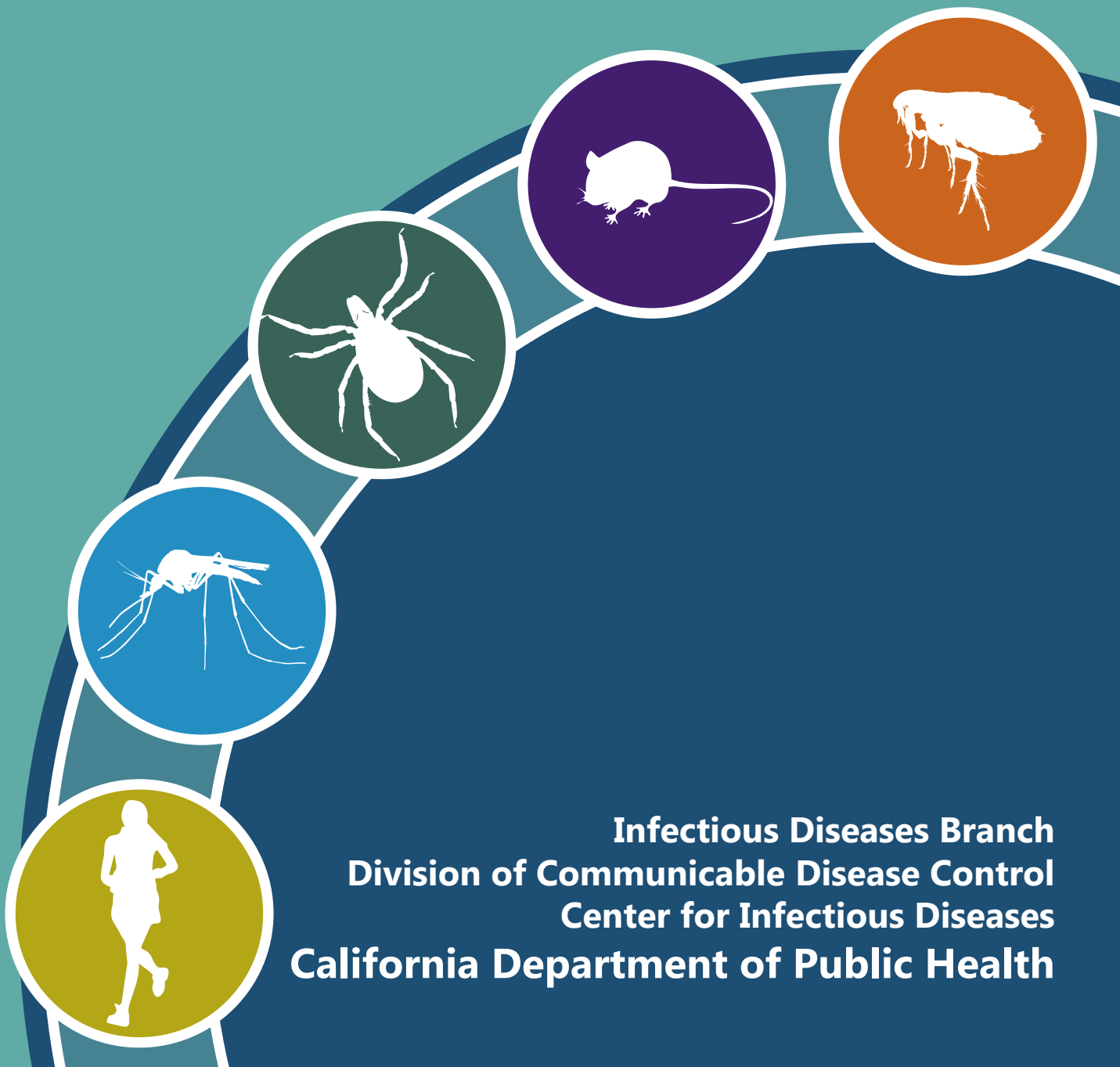
Vector-Borne Disease Section
Annual Report 2018



Infectious Diseases Branch
Division of Communicable Disease Control
Center for Infectious Diseases
California Department of Public Health

2018

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

CHHS
California Health & Human Services Agency

California Department of
PublicHealth

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Preface

I am pleased to present to you the 2018 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 2018.

In California, West Nile virus (WNV) continues to pose the greatest vector-borne disease threat. In 2018, however, the number of WNV disease cases was lower than during the preceding six years, although activity was elevated in some parts of the state, such as the Sacramento Valley region. Of the 217 human cases reported, 71% were the severe neuroinvasive form of the disease, and there were 11 fatalities. In addition to WNV activity, St. Louis encephalitis virus (SLEV) activity was detected in mosquitoes or sentinel chickens in nine counties, and there were five human cases.

The number of travel-associated human cases of Zika (68), dengue (107), and chikungunya (27) declined compared to 2017, but the distribution and abundance of the *Aedes* mosquito vectors of these viruses continued to increase in California. Through 2018, *Aedes aegypti* (yellow fever mosquito) and/or *Aedes albopictus* (Asian tiger mosquito) had been detected in 247 cities or census designated places; these species are well established in 12 counties. Although the number of Zika, dengue, and chikungunya cases declined in 2018, cases continue to be identified in California residents, and there is the ongoing threat of local virus transmission where vector species are established.

Flea-borne typhus is endemic in parts of southern California, with a record 174 cases reported in 2018; 78% of these case-patients required hospitalization. There was evidence of plague activity in 7 of the 31 counties where surveillance was conducted, but no human cases were identified. In 2018, four cases of hantavirus infection were reported, including three fatalities. For the first time, a human case was reported from Santa Cruz County.

Human cases of six different tick-borne diseases were reported in California in 2018, including 155 cases of Lyme disease. The number of Lyme disease cases has increased slightly in recent years, with approximately 38% of California's 2018 cases associated with travel to highly endemic regions of the United States, such as the Northeast and Midwest. There were 14 cases of tick-borne relapsing fever (TBRF) in 2018. Follow-up of several TBRF cases required an environmental investigation to reduce exposure risk to future occupants of these primarily rural, high-elevation cabins and facilities.

VBDS activities in 2018 included expanding public education through social media, digital and print materials, and the development of 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 2018 are listed here.

Rodent-borne Diseases

Alameda County Vector Control Services District; County of San Diego Vector Control Program (VCP); National Park Service (NPS); Northwest Mosquito and Vector Control District (MVCD); Orange County MVCD; Placer County MVCD; Riverside County Department of Environmental Health VCP; San Bernardino County VCP; San Mateo MVCD; Santa Clara County Vector Control District (VCD); Santa Cruz County MVCD; 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 Vector Control Services District; Army Corps of Engineers; California Department of Fish and Wildlife; El Dorado County VCP; Los Angeles County Agricultural Commissioner; Los Angeles County Vector Management Program; Mono County Environmental Health Services; Mosquito and Vector Management District of Santa Barbara; NPS; Placer County MVCD; Riverside County VCP; San Bernardino County VCP; San Diego County VCP; San Mateo County MVCD; Sierra County Environmental Health Department; United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services; USFS; Ventura County Environmental Health VCP.

