	**10 (1.2)**		

Abbreviations:

DEH, Department of Environmental Health; MVCD, Mosquito and Vector Control District; VCP, Vector Control Program; VCSD, Vector Control Services District

[a] Tested by polymerase chain reaction (PCR) specific for *Borrelia burgdorferi* sensu stricto.

[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] 11,897 adult ticks in 2,725 pools were tested for *Borrelia miyamotoi*.

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). Some specimens including those with inconclusive results or from counties with enzootic St. Louis encephalitis virus (SLEV) activity, were forwarded to the CDPH-VRDL for further testing with plaque reduction neutralization tests (PRNT). Additional WNV infections were identified through nucleic acid test screening performed by blood and organ donation centers.

The number of human WNV cases reported in 2021 was the lowest reported since 2010, and the third lowest reported following the introduction of WNV into California in 2003.

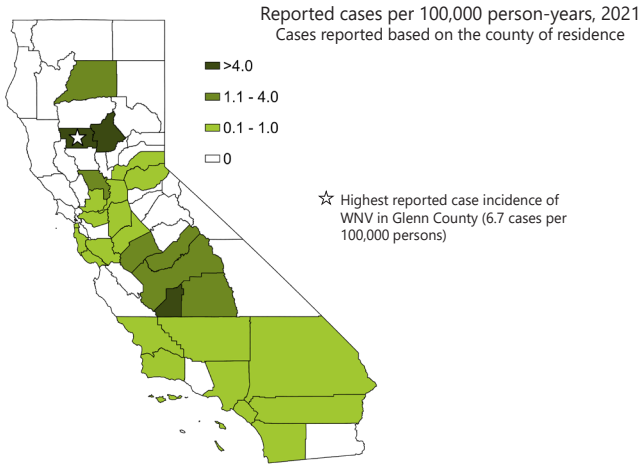


Figure 4.1. Incidence of reported human cases of West Nile virus, by county, California, 2021

In 2021, a total of 129 symptomatic and 19 asymptomatic infections with WNV were identified, which was a 44% decrease compared to the number of total infections (263) reported in 2020 (Table 4.1). Of the 129 clinical cases, 97 (75%) were classified as West Nile neuroinvasive disease (e.g., encephalitis, meningitis, acute flaccid paralysis, or other neurologic dysfunction) and 32 (25%) were classified as West Nile non-neuroinvasive disease. Case-patients were residents of 28 counties and 81 (63%) were male. Incidence was highest (6.7 cases per 100,000 persons) in Glenn County (Table 4.1, Figure 4.1). The median age for neuroinvasive cases was 65 years (range, 4 to 85 years), and among non-neuroinvasive cases, the median age was 59 years (range, 13 to 85 years). The median age of the 12 WNV-associated fatalities was 74 years (range, 52 to 85 years). Dates of symptom onset for all reported cases ranged from March 31 to November 27.

Table 4.1. Reported WNV human cases by county of residence, California, 2012-2021

County	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2021 incidence per 100,000 person-years	10 year incidence per 100,000 person-years
Alameda	2	0	1	0	0	1	0	1	0	0	0.00	0.03
Alpine	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Amador	0	0	0	0	1	0	1	1	0	0	0.00	0.80
Butte	10	24	24	53	21	4	12	5	4	13	6.41	8.39
Calaveras	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Colusa	3	2	3	1	2	0	0	1	0	0	0.00	5.39
Contra Costa	4	5	5	1	4	4	4	1	4	2	0.17	0.29
Del Norte	0	0	0	0	0	0	0	0	0	0	0.00	0.00
El Dorado	0	1	0	0	1	0	0	0	1	1	0.51	0.20
Fresno	24	8	43	8	14	13	14	51	10	14	1.36	1.94
Glenn	7	9	10	19	6	0	2	0	1	2	6.74	18.87
Humboldt	0	0	0	0	0	0	1	0	0	0	0.00	0.08
Imperial	1	0	1	1	0	3	0	3	1	0	0.00	0.54
Inyo	0	0	0	0	0	4	0	0	0	0	0.00	2.15
Kern	25	25	11	11	17	30	13	28	8	8	0.88	1.93
Kings	3	1	4	0	8	5	0	3	2	8	5.24	2.23
Lake	1	0	1	2	1	0	1	0	2	0	0.00	1.25
Lassen	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Los Angeles	163	151	253	286	151	277	43	31	90	16	0.16	1.45
Madera	3	3	3	4	6	2	4	3	6	3	1.89	2.33
Marin	0	2	0	1	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	0	1	2	0	0	0	0	0	0	0.00	0.35
Merced	13	0	1	1	0	10	2	10	12	6	2.11	1.93
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	1	0	0	0	1	0	1	0	0	0	0.00	0.07
Napa	0	1	0	0	0	0	1	0	0	0	0.00	0.15
Nevada	0	0	0	2	0	0	1	0	0	0	0.00	0.31
Orange	42	10	263	92	32	33	9	5	17	3	0.10	1.60
Placer	12	6	7	0	7	0	9	1	2	2	0.49	1.14
Plumas	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Riverside	19	35	14	127	11	32	15	12	10	3	0.12	1.13
Sacramento	29	11	10	4	25	6	15	4	7	6	0.38	0.75
San Benito	0	0	0	0	0	0	0	0	0	0	0.00	0.00
San Bernardino	33	13	21	54	8	57	9	7	3	1	0.05	0.95
San Diego	1	0	11	42	20	2	2	3	1	3	0.09	0.26
San Francisco	1	1	0	0	0	1	0	0	0	1	0.11	0.05
San Joaquin	13	8	9	2	13	14	14	7	2	7	0.89	1.14
San Luis Obispo	0	0	0	0	0	0	0	2	0	2	0.74	0.15
San Mateo	0	0	0	0	0	0	0	0	0	1	0.13	0.01
Santa Barbara	0	1	0	0	0	0	0	0	0	2	0.45	0.07
Santa Clara	0	2	10	8	1	0	1	1	0	3	0.16	0.14
Santa Cruz	0	0	0	0	0	0	0	0	0	1	0.38	0.04
Shasta	1	1	2	3	1	1	1	0	2	3	1.69	0.84
Sierra	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Siskiyou	0	0	0	1	0	0	0	0	0	0	0.00	0.23
Solano	2	1	5	1	4	1	0	1	1	2	0.46	0.41
Sonoma	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Stanislaus	26	17	33	13	26	28	15	16	35	5	0.90	3.85
Sutter	8	10	8	2	12	3	1	1	1	0	0.00	4.54
Tehama	4	5	4	5	5	2	2	0	2	0	0.00	4.44
Trinity	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Tulare	7	5	21	13	10	12	8	24	7	8	1.66	2.39
Tuolumne	0	0	0	0	0	0	1	0	0	0	0.00	0.19
Ventura	7	2	1	6	7	1	2	2	0	0	0.00	0.34
Yolo	10	6	15	8	16	6	11	1	4	3	1.38	3.63
Yuba	4	13	6	10	11	1	2	0	0	0	0.00	5.92
Total WNV disease	**479**	**379**	**801**	**783**	**442**	**553**	**217**	**225**	**235**	**129**	**0.32**	**1.07**
Asymptomatic Infections[a]	48	54	91	77	41	47	26	18	28	19		
Total WNV infections	**527**	**433**	**892**	**860**	**483**	**600**	**243**	**243**	**263**	**148**	**0.37**	**1.19**