Tick-borne Diseases

Butte County MVCD; California Department of Fish and Wildlife (CDFW); Marin County Department of Health and Human Services; Marin-Sonoma MVCD; Napa County Mosquito Abatement District; NPS; Orange County MVCD; Placer County MVCD; Sacramento-Yolo County MVCD; San Bernardino County VCP; San Diego County VCP; San Mateo County MVCD; Santa Clara County VCD; Santa Cruz County MVCD; USFS.

Mosquito-borne Diseases

California Animal Health and Food Safety Laboratory-Davis; CDFW; Davis Arbovirus Research and Training 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
Daniela Muhawi, Graphic Design.

Suggested Citations

Annual Report

California Department of Public Health. Vector-Borne Disease Section Annual Report, 2018. Kjemtrup AM and Kramer, V. editors. Sacramento, California, 2019. pp 1-29. https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/VBDSAnnualReports.aspx

Chapters

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

1 Rodent-borne Diseases
Jackson, B and Kjemtrup, A. Chapter 1: Rodent-borne Diseases. In: Vector-Borne Disease Section Annual Report, 2018. California Department of Public Health, Sacramento, California, 2019. pp 1-3.

2 Flea-borne Diseases
Tucker, J and Porse, C. Chapter 2: Flea-borne Diseases. In: Vector-Borne Disease Section Annual Report, 2018. California Department of Public Health, Sacramento, California, 2019. pp 4-6.

3 Tick-borne Diseases
Yoshimizu, M and Kjemtrup, A. Chapter 3: Tick-borne Diseases. In: Vector-Borne Disease Section Annual Report, 2018. California Department of Public Health, Sacramento, California, 2019. pp 7-12.

4 Mosquito-Borne Diseases
Feiszli, T; Snyder, R; Porse, C and Metzger, M. Chapter 4: Mosquito-borne Diseases. In: Vector-Borne Disease Section Annual Report, 2018. California Department of Public Health, Sacramento, California, 2019. pp 13-20.

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, 2018. California Department of Public Health, Sacramento, California, 2019. pp 21-24.

6 Vector Control Technician Certification Program
Niemela, M. Chapter 6: Vector Control Technician Certification Program. In: Vector-Borne Disease Section Annual Report, 2018. California Department of Public Health, Sacramento, California, 2019. pp 25-26.

7 Public Information Materials, Publications
Nicolici, A. Chapter 7: Public Information Materials, Publications. In: Vector-Borne Disease Section Annual Report, 2018. California Department of Public Health, Sacramento, California, 2019. pp 27-29.

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; 116180; and 116130]. CDPH-VBDS provides leadership, information, and consultation on vector-borne diseases and vectors to the general public and agencies engaged in the prevention and control of vector-borne diseases. CDPH-VBDS staff, located in four 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 vectors and vector- borne diseases, such as West Nile virus, Zika, chikungunya, dengue, and invasive *Aedes* mosquitoes
- Provide laboratory and proficiency testing for vector-borne disease agents in arthropods and vertebrates and testing for pesticide resistance in mosquitoes
- Conduct emergency vector control when disease outbreaks occur
- Advise local agencies on public health issues related to vector-borne diseases
- Advise local agencies on regulatory issues pertaining to mosquito and vector control
- Oversee the Cooperative Agreement (HSC 116180) between CDPH and local vector control agencies
- Oversee the Vector Control Technician Certification and Continuing Education programs
- Provide information, training, and educational materials to governmental agencies, the medical community, and the public
- Provide consultation on issues related to the management of bed bugs, head lice, flies, 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 on restricted use of 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 general public.

Human disease surveillance

Human cases of hantavirus infection, which include both hantavirus pulmonary syndrome (HPS) 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 investigation, which may include trapping rodents and collaborating with CDPH-VRDL to test for Sin Nombre virus to evaluate unusual exposure or potential for additional exposure. In 2018, four cases of HPS were reported in California residents. Case patients were residents of Merced, Placer, San Joaquin, and Santa Cruz counties. Three of the cases were fatal. Three case-patients were male, and the median age for all patients was 35.5 years old (range, 24 to 61 years old). Months of illness onset were March (2), April, and November. Environmental investigations were conducted for the Placer and Santa Cruz County cases. Antibodies to Sin Nombre virus (SNV) were not detected in two deer mice (*Peromyscus maniculatus*) collected from the possible exposure site of the Placer County case-patient. In Santa Cruz, SNV antibodies were detected in 5 (28%) of 18 deer mice collected from the possible exposure site of the case-patient. Exposure information could not be obtained for the Merced County case-patient, and San Joaquin environmental investigation will occur in 2019. Environmental assessment of an exposure site of a hantavirus case identified in late 2017 from Los Angeles County yielded two deer mice which tested negative for SNV. Since 1980, hantavirus infection has been diagnosed in 84 California residents, with the majority of cases exposed to SNV in the interior mountain ranges of the state or eastern Sierra (Figure 1.1).

In January 2018, CDPH-VBDS and local health departments participated in contact tracing following identification of an individual infected with Andes virus (ANDV), a species of New World hantavirus. The case-patient had traveled to the Andes region of Argentina where the virus is endemic, and subsequently to multiple other states in the United States, including California. Unlike other hantavirus species, ANDV can be transmitted person-to-person. Eight contacts in six California counties were identified. None of the contacts were ill at the time of follow-up; five of these who reported a recent respiratory illness were tested for ANDV and were negative. The case represents the first confirmed importation of ANDV to the United States.

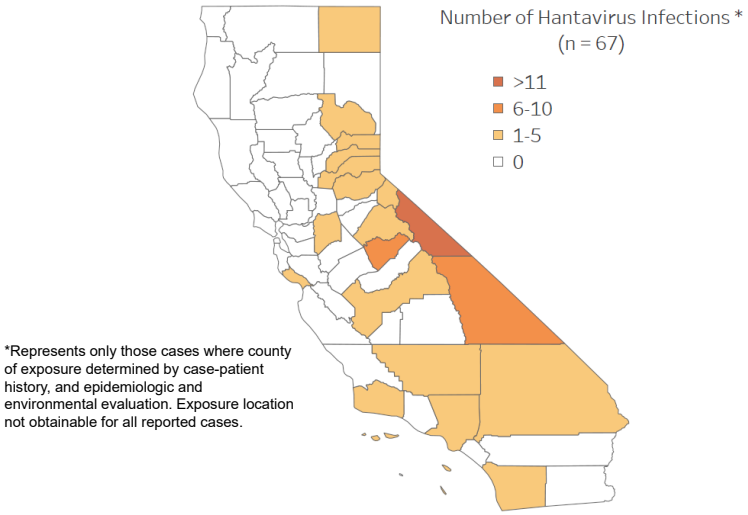


Figure 1.1. Likely county of exposure for reported hantavirus infections (1980 – 2018)

Table 1.1 Serologic evidence of hantavirus (Sin Nombre) infection in California rodents, 2009 - 2018

		2018			2009-2018		
Species	Common name	No. tested	No. reactive	Percent	No. tested	No. reactive	Percent
Peromyscus boylii	brush mouse	120	0		699	6	0.9
Peromyscus californicus	California mouse	217	4	1.8	1,485	24	1.6
Peromyscus crinitus	canyon mouse	1	0		67	2	3.0
Peromyscus eremicus	cactus mouse	266	3	1.1	1,703	50	2.9
Peromyscus e. fraterculus	northern Baja mouse	26	0		1,435	13	0.9
Peromyscus maniculatus	deer mouse	643	141	21.9	4,947	546	11.0
Peromyscus truei	piñon mouse	68	1	1.5	373	3	0.8
Peromyscus sp.	unspeciated *Peromyscus*				2	0	
Peromyscus spp. subtotal		1,341	149	11.1	10,711	644	6.0
Reithrodontomys megalotis	western harvest mouse	95	12	12.6	1,056	109	10.3
Neotoma spp.	woodrats	45	0		298	1	0.3
Microtus spp.	voles	11	1	9.1	163	25	15.3

Rodent surveillance

In 2018, 1,492 rodents (Genera: *Microtus*, *Neotoma*, *Peromyscus*, and *Reithrodontomys*) were tested for antibodies to SNV (Table 1.1). Of 1,341 *Peromyscus* spp. sampled, 149 (11.1%) were positive for SNV antibodies. Seroprevalence in deer mice, the primary reservoir for SNV, was 21.9% (Table 1.1). At least one deer mouse was SNV antibody-positive in 17 of 24 counties sampled in 2018 (Table 1.2). SNV antibody has been detected in deer mice from 25 of 41 counties sampled in the last 10 years; prevalence ranged from 2.0% to 33.3% (average 11.0%) over that time period (Table 1.2).

Additionally, 12 (12.6%) of 95 western harvest mice (*Reithrodontomys megalotis*) and 1 (9.1%) of 11 voles (*Microtus* spp.) demonstrated reactivity to SNV (Table 1.1). None of 45 woodrats (*Neotoma* 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 (e.g., El Moro Canyon or Isla Vista), which cross react to the Sin Nombre assay. In California, no hantaviruses other than SNV have been shown to be pathogenic to humans.

The SNV seroprevalence (21.9%) in *Peromyscus maniculatus* in 2018 is the highest estimate in the past ten years (range 6.0% - 21.9%) and may reflect the multiple, recent years of abundant precipitation, which in turn promotes *Peromyscus* population growth and concomitant virus transmission.

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 five-year cooperative agreement to decrease the risk of contracting vector-borne diseases through increased health education, vector surveillance, and public health research. CDPH-VBDS worked with YOSE and HH staff in 2018 on hantavirus prevention. Activities included rodent surveillance to estimate deer mouse abundance and SNV prevalence, facility evaluations, and improving employee training and public education. In 2018, deer mouse surveillance was conducted in two areas of the park. In Yosemite Valley, 2 (4.9%) of 41 deer mice were positive for SNV antibodies, as were 8 (28.6%) of 28 deer mice trapped in Tuolumne Meadows. In addition, 55 buildings were evaluated for rodent-borne disease risks. Staff of CDPH-HH provided recommendations to YOSE and its associated partners based on surveillance results and facility evaluations.

In May 2014, the National Park Service and HH entered into a master agreement, which allows park units within California to obtain vector-borne disease related services from HH and CDPH. Lassen Volcanic National Park (LAVO) continued a task agreement in 2018 for services that included hantavirus risk reduction, such as facility evaluations and deer mouse surveillance to estimate rodent abundance and SNV prevalence. In 2018, deer

mouse surveillance was conducted in two areas of LAVO. At Mineral Headquarters, two (40.0%) of five deer mice were positive for SNV antibodies, while one (11.1%) of nine deer mice at Manzanita Lake employee housing were reactive to SNV antibodies. In addition, eight buildings in LAVO were evaluated for vector-borne disease risks. Staff of CDPH-HH provided recommendations to LAVO based on surveillance results and facility evaluations.

Table 1.2. Serologic evidence of hantavirus (Sin Nombre) infection in *Peromyscus maniculatus* in California, 2009-2018

	2018			2009-2018		
County	No. tested	No. reactive	Percent	No. tested	No. reactive	Percent
Alameda	6	0	0.0	107	0	0.0
Alpine	9	2	22.2	9	2	22.2
Amador				8	0	0.0
Butte				6	0	0.0
Calaveras	4	1	25.0	4	1	25.0
Colusa				2	0	0.0
Contra Costa				13	0	0.0
Del Norte	1	0	0.0	1	0	0.0
El Dorado	26	5	19.2	369	91	24.7
Fresno				8	0	0.0
Glenn				5	0	0.0
Humboldt	13	0	0.0	26	0	0.0
Inyo				26	8	30.8
Kern				25	1	4.0
Lassen	8	5	62.5	98	11	11.2
Los Angeles	2	0	0.0	26	0	0.0
Mariposa	43	2	4.7	276	26	9.4
Modoc	4	1	25.0	39	9	23.1
Mono	199	78	39.2	302	97	32.1
Napa				12	2	16.7
Nevada	38	11	28.9	69	13	18.8
Orange	15	0	0.0	336	36	10.7
Placer	2	0	0.0	91	4	4.4
Plumas	7	1	14.3	85	19	22.4
Riverside	29	2	6.9	413	34	8.2
San Benito				5	0	0.0
San Bernardino				245	5	2.0
San Diego	139	10	7.2	1,552	61	3.9
San Mateo	19	4	21.1	158	29	18.4
Santa Barbara	3	0	0.0	3	0	0.0
Santa Clara				16	0	0.0
Santa Cruz	18	5	27.8	32	5	15.6
Shasta	9	1	11.1	92	18	19.6
Sierra				33	1	3.0
Siskiyou	6	2	33.3	95	22	23.2
Sutter				9	0	0.0
Tehama	5	2	40.0	86	18	20.9
Trinity				3	0	0.0
Tulare				15	0	0.0
Tuolumne	38	9	23.7	244	32	13.1
Ventura				3	1	33.3
Total	**643**	**141**	**21.9**	**4,947**	**546**	**11.0**

2 Flea-borne Diseases

Plague and flea-borne typhus 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 will perform serology or PCR for samples requiring additional confirmation. One hundred seventy-four cases of flea-borne typhus were reported to CDPH in 2018. One hundred (57%) of these were classified as confirmed cases according to CDPH working surveillance definition, 64 (37%) were probable, and 10 (6%) were suspect. One hundred thirty-six (78%) of the case-patients required hospitalization. Case-patients were residents of Los Angeles (149), Orange (20), San Bernardino (1), San Diego (2), San Mateo (1), and Shasta (1) counties. Flea-borne typhus is considered endemic in parts of Orange and Los Angeles counties. The case-patients from San Bernardino, San Mateo, and Shasta counties reported travel outside the United States during the incubation period.

Plague

No cases of plague in humans were reported in 2018.

Animal disease surveillance

Domestic pets

No cases of plague in domestic pets were reported in 2018.