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

St. Louis encephalitis virus

Four symptomatic cases of SLEV infection were identified in 2021. All cases presented with neuroinvasive disease and no fatalities were reported. Case-patients were residents of four counties (Table 4.5) and two (50%) were male. The median age was 68 years (range, 56 to 80 years) and dates of symptom onset ranged from August 3 to November 15.

Malaria

In 2021, 84 confirmed cases of malaria were reported to CDPH. Case-patients were residents of 20 California counties and 60 (71%) were male. The median age was 39 years (range, 6 to 74 years). Of the 74 cases for which the *Plasmodium* species was determined, 60 were *P. falciparum*, 11 *P. vivax*, 1 *P. malariae*, and 2 *P. ovale*. Eighty-three case-patients reported compatible travel history to malaria-endemic areas including Africa (73), Asia (9), and Central America. Exposure information for one case-patient was not available.

Chikungunya

Seven cases of chikungunya were reported to CDPH in 2021; all met the criteria for a probable case (Table 4.2). Case-patients were residents of six California counties, five (71%) were male, and the median age was 50 years (range, 26 to 65 years). No locally acquired cases were reported. All case-patients reported travel to chikungunya-endemic or outbreak areas including Central America (2), India (4), and Southeast Asia.

Dengue

In 2021, 33 cases of dengue were reported to CDPH; seven of these met the criteria for a confirmed case and 26 were probable (Table 4.2). Case-patients were residents of 11 California counties, 25 (76%) were male, and the median age was 43 years (range, 10 months to 73 years). No locally acquired cases were reported. Travel region history included South Asia (16), North America (Mexico [9], Puerto Rico), Central America (5), South East Asia, and the Caribbean.

Zika

In 2021, two infections of Zika virus were reported to CDPH; one met the criteria for a confirmed infection and the other was a probable case. Counties of residence for the case-patients were San Francisco and Marin counties (Table 4.2) One exposure was related to travel in Mexico; the other to Central America.

Table 4.2. Reported confirmed and probable *Aedes*-transmitted diseases in humans by county, California, 2021

County	Chikungunya	Dengue	Zika	TOTAL
Alameda	0	2	0	2
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	0	0	0
Del Norte	0	0	0	0
El Dorado	0	0	0	0
Fresno	0	1	0	1
Glenn	0	0	0	0
Humboldt	0	0	0	0
Imperial	0	0	0	0
Inyo	0	0	0	0
Kern	0	0	0	0
Kings	0	0	0	0
Lake	0	0	0	0
Lassen	0	0	0	0
Los Angeles	0	5	0	5
Madera	0	0	0	0
Marin	1	0	1	2
Mariposa	0	0	0	0
Mendocino	0	0	0	0
Merced	0	0	0	0
Modoc	0	0	0	0
Mono	0	0	0	0
Monterey	0	0	0	0
Napa	0	0	0	0
Nevada	0	0	0	0
Orange	0	5	0	5
Placer	1	0	0	1
Plumas	0	0	0	0
Riverside	0	0	0	0
Sacramento	0	3	0	3
San Benito	0	0	0	0
San Bernardino	0	0	0	0
San Diego	1	3	0	4
San Francisco	1	0	1	2
San Joaquin	0	2	0	2
San Luis Obispo	0	0	0	0
San Mateo	0	1	0	1
Santa Barbara	0	1	0	1
Santa Clara	3	8	0	11
Santa Cruz	0	0	0	0
Shasta	0	0	0	0
Sierra	0	0	0	0
Siskiyou	0	0	0	0
Solano	0	2	0	2
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	0	0	0
Yolo	0	0	0	0
Yuba	0	0	0	0
TOTAL	**7**	**33**	**2**	**42**

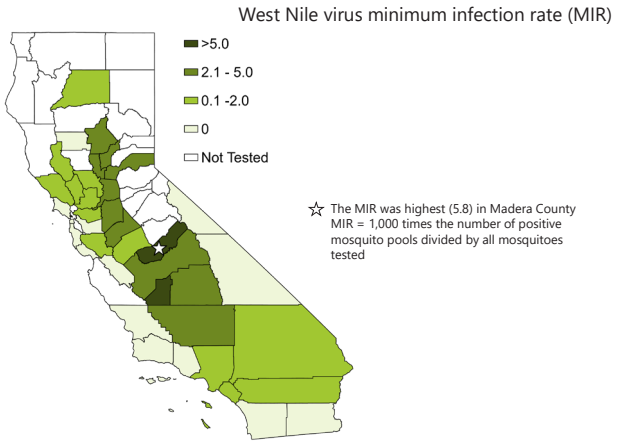


Figure 4.2. West Nile virus minimum infection rate of *Culex* spp. mosquitoes, by county, California, 2021

Mosquito surveillance

In 2021, a total of 1,162,064 mosquitoes (45,041 pools) collected in 37 counties were tested at the University of California, Davis Arbovirus Research and Training (DART) Laboratory or at one of 12 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 2,263 mosquito pools from 25 counties, and SLEV was detected in 46 mosquito pools from 8 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 1.9; the MIR was highest (5.8) in Madera 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 five *Culex* species (*Cx. erythrothorax*, *Cx. pipiens*, *Cx. quinquefasciatus*, *Cx. stigmatosoma*, and *Cx. tarsalis*) (Table 4.4), and SLEV was identified from three *Culex* species (*Cx. pipiens*, *Cx. quinquefasciatus*, and *Cx. tarsalis*). In 2021, the first detection of WNV in mosquitoes was from a *Cx. tarsalis* pool collected in Kern County on May 19, and the last detection was from a *Cx. quinquefasciatus* pool collected in Orange County on November 23. The first detection of SLEV in mosquitoes was from a *Cx. quinquefasciatus* pool collected in Imperial County on July 13, and the last detection was from a *Cx. tarsalis* pool collected in Riverside County on November 9.