Wild animals

The CDPH Vector-Borne Disease Section (CDPH-VBDS) plague surveillance program tested 756 wild rodents and 195 carnivores from 31 California counties in 2018 (Figure 2.1, Table 2.1). Serum antibodies to *Yersinia pestis* were observed in 12 rodents and 3 carnivores from seven counties (Figure 2.1, Table 2.1). The 746 rodents tested for plague antibodies in 2018 included: 351 chipmunks (*Tamias* spp.), 154 California ground squirrels (*Otospermophilus beecheyi*), 127 mice and voles (*Peromyscus* spp. and *Microtus* spp.), 66 golden-mantled ground squirrels (*Callospermophilus lateralis*), 30 wood rats (*Neotoma* spp.), 9 Belding's ground squirrels (*Urocitellus beldingi*), 5 Norway rats (*Rattus norvegicus*), and 4 Douglas squirrels (*Tamiasciurus douglasii*). For those samples collected by CDPH-VBDS, antibodies to *Y. pestis* were detected in four lodgepole chipmunks (*Tamias speciosus*) from Mono County, three yellow pine chipmunks (*Tamias amoenus*) from El Dorado and Nevada counties, three shadow chipmunks (*Tamias senex*) from Plumas County, and two California ground squirrels from El Dorado and Inyo counties (Table 2.1). The ten rodent carcasses submitted from six counties and cultured by the CDPH Microbial Disease Laboratory's reference bacteriology unit were all negative (Table 2.1). The 195 wild carnivores tested for plague antibodies included: 143 coyotes (*Canis latrans*), 28 black bears (*Ursus americanus*), 14 mountain lions (*Puma concolor*), 4 gray foxes (*Urocyon cinereoargenteus*), 3 bobcats (*Lynx rufus*), 2 raccoons (*Procyon lotor*), and 1 short-tailed weasel (*Mustela erminea*). Two black bears from Mariposa County and one coyote from Siskiyou County were positive for *Y. pestis* antibodies (Table 2.1).

Independent county-wide plague surveillance programs included the San Diego County Department of Environmental Health, Vector Control

Program and the County of Los Angeles Public Health-Vector Management Program. Of the 478 rodents tested by San Diego, one big-eared woodrat (*Neotoma macrotis*) from Tecate was positive for antibodies to *Y. pestis* (Figure 2.1). Los Angeles County tested 45 California ground squirrels and all were negative. Data from these programs are not included in Table 2.1.

Rodent Flea Testing

A total of 710 fleas collected from sylvatic rodents or their burrows were identified to species, combined into 277 pools, and tested for the presence of *Yersinia pestis* bacteria. Three flea pools tested PCR-positive for *Y. pestis*. One pool consisted of *Ceratophyllus ciliatus* collected from a lodgepole chipmunk from Mono County in June, and the other two contained *Eumolpianus eumolpi* collected from a yellow-pine chipmunk and Belding's ground squirrel from Nevada County in July.

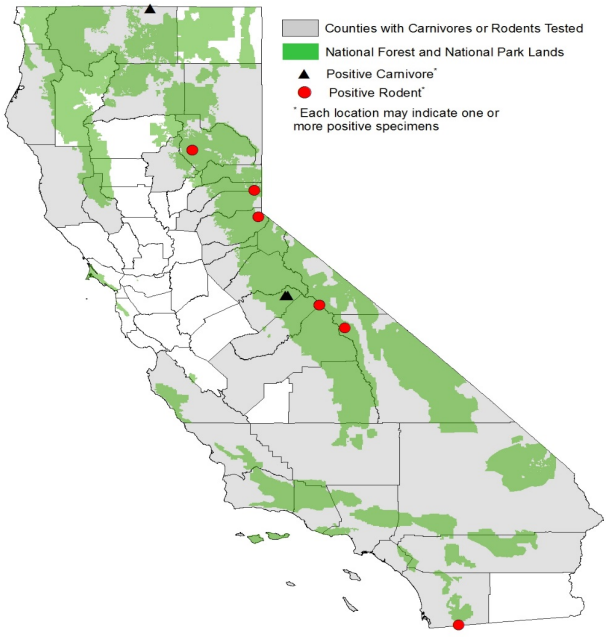


Figure 2.1. Approximate locations of carnivores or rodents on federal lands that tested positive for serum antibodies to *Yersinia pestis*, California, 2018

Table 2.1 CDPH-VBDS plague surveillance results in wild rodents and carnivores by location, California, 2018

County Location	No. rodents tested[a]	No. carnivores tested	Antibody positive specimens		
			Species	Titer	Month
Alpine	**12**				
Amador		**2**			
Butte		**15**			
Calaveras		**15**			
El Dorado	**44 (5)**	**3**			
Eldorado NF, Fallen Leaf CG			CA G Sq	1:512	September
Eldorado NF, Fallen Leaf CG			Chipmunk, YP	1:512	September
Fresno		**1**			
Humboldt	**9**				
Inyo	**51**				
Inyo NF, Four Jeffrey CG			CA G Sq	1:64	June
Kern	**6**	**37**			
Lake		**1**			
Lassen	**5**				
Los Angeles	**41 (1)**	**11**			
Madera	**19**	**20**			
Mariposa		**4**			
Yosemite NP			Black Bear	1:64	June
Yosemite NP			Black Bear	1:32	April
Mendocino		**28**			
Mono	**162 (1)**	**1**			
Woods Lodge			Chipmunk, LP	1:512	June
Woods Lodge			Chipmunk, LP	1:256	June
Inyo NF, Lake George CG			Chipmunk, LP	1:128	June
Inyo NF, Lake George CG			Chipmunk, LP	1:128	June
Monterey		**8**			
Nevada	**96**	**2**			
Martis Creek Recreational Area			Chipmunk, YP	1:64	July
Martis Creek Recreational Area			Chipmunk, YP	1:128	August
Orange	**14**				
Placer	**21 (1)**	**1**			
Plumas	**83**				
Plumas NF, Bucks Lake			Chipmunk, S	1:512	July
Plumas NF, Bucks Lake			Chipmunk, S	1:256	July
Plumas NF, Bucks Lake			Chipmunk, S	1:32	July
Riverside	**41**				
San Bernardino	**8**	**2**			
San Luis Obispo	**14**	**10**			
Santa Barbara	**20**	**5**			
Shasta	**40**				
Sierra	**(1)**				
Siskiyou	**23**	**29**			
Dorris			Coyote	1:64	March
Tulare	**16**				
Tuolumne	**9 (1)**				
Ventura	**21**				
Total	**756**	**195**			

[a] All samples are blood samples for serology except those numbers in parentheses are cacasses tested by culture

Abbreviations: Chipmunk, S: Shadow chipmunk (*Tamias senex*)
Chipmunk, LP: Lodgepole chipmunk (*Tamias speciosus*)
Chipmunk, YP: Yellow-pine chipmunk (*Tamias amoenus*)
CaGSq: California ground squirrel (*Otospermophilus beecheyi*)
Black Bear (*Ursus americanus*)
Coyote (*Canis latrans*)
NF: National Forest
NP: National Park
CG: Campground

3 Tick-borne Diseases

At least 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

Testing for human cases of tick-borne diseases is performed at commercial laboratories. Confirmation of some anaplasmosis and spotted fever group *Rickettsia* spp. may be performed at the California Department of Public Health (CDPH) Viral and Rickettsial Disease Laboratory (CDPH-VRDL).

Anaplasmosis

In 2018, five cases of anaplasmosis caused by *Anaplasma phagocytophilum* were reported to CDPH: four met national surveillance criteria for a confirmed case and one met the criteria for a probable case. Case-patients were residents of Los Angeles (2), Orange, Santa Barbara, and Santa Clara counties. Median age was 53 years (range, 31 to 78 years) and four (80%) were male. Two cases recalled out-of-state travel to another state endemic for *Anaplasma phagocytophilum*; one recalled a tick bite acquired in Mariposa County, and travel history was not available for two cases.

Babesiosis

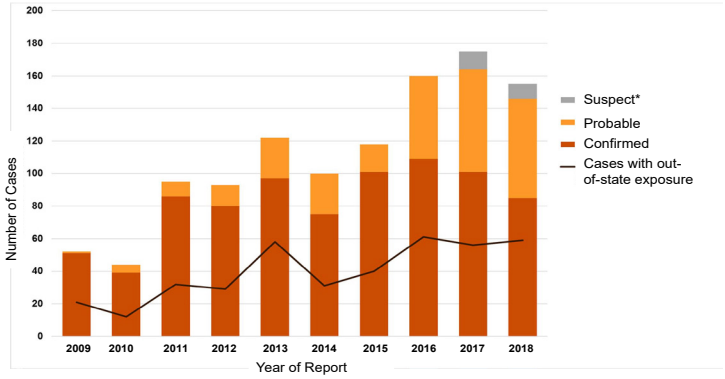
Six cases of babesiosis caused by *Babesia* spp. were reported to CDPH in 2018. Four met national surveillance criteria for a confirmed case and two were probable cases. *Babesia microti* was identified by PCR in four of the cases; the two probable cases had elevated titers to *B. microti* or *B. duncani*. Case-patients were residents of Santa Clara (2), San Diego (3), and San Francisco counties. Median age of case-patients was 58 years (range, 6 to 78 years) and three (50%) were female. Four case-patients visited emergency departments and three were hospitalized. Five reported travel to the northeastern United States where *B. microti* is endemic and three recalled a tick bite while there. The one probable case-patient with a *B. duncani* elevated titer reported a recent tick bite acquired in western-facing Sierra Nevada mountains.

Ehrlichiosis

Two cases of ehrlichiosis caused by *Ehrlichia chaffeensis* were reported to CDPH in 2018. Both cases met surveillance criteria for a probable case. Case-patients were residents of San Bernardino County. One case-patient had travel history through *E. chaffeensis*–endemic states (southeastern United States), and travel history was unknown for the other case-patient.

Lyme Disease

A total of 155 cases of Lyme disease caused by *Borrelia burgdorferi* were reported in 2018; 85 of these met the surveillance case definition criteria for a confirmed case, 61 were probable, and 9 were suspect cases with erythema migrans rash with exposure in California (Figure 3.1). Of the 85 confirmed cases, case-patients were residents of 23



* In 2017, the Lyme disease case definition changed so that cases with erythema migrans rash only (no laboratory support) and California exposure were classified as suspect, rather than confirmed.

Figure 3.1. Confirmed and probable Lyme disease cases, including cases reporting travel within incubation period, by report year 2009 - 2018

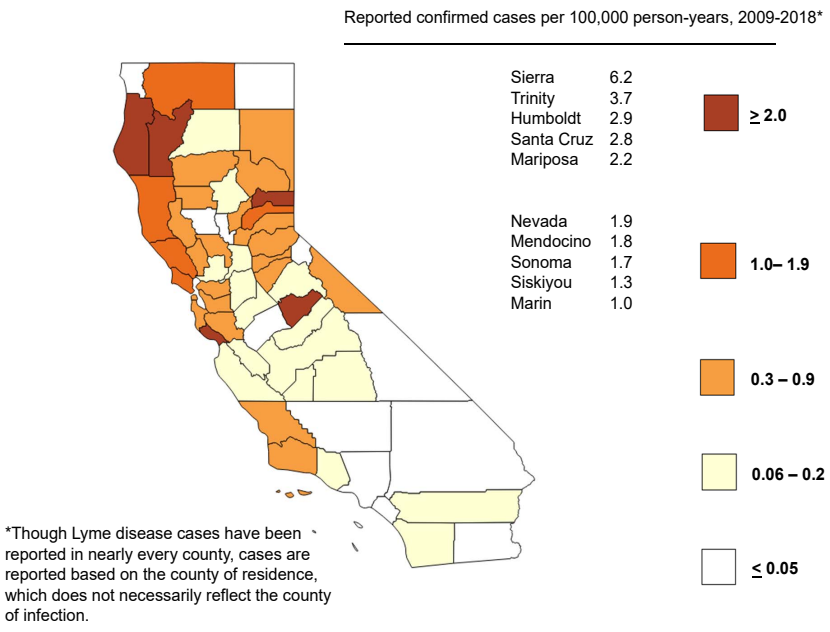


Figure 3.2. Incidence of reported confirmed Lyme disease, by county, California, 2009 - 2018

counties, with San Francisco County reporting the largest number of cases (15) (Table 3.1). The median age of confirmed Lyme disease case-patients was 40 years (range, 2 to 85 years) and 42 (50%) were female. Of the 43 confirmed case-patients for whom race was reported, 35 (81%) self-identified as white, 3 (7%) as Asian, 2 (5%) as black, and 2 (5%) as other. Erythema migrans (EM) was identified in 28 (34%) confirmed case-patients, 24 (86%) of whom had onset of EM noted between May and September. Between 2008 and 2017, the highest incidence of Lyme disease was in the northwest and northern counties with western-facing Sierra slopes (Figure 3.2). Of the 79 (51%) case-patients reporting travel history within the incubation period, 59 (75%) reported exposure outside of California, most commonly in the northeastern United States.

Spotted fever group rickettsiosis

Twelve cases of Rocky Mountain spotted fever (RMSF), caused by *Rickettsia rickettsii*, were reported to CDPH in 2018; one met the surveillance criteria for a confirmed case and 11 were probable cases. Case-patients were residents of ten counties: Alameda, Imperial, Los Angeles, Madera, Placer, Riverside (2), San Bernardino, San Diego, San Francisco (2), and Ventura. Eight (67%) case-patients were male, and the median age was 50.5 years (range, 19 to 81 years). Seven (58%) reported possible exposure outside their county of residence including to counties in California (El Dorado, Santa Cruz) or to Florida, North Carolina, South Carolina, and Mexico (2). One probable case of African tick-bite fever caused by *Rickettsia africae* was identified from a traveler returning from South Africa.

Tick-borne relapsing fever

Fourteen cases of tick-borne relapsing fever (TBRF), caused by *Borrelia hermsii*, were reported to CDPH in 2018; ten (71%) of these met CDPH working surveillance case definition criteria for a confirmed case and four (29%) were probable. Median age of confirmed case-patients was 31 years (range, 4 to 64 years) and eight (57%) were female. Case-patients were residents of nine counties: Alameda, Los Angeles (3), Marin, Mono (2), Orange, San Diego, Santa Cruz (2), Tulare, and Ventura (2). States or California counties where case-patients (confirmed and probable) were likely exposed in the three weeks prior to illness onset included Nevada State, Amador, Mono (8), Nevada, Placer, San Bernardino, and Tulare.