Table 4.3. West Nile Virus (WNV) positive mosquito pools and minimum infection rate, by county, California, 2021

County	No. mosquitoes tested[a]	No. mosquito pools tested	WNV positive pools[a]	WNV Minimum Infection Rate[b]
Alameda	8,601	450	0	0.0
Alpine	0			
Amador	0			
Butte	19,105	405	80	4.2
Calaveras	0			
Colusa	0			
Contra Costa	14,415	396	8	0.6
Del Norte	0			
El Dorado	0			
Fresno	46,232	1,477	219	4.7
Glenn	1,500	30	0	0.0
Humboldt	0			
Imperial	2,049	140	0	0.0
Inyo	760	16	0	0.0
Kern	20,934	636	103	4.9
Kings	6,558	181	34	5.2
Lake	5,159	291	4	0.8
Lassen	0			
Los Angeles	133,650	3,805	260	1.9
Madera	22,746	579	131	5.8
Marin	2,528	93	0	0.0
Mariposa	0			
Mendocino	0			
Merced	9,311	520	10	1.1
Modoc	0			
Mono	0			
Monterey	0			
Napa	3,072	138	1	0.3
Nevada	0			
Orange	133,765	4,962	51	0.4
Placer	31,062	2,073	63	2.0
Plumas	0			
Riverside	198,116	5,988	112	0.6
Sacramento	55,404	4,883	120	2.2
San Benito	247	19	0	0.0
San Bernardino	36,201	2,168	9	0.2
San Diego	19,317	1,283	0	0.0
San Francisco	0			
San Joaquin	84,207	2,537	389	4.6
San Luis Obispo	1,771	59	0	0.0
San Mateo	3,414	127	0	0.0
Santa Barbara	2,402	94	0	0.0
Santa Clara	20,304	2734	4	0.2
Santa Cruz	1,904	150	0	0.0
Shasta	16,631	635	28	1.7
Sierra	0			
Siskiyou	0			
Solano	15,180	424	22	1.4
Sonoma	11,811	420	2	0.2
Stanislaus	50,551	1,612	152	3.0
Sutter	8,552	251	18	2.1
Tehama	0			
Trinity	0			
Tulare	131,364	3,420	375	2.9
Tuolumne	0			
Ventura	3,164	65	0	0.0
Yolo	34,933	1,826	56	1.6
Yuba	5,144	154	12	2.3
Total	**1,162,064**	**45,041**	**2,263**	**1.9**

[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, 2021

Mosquito Species	No. Pools Tested	No. Mosquitoes	WNV +	Minimum Infection Rate[a]
***Culex* species**				
Cx. erythrothorax	1,613	57,473	1	0.1
Cx. pipiens	9,426	143,622	362	2.5
Cx. quinquefasciatus	17,611	518,977	881	1.7
Cx. restuans	2	3	0	0.0
Cx. stigmatosoma	611	6,984	25	3.6
Cx. tarsalis	15,048	428,042	993	2.3
Cx. thriambus	94	207	0	0.0
All *Culex*	**44,405**	**1,155,308**	**2,262**	**2.0**
***Anopheles* species**				
An. franciscanus	1	2	0	0.0
An. freeborni	1	1	0	0.0
An. hermsi	6	28	0	0.0
An. punctipennis	5	135	0	0.0
All *Anopheles*	**13**	**166**	**0**	**0.0**
***Aedes* species**				
Ae. aegypti	371	2,291	0	0.0
Ae. albopictus	1	11	0	0.0
Ae. melanimon	18	357	0	0.0
Ae. nigromaculis	3	111	0	0.0
Ae. vexans	19	825	0	0.0
All *Aedes*	**412**	**3,595**	**0**	**0.0**
Other species				
Culiseta incidens	134	1,414	0	0.0
Culiseta inornata	21	233	0	0.0
Culiseta particeps	22	480	0	0.0
Unknown	34	868	1	0.0
All other	**211**	**2,995**	**1**	**0.3**

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

Sentinel chickens are a useful surveillance tool since chickens are exposed to mosquitoes 24 hours a day, 7 days a week, and can be the first or only indication of arbovirus activity in an area.

Animal surveillance

Chicken serosurveillance

In 2021, 24 local mosquito and vector control agencies in 23 counties maintained 86 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 5,930 chicken blood samples tested, 90 seroconversions to WNV were detected among 29 flocks in 12 counties (Tables 4.6, 4.8). Statewide, 16% 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 2021, the first and last WNV seroconversions were detected in Butte County on July 20 and October 12, respectively. In addition, two SLEV seroconversions were detected among two flocks in Merced County on September 2 (Table 4.5).

Table 4.5. Infections with St. Louis encephalitis virus in humans, mosquito pools, and sentinel chickens, by county, California, 2021

County	Humans	Mosquito Pools[a]	Sentinel Chickens
Fresno	1	7	NT
Imperial	0	3	NT
Kern	1	0	NT
Kings	0	1	NT
Madera	0	3	NT
Marin	1	0	NT
Merced	0	2	2
Riverside	0	24	NT
Stanislaus	1	2	NT
Tulare	0	4	0
State Totals	**4**	**46**	**2**

NT= no samples tested

[a]Positive mosquito pools included *Culex tarsalis* (34 pools), *Cx. quinquefasciatus* (8 pools), *Cx. pipiens* (4 pools)

Table 4.6. Results of testing sentinel chickens for West Nile (WNV) virus, by county, California, 2021

County	No. flocks	No. chickens[a]	No. WNV positive flocks	WNV positive sera
Alameda	2	8	0	0
Butte	7	54	6	27
Calaveras	1	10	0	0
Colusa	1	9	1	1
Contra Costa	4	24	0	0
Glenn	1	10	0	0
Lake	2	12	1	4
Los Angeles	22	125	1	3
Merced	8	48	7	19
Nevada	1	4	0	0
Sacramento	3	15	1	1
San Benito	1	8	0	0
San Mateo	2	14	0	0
Santa Barbara	4	26	0	0
Santa Cruz	2	12	0	0
Shasta	6	41	2	3
Solano	3	21	0	0
Sutter	5	35	3	11
Tehama	3	30	3	5
Tulare	1	10	1	10
Ventura	3	28	0	0
Yolo	2	10	2	4
Yuba	2	14	1	2
Total	**86**	**568**	**29**	**90**

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

Dead bird surveillance for West Nile virus

In 2021, the California WNV and Dead Bird Call Center and website received 5,224 dead bird reports from the public in 52 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 12 local agencies by RT-qPCR. Of the 1,755 carcasses deemed suitable for testing, WNV was detected in 210 (12%) carcasses from 20 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 2021, the first WNV-positive dead bird was a pine siskin reported from San Joaquin County on March 9, and the last WNV-positive dead bird was a red-tailed hawk reported from San Diego County on December 27.

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 2021, WNV infection was detected in 13 horses from eight counties (Table 4.8). Two of the horses died or were euthanized as a result of their infection.

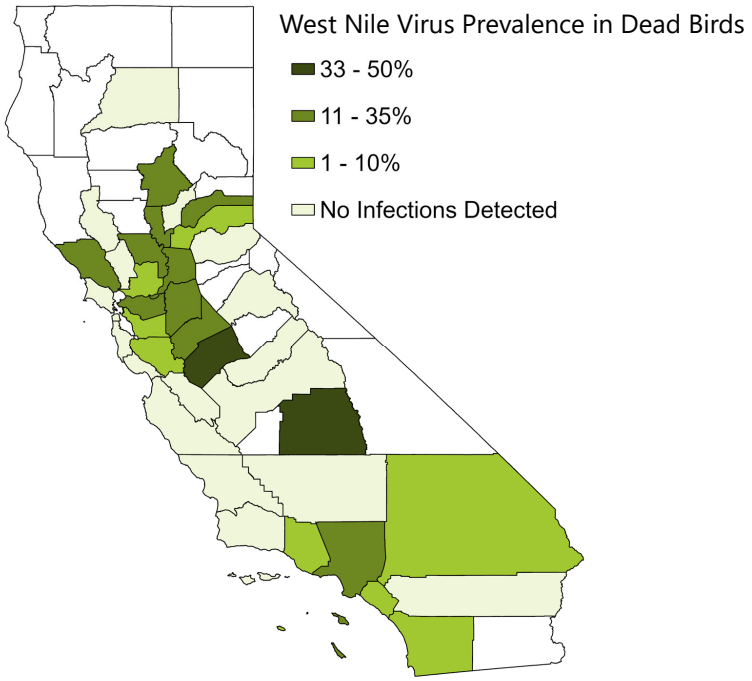


Figure 4.3. Prevalence of West Nile virus infection in dead birds, California, 2021

Table 4.7. Dead birds reported, tested, and positive for West Nile virus, by county, California, 2021

County	Reported	Tested[a]	Positive	%
Alameda	290	77	2	3
Alpine	0			
Amador	6	0		
Butte	32	11	2	18
Calaveras	4	0		
Colusa	2	0		
Contra Costa	392	37	4	11
Del Norte	1	0		
El Dorado	37	8	0	0
Fresno	91	8	0	0
Glenn	4	0		
Humboldt	1	0		
Imperial	1	0		
Inyo	1	0		
Kern	27	4	0	0
Kings	9	0		
Lake	6	4	0	0
Lassen	0			
Los Angeles	762	133	43	32
Madera	6	2	0	0
Marin	39	2	0	0
Mariposa	1	0		
Mendocino	5	0		
Merced	35	2	1	50
Modoc	0			
Mono	0			
Monterey	13	7	0	0
Napa	26	8	0	0
Nevada	20	7	2	29
Orange	553	435	7	2
Placer	120	52	5	10
Plumas	0			
Riverside	108	26	0	0
Sacramento	712	403	100	25
San Benito	5	1	0	0
San Bernardino	110	26	1	4
San Diego	137	76	1	1
San Francisco	37	8	0	0
San Joaquin	133	54	17	31
San Luis Obispo	26	8	0	0
San Mateo	302	78	0	0
Santa Barbara	36	10	0	0
Santa Clara	453	93	1	1
Santa Cruz	66	18	0	0
Shasta	19	1	0	0
Sierra	0			
Siskiyou	1	0		
Solano	65	24	2	8
Sonoma	96	9	1	11
Stanislaus	124	14	2	14
Sutter	27	7	1	14
Tehama	2	0		
Trinity	1	0		
Tulare	48	14	7	50
Tuolumne	2	1	0	0
Ventura	48	14	1	7
Yolo	162	70	10	14
Yuba	20	3	0	0
Totals	**5,224**	**1,755**	**210**	**12**