Table 3.1: Reported confirmed Lyme disease cases by county of residence, California, 2009-2018

County	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL	Incidence per 100,000 person-years
Alameda	1	2	2	4	0	4	9	9	12	4	47	0.30
Alpine	0	0	0	0	0	0	0	0	0	0	0	0.00
Amador	0	0	0	0	1	0	2	0	0	0	3	0.79
Butte	2	0	0	0	0	1	0	2	0	0	5	0.22
Calaveras	0	0	0	0	0	0	1	0	1	0	2	0.44
Colusa	0	0	0	0	0	0	0	0	0	0	0	0.00
Contra Costa	0	1	1	4	5	2	4	6	12	10	45	0.41
Del Norte	0	0	0	0	0	0	0	0	0	0	0	0.00
El Dorado	2	1	0	2	0	2	2	1	2	0	12	0.66
Fresno	0	1	1	4	0	1	1	1	0	1	10	0.10
Glenn	0	0	0	0	0	1	0	0	0	0	1	0.35
Humboldt	4	4	5	4	4	4	6	4	3	1	39	2.88
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	1	1	0	0	0	0	1	1	0	0	4	0.05
Kings	1	0	0	0	1	0	0	1	0	0	3	0.20
Lake	0	0	0	0	0	0	1	1	0	0	2	0.31
Lassen	0	0	0	0	0	0	0	1	0	0	1	0.31
Los Angeles	3	1	8	2	17	6	6	1	3	2	49	0.05
Madera	0	0	1	0	0	0	0	0	0	0	1	0.07
Marin	1	1	1	3	6	5	5	3	0	1	26	1.00
Mariposa	0	0	0	1	1	1	1	0	0	0	4	2.20
Mendocino	5	1	3	4	0	1	0	1	1	0	16	1.81
Merced	0	0	1	0	0	0	0	0	0	0	1	0.04
Modoc	0	0	0	0	0	0	0	0	0	0	0	0.00
Mono	0	0	0	0	1	0	0	0	0	0	1	0.72
Monterey	0	1	1	1	1	0	0	1	0	0	5	0.12
Napa	1	0	1	1	0	2	2	2	0	1	10	0.72
Nevada	1	3	6	2	1	1	1	2	0	2	19	1.93
Orange	0	0	6	0	0	0	0	1	0	0	7	0.02
Placer	2	0	1	2	1	0	0	2	3	0	11	0.30
Plumas	0	0	0	0	0	1	0	0	0	0	1	0.50
Riverside	4	0	4	0	2	1	1	3	1	1	17	0.07
Sacramento	1	0	1	2	0	0	0	1	1	2	8	0.05
San Benito	0	0	0	0	0	0	1	0	0	0	1	0.18
San Bernardino	0	0	2	0	1	0	1	0	0	0	4	0.02
San Diego	7	4	8	7	8	8	9	7	1	9	68	0.21
San Francisco	1	1	1	2	5	0	0	0	10	15	35	0.41
San Joaquin	0	0	0	1	0	1	0	1	0	1	4	0.06
San Luis Obispo	0	0	0	1	4	3	3	2	1	1	15	0.55
San Mateo	0	3	0	1	3	6	5	5	4	0	27	0.36
Santa Barbara	0	1	3	0	6	0	4	7	3	3	27	0.62
Santa Clara	2	2	11	4	13	5	10	11	7	5	70	0.37
Santa Cruz	3	8	9	5	5	6	8	7	15	10	76	2.81
Shasta	0	0	1	1	0	0	0	0	0	0	2	0.11
Sierra	0	0	0	1	0	0	0	0	0	1	2	6.22
Siskiyou	0	0	0	1	1	0	1	1	1	1	6	1.34
Solano	0	0	0	0	0	0	0	3	2	2	7	0.16
Sonoma	8	2	6	12	7	11	12	11	8	8	85	1.72
Stanislaus	1	0	0	0	0	0	1	1	2	2	7	0.13
Sutter	0	0	0	0	0	0	0	0	0	0	0	0.00
Tehama	0	0	0	0	0	0	0	3	1	0	4	0.63
Trinity	0	0	2	1	0	1	1	0	0	0	5	3.65
Tulare	0	0	0	1	0	0	1	1	0	0	3	0.07
Tuolumne	0	0	0	0	0	0	1	0	0	0	1	0.18
Ventura	0	0	0	3	2	0	0	3	3	2	13	0.15
Yolo	0	0	0	1	1	0	1	1	3	0	7	0.33
Yuba	0	1	0	2	0	1	0	0	0	0	4	0.54
TOTAL	**51**	**39**	**86**	**80**	**97**	**75**	**102**	**108**	**100**	**85**	**823**	**0.21**

Tick surveillance

Anaplasma phagocytophilum

In 2018, CDPH Vector-Borne Disease Section (CDPH-VBDS), in collaboration with Napa County Mosquito Abatement District and Santa Cruz Mosquito and Vector Control District (MVCD), collected and tested 528 adult, 64 nymphal, and 11 larval western blacklegged ticks (*Ixodes pacificus*) from Napa and Santa Cruz counties for the presence of *Anaplasma phagocytophilum*. Eleven (2.1%) adult western blacklegged ticks tested positive by real-time polymerase chain reaction (RT-PCR) at the CDPH-VBDS laboratory (Table 3.2). Ten positive adults were collected from Bothe-Napa Valley State Park, Napa County, and one positive adult was collected from Chaminade, Santa Cruz County. Reported to CDPH-VBDS in 2018, San Mateo MVCD collected and tested 3,555 adult western blacklegged ticks in 716 pools from 14 parks, and 534 nymphal western blacklegged ticks in 269 pools from 8 parks. Positive adult ticks were collected at the following locations (minimum infection prevalence --defined as the number of positive tick pools divided by the total number of ticks tested in a pool multiplied by 100-- is shown in parentheses): Coal Creek Open Space Preserve (OSP) (1.8%), Los Trancos OSP (1.8%), Big Canyon Park (1.0%), Purisima Creek Redwoods OSP (0.8%), Memorial Park (0.7%), Laurelwood Park (0.3%), and Eaton Park (0.2%). One positive nymphal pool was collected from Coal Creek OSP (1.2%). (Table 3.2).

Francisella tularensis

In 2018, CDPH-VBDS tested a total of 255 Pacific Coast tick (*Dermacentor occidentalis*) adults, and 2 American dog tick (*Dermacentor variabilis*) adults from San Diego and San Mateo counties, for *Francisella tularensis*, the causative agent of tularemia. Three adult Pacific Coast ticks collected from Los Penasquitos Canyon Preserve, San Diego County, were positive for *Francisella tularensis* type B. Reported to CDPH-VBDS, San Diego Vector Control Program tested 1,929 Pacific Coast tick adults in 282 pools, and 83 American dog tick adults in 17 pools for *Francisella tularensis*. All ticks tested negative.

Rickettsia philipii

In 2018, CDPH-VBDS prepared DNA for testing 960 adult, 7 nymphal, and 1 larval Pacific Coast ticks from Colusa, El Dorado, Inyo, Kern, Los Angeles, Marin, Mariposa, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, San Mateo, Santa Barbara, and Santa Clara counties, and 50 adult American dog ticks from Marin and San Mateo counties for *Rickettsia philipii*, the agent of Pacific Coast tick fever. Tick collections were often conducted in collaboration with the local vector control agency. All ticks were tested by RT-PCR at CDPH-VRDL. Ten adult (1.0%) Pacific Coast ticks positive for *R. philipii* were detected in three counties: Kern (2/35=5.7%), Orange (5/137=3.7%), and San Bernardino (3/145=2.1%).