[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, 2021

County	Humans[a]	Horses	Dead Birds	Mosquito Pools	Sentinel Chickens
Alameda	0	0	2	0	0
Alpine	0	0	NT	NT	NT
Amador	0	1	NT	NT	NT
Butte	15	0	2	80	27
Calaveras	0	0	NT	NT	0
Colusa	0	0	NT	NT	1
Contra Costa	2	0	4	8	0
Del Norte	0	0	NT	NT	NT
El Dorado	1	0	0	NT	NT
Fresno	17	2	0	219	NT
Glenn	2	0	NT	0	0
Humboldt	0	0	NT	NT	NT
Imperial	0	0	NT	0	NT
Inyo	0	0	NT	0	NT
Kern	10	0	0	103	NT
Kings	10	1	NT	34	NT
Lake	0	0	0	4	4
Lassen	0	0	NT	NT	NT
Los Angeles	19	0	43	260	3
Madera	4	0	0	131	NT
Marin	0	0	0	0	NT
Mariposa	0	0	NT	NT	NT
Mendocino	0	0	NT	NT	NT
Merced	7	1	1	10	19
Modoc	0	0	NT	NT	NT
Mono	0	0	NT	0	NT
Monterey	0	0	0	NT	NT
Napa	0	0	0	1	NT
Nevada	0	0	2	NT	0
Orange	3	0	7	51	NT
Placer	2	0	5	63	NT
Plumas	0	0	NT	NT	NT
Riverside	3	0	0	112	NT
Sacramento	6	2	100	120	1
San Benito	0	0	0	0	0
San Bernardino	2	0	1	9	NT
San Diego	3	0	1	0	NT
San Francisco	1	0	0	0	NT
San Joaquin	8	3	17	389	NT
San Luis Obispo	2	0	0	0	NT
San Mateo	1	0	0	0	0
Santa Barbara	2	0	0	0	0
Santa Clara	3	0	1	4	NT
Santa Cruz	1	0	0	0	0
Shasta	3	0	0	28	3
Sierra	0	0	NT	NT	NT
Siskiyou	0	0	NT	NT	NT
Solano	2	0	2	22	0
Sonoma	0	0	1	2	NT
Stanislaus	6	1	2	152	NT
Sutter	0	0	1	18	11
Tehama	0	0	NT	NT	5
Trinity	0	0	NT	NT	NT
Tulare	9	0	7	375	10
Tuolumne	0	0	0	NT	NT
Ventura	0	0	1	0	0
Yolo	4	0	10	56	4
Yuba	0	2	0	12	2
State Totals	**148**	**13**	**210**	**2,263**	**90**

[a]Includes asymptomatic infections detected through blood bank screening

NT= no samples tested

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.

Since 2011, local vector control agencies have detected *Ae. aegypti* and *Ae. albopictus* mosquitoes in 329 cities or census-designated places (CDP) in 24 counties; populations of *Ae. aegypti* and *Ae. albopictus* are considered established in 22 and 3 counties, respectively. *Aedes notoscriptus* are established in parts of Los Angeles, Orange, and San Diego counties, and since 2014, have been detected in 44 cities and CDP (Figure 4.4).

In 2021, *Ae. aegypti* mosquitoes were discovered for the first time in 11 new cities and six CDP within established counties. *Aedes albopictus* and *Ae. notoscriptus* were not detected in any new locations. Local vector control agencies with invasive *Aedes* continued refining *Aedes*-specific surveillance and public education and outreach programs. Emphasis was placed on the public's role in helping minimize invasive *Aedes* habitat on private property and personal protection measures against mosquito bites. 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 2021, a total of 19,711 *Ae. aegypti* mosquitoes were tested for chikungunya, dengue, and Zika viruses; all were negative. In addition, 2,291 *Ae. aegypti* and 11 *Ae. albopictus* were tested for WNV, SLEV, and WEEV; all were negative (Table 4.4).

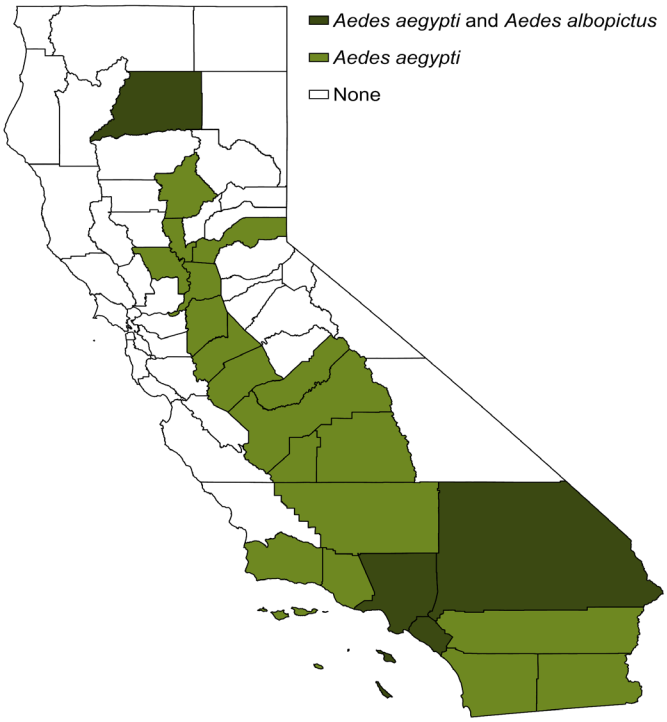


Figure 4.4. Invasive *Aedes* mosquito detections, by county, California, 2021

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 is 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 arthropod 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 2021. For each Forest, activities and testing results for selected vector-borne diseases are summarized in Tables 5.1 through 5.3, and highlights are described below.

2021 U.S. Forest Service Highlights

- Four (28.5%) of 14 Forests where specimens were collected for plague testing showed evidence of plague activity (Table 5.3), with the eastern Sierra, from the Lake Tahoe Basin Management Unity to the Inyo NF, showing the most activity.
- Bacterial and/or serological evidence of plague activity has been documented annually on the Lake Tahoe Basin Management Unit since 2012, including likely exposure of a human plague case in 2020; 20 (24.3%) of 82 rodents tested positive in 2021 (Table 5.3).
- VBDS biologists, with support from El Dorado County vector control staff, applied flea controlling insecticidal dust to more than 450 rodent burrows over approximately 12 acres in the vicinity of Taylor Creek Visitor Center on the Lake Tahoe Basin Management Unit in response to a plague positive rodent carcass and fleas (Table 5.2).
- Tick surveillance and testing on the Tahoe National Forest found ticks infected with both *Borrelia burgdorferi*, the causative agent for Lyme disease, and *Borrelia miyamotoi*, a recently recognized relapsing fever pathogen (Table 5.3).
- Over 150 soft ticks (*Ornithodoros hermsi*) were collected from a cabin on Lake Tahoe Basin Management Unit leased lands; 6 (5.2%) of 116 tested were positive for *Borrelia hermsii*, the causative agent for tick-borne relapsing fever (TBRF) (Tables 5.2, 5.3).
- The VBDS laboratory has expanded testing for tick-borne human pathogens to include detection of *Anaplasma phagocytophilum*, an intracellular bacterial pathogen found in *Ixodes* ticks (Table 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, 2021

National Forest	Disease Risks/Services Addressed	Facility Evaluation[a]	Presentation Audiences	Forest Locations Visited/Contacted[b]
Angeles/ San Gabriel Mountain National Monument	Plague; Tick-borne diseases			Supervisor's Office; Gateway Ranger District, Apple Tree, Big Rock, Blue Ridge, Coldbrook, Crystal Lake, Horse Flats, Little Pines, Los Alamos, Manzanita, Montecristo, Mountain Oak, Peavine, and Table Mountain campgrounds; Jackson Lake Picnic Area; Chantry Flat Recreation Area; Sturtevant Falls trail
Cleveland	Hantavirus; Plague; Tick-borne diseases			Supervisor's Office; Descanso, Palomar, and Trabuco Ranger District Offices; Blue Jay, Bobcat Meadows, Boulder Oaks, Burnt Rancheria, Cibbet Flat, Fry Creek, Horse Heaven, Indian Hills, Laguna, Oak Grove, Observatory, and Wooded Hills campgrounds; Inaja Memorial Picnic Area; Inaja, San Juan, and Secret Canyon 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; Fleming Meadow Trail System
Inyo	Hantavirus; Plague; Tick-borne diseases	Private residence on long-term leased lands (tick-borne relapsing fever case)	Safety presentation via internet, new employee orientation	Supervisor's Office; Mammoth Lakes, Mono Lake, Mt. Whitney and White Mountain Ranger District Offices; Aerie Crag, Aspen, Big Bend, Big Meadow, Coldwater, East Fork, Ellery Lake, French, Irish Meadow, Junction, June Lake, Lake George, Lake Mary, Lower Gray's Meadow, New Shady Rest, Pine City, Saddlebag Lake, Sherwin Creek, Oh Ridge, Old Shady Rest, Reversed Creek, Rush Creek, Sawmill Walk-in, Tioga Lake, and Twin Lakes campgrounds; long-term leased lands in Pine Glade Residence Tract; Cottonwood Canynon Trail.
Klamath	Plague			Supervisor's Office; Goosenest and Happy Camp/Oak Knoll Ranger District Offices.
Lake Tahoe Basin Management Unit	Hantavirus; Plague; Tick-borne diseases	Private residence and private vendor on long-term leased lands (tick-borne relapsing fever cases)		LTBMU Supervisors Office; Tallac Historical Site and Tallac Point; Taylor Creek Visitor Center; Fallen Leaf Campground; Emerald Bay Tract Area.
Lassen	Plague; Tick-borne diseases			Supervisor's Office; Almanor, Eagle Lake, and Hat Creek Ranger District Offices; Potato Patch Campground, Big Chico Creek and Deer Creek trails.
Los Padres	Hantavirus; Plague; Tick-borne diseases	Apache Saddle Station, Chuchupate Ranger Station, Ozena Fire Station		Supervisor's Office; Mt. Pinos, Ojai, Santa Barbara, and Santa Lucia Ranger District Offices; Caballo, Camp Alto, Halfmoon, Marian, McGill, Mt. Pinos, Pine Mountain, Pine Springs, Reyes Creek, Reyes Peak, Thorn Meadows, and Toad Springs campgrounds; Potrero John, and Rose Valley Falls trails
Mendocino	Tick-borne diseases			Supervisors Office; Grindstone and Upper Lake Ranger District Offices; Stoneyford Work Center; Middle Creek Campground and Road 301M
Modoc	Hantavirus; Plague			Supervisor's Office; Warner Mountain, Devil's Garden, Doublehead, and Big Valley Ranger Districts
Plumas				Supervisor's Office; Beckwourth and Mt. Hough Ranger District Offices; Gold Lake, Goose Lake, and Lakes Basin campgrounds
San Bernardino	Hantavirus; Plague; Tick-borne diseases, West Nile Virus			Supervisor's Office, Front Country, Mountaintop, and San Jacinto Ranger District Offices; Apple White, Big Pine Flat, Crab Flats, Dogwood, Fern Basin, Green Valley, Hanna Flat, Heart Bar, Holcomb Valley, Horse Springs, Lake Hemet, North Shore, Serrano, and Tent Peg Group campgrounds; Apple White Picnic Area; Middle Fork Lytle Creek, Pacific Crest (Swarthout Canyon area) trails; Penstock Rd.
Sequoia	Hantavirus; Tick-borne diseases	Porterville Work Station	Safety presentation via MS Teams to the Kern River Ranger District	Supervisor's Office; Kern River, and Western Divide Ranger District Offices; Cedar Creek Campground; South Fork Wildlife Area
Shasta-Trinity	Plague; Tick-borne diseases		Hayfork Ranger Station	Supervisor's Office; Mount Shasta, South Fork, and Trinity River Management Units; Whiskeytown-Shasta Trinity NRA; Gemmil Fulch Picnic Area
Sierra	Plague; Tick-borne diseases		Pre-recorded Safety presentation made available to the Safety Officer	Supervisor's Office; High Sierra Ranger District; Private residence on long-term leased lands
Six Rivers	Hantavirus; Plague; Tick-borne diseases			Supervisor's Office; Lower Trinity, Mad River, and Orleans Ranger District Offices; Smith River National Recreation Area Office; McKinleyville Nursery; Boise Creek East Fork, Panther Flat, Patrick's Creek, and Shelly Creek campgrounds; Old South Kelsey Trail; Forest Road 16N02
Stanislaus	Plague		Safety presentation via MS Teams to the Forest	Supervisor's Office; Calaveras, Groveland, Mi-Wok, and Summit Ranger District Offices; Baker, Brightman Flat, Boulder Flat, Camp Liahona Alp, Cascade Creek, Clark Fork, Clark Fork Horse Camp, Dardanelles, Deadman, Eureka Valley, Meadowview, Niagra Creek, Peaceful Pines, Pigeon Flat, Pinecrest, Pioneer Trail Group, and Sand Flat Alp campgrounds; Arnot Creek, Clark Fork, Disaster Creek, Kennedy Meadows, Saint Mary's Pass, and Sonora Pass trailheads; Cottonwood and Douglas picnic areas; Columns of the Giants; Donnell Vista Point; and Cascade Creek OHV Registration Site; Baker Historical Station, High Sierra Institute
Tahoe	Plague; Tick-borne diseases		Video safety presentation provided to the Yuba River Ranger District	Supervisor's Office; American River, Sierraville, Truckee, and Yuba River Ranger District Offices; Berger Creek, Bullard's Bar, Convict Flat, Dark Day, Diablo, Hampshire Rocks, Indian Springs, Indian Valley, Logger, Packsaddle, Sardine Lake, Salmon Creek, Snag Lake, Upper and Lower Little Truckee, and Yuba Pass campgrounds; Packer Lake Picnic Area, and Sand Pond Day Use Area; North Yuba, Prosser Creek, and Sagehen Creek trails; Clerkins Ranch Road