Borrelia spirochetes

Borrelia burgdorferi sensu lato

In 2018, local, state, and federal agencies in collaboration with CDPH-VBDS collected 17,583 adult, 1,149 nymphal, and 612 larval western blacklegged ticks from 33 counties to test for *Borrelia burgdorferi*, the agent of Lyme disease. Collection and testing data for western blacklegged ticks are collated by CDPH-VBDS. From the 30 counties where ticks were tested individually, the overall prevalence of *B. burgdorferi* sensu lato was 1.0% in adult ticks and 3.6% in nymphal ticks (Table 3.3). Ticks were tested individually either by RT-PCR only or by direct fluorescent antibody (DFA) followed by RT-PCR. Ticks

Table 3.2. Infection prevalence and minimum infection prevalence of *Anaplasma phagocytophilum* in *Ixodes pacificus* ticks, California, 2018

	No. Ticks Tested (pools)[a]			Positive *A. phagocytophilum*				
County	Adults	Nymphs	Larvae	Adults (IP/MIP)	Nymphs (IP/MIP)	Larvae (IP/MIP)	Collected by	Laboratory
Napa	505	64	11 (3)	10 (2.0)	0	0	CDPH-VBDS; Napa MAD	CDPH-VBDS
San Mateo	3,555 (716)	534 (269)	0	15 (0.4)	1 (0.2)	0	San Mateo MVCD	San Mateo MVCD
Santa Cruz	23	0	0	1 (4.3)	0	0	Santa Cruz MVCD	CDPH-VBDS

[a] If no pools listed then ticks were tested individually.

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

Abbreviations:

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

tested by local vector control agencies in pools were tested by RT-PCR. In the nine counties where ticks were tested in pools, the adult MIP was 0.8% and nymphal MIP was 1.3% (Table 3.4). Larval ticks were negative.

Borrelia miyamotoi

In 2018, of the western blacklegged ticks collected, 16,632 adult, 1,149 nymphal, and 612 larval ticks were tested for *Borrelia miyamotoi*, a relapsing fever-type spirochete implicated in human disease in the eastern United States and Europe. Of the 5,428 individually tested adults and 615 individually tested nymphs, 36 (0.7%) and 8 (1.3%), respectively, tested positive (Table 3.3). Of the 11,204 adult ticks tested in 3,710 pools and 534 nymphs tested in 269 pools, 69 (0.6% MIP) and 5 (0.9% MIP), respectively, tested positive (Table 3.4). Larvae were tested from six counties: Butte, Colusa, Marin, Napa, Nevada, and San Mateo. Larvae from three counties tested positive (0.5% MIP): San Mateo (1 positive pool from 442 larvae in 91 pools=0.2% MIP), Marin (1 positive pool from 39 larvae in 6 pools=2.6% MIP), and Nevada (1 positive pool from 21 larvae in 3 pools=4.8% MIP).

Table 3.3. Infection prevalence of *Borrelia burgdorferi* sensu lato and *Borrelia miyamotoi* spirochetes in *Ixodes pacificus* ticks, California, 2018

County	No. Ticks Tested		Positive *B. burgdorferi*		Positive *B. miyamotoi*		Collected by	Laboratory
	Adults	Nymphs	Adults (IP)[a]	Nymphs (IP)	Adults (IP)	Nymphs (IP)		
Butte	35	82					CDPH-VBDS	CDPH-VBDS
Colusa	2	9					CDPH-VBDS	CDPH-VBDS
El Dorado	201	86	11 (5.5)	13 (15.1)	2 (1.0)	2 (2.3)	CDPH-VBDS	CDPH-VBDS
Inyo	8						CDPH-VBDS	CDPH-VBDS
Kern	20						CDPH-VBDS	CDPH-VBDS
Los Angeles	338						CDPH-VBDS	CDPH-VBDS
Marin	283	100	11 (3.9)	4 (4.0)	1 (0.4)	2 (2.0)	CDPH-VBDS; Marin-Sonoma MVCD	CDPH-VBDS; Marin-Sonoma MVCD
Mariposa	66						CDPH-VBDS	CDPH-VBDS
Merced	1						CDPH-VBDS	CDPH-VBDS
Napa	540	69	17 (3.2)	4 (5.8)	11 (2.0)	3 (4.4)	CDPH-VBDS; Napa MAD	CDPH-VBDS
Nevada	199	97		1 (1.0)	1 (0.5)	1 (1.0)	CDPH-VBDS	CDPH-VBDS
Orange	140		1 (0.7)				CDPH-VBDS	CDPH-VBDS
Placer	56	2			1 (1.8)		CDPH-VBDS	CDPH-VBDS
Riverside	188						San Mateo MVCD	San Mateo MVCD
San Bernardino	86		1 (1.2)				CDPH-VBDS	CDPH-VBDS
San Diego	401						Santa Cruz MVCD	CDPH-VBDS
San Luis Obispo	211						CDPH-VBDS	CDPH-VBDS
Santa Barbara	3						CDPH-VBDS	CDPH-VBDS
Santa Clara	161				1 (0.6)		CDPH-VBDS	CDPH-VBDS
Santa Cruz	401		4 (1.0)		3 (0.8)		CDPH-VBDS	CDPH-VBDS
Shasta	111	47					CDPH-VBDS	CDPH-VBDS
Solano	22						CDPH-VBDS	CDPH-VBDS
Sonoma	2	113		1 (0.9)		1 (0.9)	Marin-Sonoma MVCD	Marin-Sonoma MVCD
Stanislaus	62						CDPH-VBDS	CDPH-VBDS
Sutter	59	1					CDPH-VBDS	CDPH-VBDS
Tehama	28						CDPH-VBDS	CDPH-VBDS
Tulare	21						CDPH-VBDS	CDPH-VBDS
Tuolumne	0	10						
Ventura	43						CDPH-VBDS	CDPH-VBDS
Yuba	126	1	2 (1.6)				CDPH-VBDS	CDPH-VBDS
Total	**3,814**	**617**	**47 (1.2)**	**23 (3.7)**	**20 (0.5)**	**9 (1.5)**		

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] 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.

Abbreviations:
CDPH-VBDS, California Department of Public Health, Vector-Borne Disease; MAD, Mosquito Abatement District Laboratory; MVCD, Mosquito and Vector Control District

Table 3.4. Minimum infection prevalence of *Borrelia burgdorferi* sensu lato and *Borrelia miyamotoi* in *Ixodes pacificus* ticks, California, 2018

County	No. Ticks Tested		Positive *B. burgdorferi*		Positive *B. miyamotoi*[c]		Collected by	Laboratory
	adults	nymphs	adults (MIP)[b]	nymphs (MIP)[b]	adults (MIP)[b]	nymphs (MIP)[b]		
Butte	1,850 (370)		16 (0.9)		10 (0.5)		Butte MVCD	Placer MCVD
Marin	43 (11)		2 (4.7)		0		Marin Sonoma MVCD	Marin Sonoma MVCD
Placer	2,098 (874)		28 (1.3)		19 (0.9)		Placer MVCD	Placer MVCD
Sacramento[a]	693 (162)		11 (1.6)		n/a		Sacramento Yolo MVCD	Sacramento Yolo MVCD
San Diego	409 (85)		0		0		San Diego VCP	San Diego VCP
San Mateo	3,555 (716)	534 (269)	25 (0.7)	7 (1.3)	19 (0.5)	5 (0.9)	San Mateo MVCD	San Mateo MVCD
Santa Clara	3,205 (1642)		11 (0.3)		21 (0.7)		Santa Clara MVCD	Santa Clara MVCD
Sonoma	44 (12)		2 (4.6)		0		Marin Sonoma MVCD	Marin Sonoma MVCD
Yolo[a]	258 (55)		0		n/a		Sacramento Yolo MVCD	Sacramento Yolo MVCD
Total	**12,155 (3,927)**	**534 (269)**	**95 (0.8)**	**7 (1.3)**	**69 (0.6)**	**5 (0.9)**		

[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 pooled multiplied by 100.