[a] Some facility evaluations, in-person safety trainings, and surveillance events, were limited in 2021 due to COVID-19 restrictions

[b] Locations visited or contacted by Vector-Borne Disease Section biologists and not already listed under facility evaluation

Table 5.2: Vector-Borne Disease Related Services and Findings, USFS-CDPH Cost-Share Agreement, 2021

National Forest	Unique Services/ Unusual Findings
Angeles / San Gabriel Mountain National Monument	The 2020 Bobcat Fire had a significant negative impact on tick collection numbers from the Sturtevant Falls Trail.
Cleveland	Informed the Forest Safety Officer and the Descanso Ranger District of mice collected from Wooded Hills Campground testing positive for Sin Nombre virus (SNV), causative agent for hantavirus pulmonary syndrome (HPS), by the San Diego County Vector Control Program.
Eldorado	Four (80%) of five deer mice, and three (21%) of 14 deer mice collected from Lumberyard Fire Station and Leek Springs Lookout, respectively, tested positive for antibodies to SNV.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 (6.7%) from Sherwin Creek and two (7.7%) from Oh Ridge were seropositive. Campgrounds remained open with Plague Warning signage and VBDS plague disease prevention brochures made available to campers.
Lake Tahoe Basin Management Unit	Performed environmental follow-up of tick-borne relapsing fever cases reported after exposure in a residence on long-term leased land. Four (7.4%) of 54 *Ornithodoros hermsi* soft ticks tested by the United States Centers for Disease Control and Prevention and two (3.2%) of 62 ticks tested by CDPH-VBDS tested positive for *Borrelia hermsii* , causative agent for tick-borne relapsing fever. In response to a plague-positive rodent carcass submitted from Taylor Creek Visitor Center, CDPH-VBDS, in collaboration with El Dorado County Vector Control, conducted flea treatment of rodent burrows over a 12 acre area. Communicated findings and recommendations to Management Unit leadership.
Lassen	A record number of *Ixodes pacificus* ticks from the Forest were collected and tested for *Borrelia* and *Anaplasma* pathogens.
Los Padres	None of the 43 *Peromyscus* mice, collected and tested from three different work locations on the Forest, were positive for serum antibodies to SNV.
Modoc	Conducted a follow-up questionnaire with the Warner Mountain Ranger District concerning a hantavirus facility risk assessment conducted previously.
Plumas	Delivered 100 plague and hantavirus education and prevention brochures to the Beckwourth Ranger District office; spoke with front desk staff about available CDPH materials and the protocol to report rodent carcasses found in recreational areas for plague testing.
San Bernardino	A Stellar's Jay tested positive for West Nile virus from the Mountaintop Ranger District. A VBDS biologist informed the Forest Safety Officer and other responsible staff of the test results and to remind employees and volunteers to take precautions against mosquito bites.
Sequoia	Conducted a facility risk assessment at the Porterville Work Station which yielded no mice and found little evidence of hantavirus risk.
Sierra	A VBDS biologist consulted with a long-term leaseholder regarding a tick-borne relapsing fever case likely acquired at the leaseholder's residence. The biologist provided exclusion information and suggested private pest control involvement for soft tick control.
Six Rivers	None of 36 *Peromyscus* mice, collected and tested from three different locations on the Forest, were positive for serum antibodies to SNV.
Stanislaus	Presented information about climate change and potential impacts on vector-borne diseases to the Summit Ranger District Biologist.
Tahoe	Detected both *Borrelia burgdorferi* sensu lato and *Borrelia miyamotoi* bacteria in *Ixodes pacificus* ticks collected from 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. Contacted the R5 Public Affairs Officer to facilitate public information exchange between VBDS biologists and Forest PAOs. Notified the R5 Safety Officer 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, 2021

National Forest	Sin Nombre virus (hantavirus pulmonary syndrome)		*Yersinia pestis* (plague)						*Borrelia spp.*[c]		*Anaplasma phagocytophilum*[d]		Colorado tick fever virus[e]	
	Peromyscus mice		rodents		flea pools[a]		carnivore and wild pigs[b]		*Ixodes* spp. or *Ornithodoros* ticks		*Ixodes pacificus* ticks		*Dermacentor andersoni* ticks	
	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested
Angeles							0	1	0	15	0	15		
Cleveland			0	5	0	3	0	2	0	102	0	1		
Eldorado	7	19	0	5					0	36				
Inyo			4	55										
Klamath							0	3						
Lake Tahoe BMU			20[f]	83	3	68	1	9	6[g]	116[g]				
Lassen							0	1	0	193	0	83		
Los Padres	0	43	0	4			0	8	0	2				
Mendocino									0	19	0	19		
Modoc							0	8						
San Bernardino			1	80	0	6			0	75				
Shasta-Trinity							0	6						
Six Rivers	0	35	0	2			0	8	0	11	0	11		
Stanislaus			0	3			0	1						
Tahoe			2	40	0	37	0	1	5	165	0	20	0	39
Humboldt-Toiyabe R4													0	6
Total, all forests	**7**	**97**	**27**	**277**	**3**	**111**	**1**	**48**	**11**	**734**	**0**	**149**	**0**	**45**

[a] Flea pools may contain 1-10 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] *Borrelia* spp results do not differentiate *B. burgdorgeri*, causative agent for Lyme disease, and *B. miyamotoi*, a relapsing fever-type spirochete.

[d] VBDS Richmond Laboratory is now testing a subset of *I. pacificus* ticks for *Anaplasma phagocytophilum*, an emerging human pathogen.

[e] Special project.

[f] One of two rodent carcasses tested positive for *Y. pestis*. Both were negative for *Franciscella tularensis*, causative agent for tularemia. Totals include both serological testing of captured rodents for *Y. pestis* antibodies and carcasses tested for *Y. pestis* bacteria.

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

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 151 continuing education events in 2021. 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 2021, 1,177 Vector Control Technicians employed at 104 local public health agencies and CDPH held 2,830 certificates (Table 6.2). The agencies include special districts, departments of county government, departments of city government, and CDPH. Of these agencies, 72 are signatory to a cooperative agreement with CDPH.

In 2021, 915 individuals employed at 72 agencies held full certification status. In addition, 262 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. All training manuals, as well as practice questions and the Continuing Education Guide, are posted on the webpage dedicated to the CDPH Vector Control Technician Certification Program: https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/Vector-Control-Technician-Certification-Program.aspx.

Table 6.1. Results of certification examinations administered in 2021

Exam section	No. Exams Given	No. Passed (%)
Core	122	82 (67)
Mosquito Control	118	58 (49)
Terrestrial Invertebrate Control	87	34 (39)
Vertebrate Vector Control	72	44 (61)
Totals	**399**	**218 (55)**

Table 6.2. Vector Control Technician certificates in effect as of December 2021

	No. Certificates		
Certification Category	Full Status	Limited Status	Total
Mosquito Control	900	180	1,080
Terrestrial Invertebrate Vector Control	706	142	848
Vertebrate Vector Control	718	184	902
Totals	**2,324**	**506**	**2,830**

7 Public Information Materials, Publications

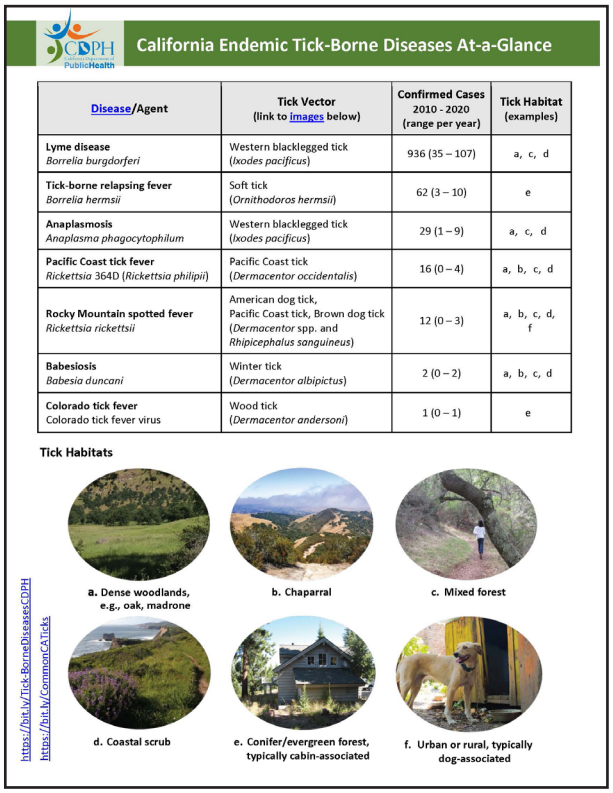
A goal of the California Department of Public Health, Vector-Borne Disease Section is to provide clear and effective information on disease prevention. This goal is pursued through approaches including presentations, development and distribution of printed and digital materials, and maintenance of websites 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 2021

- *Interactive Map of Plague in California* (ArcGIS StoryMap)
- *California Endemic Tick-Borne Diseases At-a-Glance* (fact sheet)

Expanded resources in 2021

- *Westnile.ca.gov* (website, Spanish)
- *Vector-Borne Disease Educational Materials* (webpage)
- *Don't Give Bugs a Biting Chance!* Repellent Toolkit (webpages, English/Spanish)
- *Bed Bugs* (webpage and fact sheet, English/Spanish)



California Endemic Tick-Borne Diseases At-a-Glance

Disease/Agent	Tick Vector (link to images below)	Confirmed Cases 2010 - 2020 (range per year)	Tick Habitat (examples)
Lyme disease *Borrelia burgdorferi*	Western blacklegged tick (*Ixodes pacificus*)	936 (35 – 107)	a, c, d
Tick-borne relapsing fever *Borrelia hermsii*	Soft tick (*Ornithodoros hermsii*)	62 (3 – 10)	e
Anaplasmosis *Anaplasma phagocytophilum*	Western blacklegged tick (*Ixodes pacificus*)	29 (1 – 9)	a, c, d
Pacific Coast tick fever *Rickettsia* 364D (*Rickettsia philipii*)	Pacific Coast tick (*Dermacentor occidentalis*)	16 (0 – 4)	a, b, c, d
Rocky Mountain spotted fever *Rickettsia rickettsii*	American dog tick, Pacific Coast tick, Brown dog tick (*Dermacentor* spp. and *Rhipicephalus sanguineus*)	12 (0 – 3)	a, b, c, d, f
Babesiosis *Babesia duncani*	Winter tick (*Dermacentor albipictus*)	2 (0 – 2)	a, b, c, d
Colorado tick fever Colorado tick fever virus	Wood tick (*Dermacentor andersoni*)	1 (0 – 1)	e

Tick Habitats

a. Dense woodlands, e.g., oak, madrone
b. Chaparral
c. Mixed forest
d. Coastal scrub
e. Conifer/evergreen forest, typically cabin-associated
f. Urban or rural, typically dog-associated

https://bit.ly/Tick-BorneDiseasesCDPH
https://bit.ly/CommonCATicks

Publications*

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Hacker GM, **Jackson BT**, **Niemela M**, **Andrews ES**, **Danforth ME**, **Pakingan MJ**, **Novak MG**. A Comparison of Questing Substrates and Environmental Factors That Influence Nymphal *Ixodes pacificus* (Acari: Ixodidae) Abundance and Seasonality in the Sierra Nevada Foothills of California. J Med Entomol. 2021 Jul 16;58(4):1880-1890. doi: 10.1093/jme/tjab037. PMID: 33860326; PMCID: PMC8529963.

Hahn MB, Feirer S, Monaghan AJ, Lane RS, Eisen RJ, **Padgett KA**, Kelly M. Modeling future climate suitability for the western blacklegged tick, *Ixodes pacificus*, in California with an emphasis on land access and ownership. Ticks Tick Borne Dis. 2021 Sep;12(5):101789. doi: 10.1016/j.ttbdis.2021.101789. Epub 2021 Jul 13. PMID: 34280699.

Metzger ME; A legacy of mosquito control through wetland management: a tribute to William E. Walton and his contributions to science and entomology. Wetlands Ecol. Manage. 10.1007/s11273-021-09813-9.

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

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