[c] 11,204 (3,710) adult ticks tested for *Borrelia miyamotoi*.

Abbreviations:
MVCD, Mosquito and Vector Control District; VCP, Vector Control Program

Mammal Surveillance

Francisella tularensis

CDPH-VBDS collaborates with CDPH Microbial Disease Laboratory to test mammals for *Francisella tularensis*, the agent of tularemia, by serology, DFA, PCR, and culture. Mammals may be tested for tularemia in response to reported human cases or for environmental risk assessment, including specific carcass testing requests. In 2018, small mammals were tested from El Dorado (5), Los Angeles (1), Mono (1), Placer (1), Sierra (1), and Tuolumne (1) counties. A single California ground squirrel from El Dorado County tested positive.

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. The Vector-Borne Disease Section provides surveillance and testing for pesticide resistance in mosquitoes.

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 (CDPH-VRDL), 9 local county public health laboratories, and over 75 commercial laboratories. Local county laboratories tested for WNV using an IgM enzyme immunoassay (EIA) and/or an IgM immunofluorescence assay (IFA). Specimens with inconclusive results were forwarded to CDPH-VRDL for further testing with a plaque reduction neutralization test (PRNT). Additional WNV infections were identified through nucleic acid test screening performed by blood donation centers.

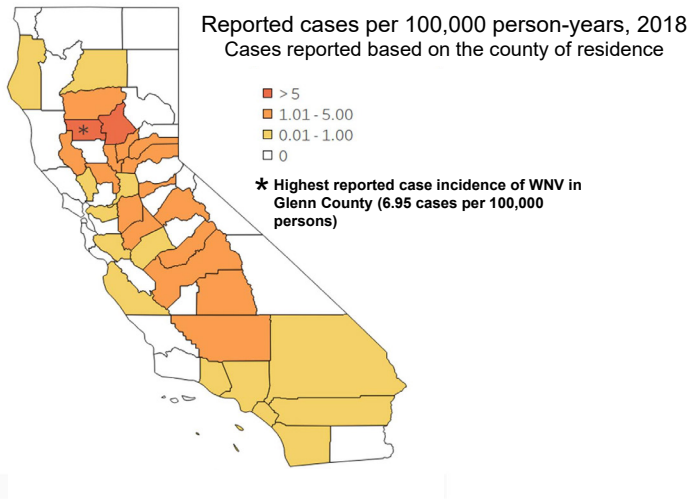


Figure 4.1. Incidence of reported human cases of West Nile virus, by county, California, 2018

In 2018, a total of 217 symptomatic and 26 asymptomatic infections with WNV were identified, a decrease in infections compared to 2017 (Table 4.1). Of the 217 clinical cases, 63 (29%) were classified as West Nile non-neuroinvasive disease and 154 (71%) were classified as West Nile neuroinvasive disease (e.g., encephalitis, meningitis, acute flaccid paralysis, or other neurologic dysfunction). Case-patients were residents of 31 counties and 140 (65%) were male. Incidence was highest (7.0 cases per 100,000 persons) in Glenn County (Table 4.1, Figure 4.1). The median age for West Nile fever cases was 53 years (range, 1 to 90 years), and for neuroinvasive cases, was 63 years (range, 4 to 91 years). The median age of the 11 WNV-associated fatalities was 71 years (range, 53 to 87 years). Dates of symptom onset for all reported cases ranged from May 6 to December 20, 2018.

St. Louis encephalitis virus

Five symptomatic cases of St. Louis encephalitis virus (SLEV) infections were identified in 2018. Case-patients were residents of four counties (Table 4.5) and two were male. The median age was 63 years, and dates of symptom onset ranged from August 23 to October 28, 2018.

Malaria

In 2018, 98 confirmed cases of malaria were reported to CDPH. Case-patients were residents of 22 California counties and 54 (55%) were male. The median age was 36 years (range, 2 to 71 years). Of the 86 cases for which the *Plasmodium* species was determined, 57 were *P. falciparum*, 20 *P. vivax*, 8 *P. ovale*, and1 *P. malariae*. Ninety-six case-patients

Table 4.1. Reported WNV human cases by county of residence, California, 2009-2018

County	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2018 incidence per 100,000 person-years	10 year incidence per 100,000 person-years
Alameda	0	1	0	2	0	1	0	0	1	0	0.00	0.03
Alpine	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Amador	0	0	1	0	0	0	0	1	0	1	2.64	0.79
Butte	2	1	3	10	24	24	53	21	3	12	5.27	6.85
Calaveras	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Colusa	0	0	0	3	2	3	1	2	0	0	0.00	5.05
Contra Costa	5	4	3	4	5	5	1	4	4	4	0.35	0.35
Del Norte	0	0	0	0	0	0	0	0	0	0	0.00	0.00
El Dorado	1	0	1	0	1	0	0	1	0	0	0.00	0.22
Fresno	13	23	9	24	8	43	8	14	10	14	1.39	1.72
Glenn	0	2	1	7	9	10	19	6	0	2	6.95	19.66
Humboldt	0	0	0	0	0	0	0	0	0	1	0.73	0.07
Imperial	0	0	0	1	0	1	1	0	3	0	0.00	0.33
Inyo	0	0	0	0	0	0	0	0	4	0	0.00	2.15
Kern	18	15	18	25	25	11	11	17	29	13	1.43	2.09
Kings	3	1	1	3	1	4	0	8	4	0	0.00	1.66
Lake	0	0	0	1	0	1	2	1	0	1	1.54	0.93
Lassen	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Los Angeles	20	4	58	163	151	253	286	151	274	43	0.42	1.39
Madera	1	7	2	3	3	3	4	6	2	4	2.53	2.28
Marin	0	0	0	0	2	0	1	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	0	0	0	1	2	0	0	0	0.00	0.34
Merced	4	1	1	13	0	1	1	0	8	2	0.72	1.16
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	1	0	0	0	1	0	1	0.23	0.09
Napa	0	0	0	0	1	0	0	0	0	1	0.71	0.14
Nevada	0	0	0	0	0	0	2	0	0	1	1.01	0.30
Orange	4	1	10	42	10	263	92	32	35	9	0.28	1.60
Placer	0	3	1	12	6	7	0	7	0	9	2.31	1.22
Plumas	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Riverside	3	0	7	19	35	14	127	11	28	15	0.62	1.13
Sacramento	0	12	4	29	11	10	4	25	6	15	0.98	0.79
San Benito	0	0	0	0	0	0	0	0	0	0	0.00	0.00
San Bernardino	2	5	4	33	13	21	54	8	54	9	0.41	0.97
San Diego	4	0	0	1	0	11	42	20	2	2	0.06	0.25
San Francisco	0	1	0	1	1	0	0	0	1	0	0.00	0.05
San Joaquin	10	6	5	13	8	9	2	13	14	14	1.85	1.31
San Luis Obispo	0	0	0	0	0	0	0	0	0	0	0.00	0.00
San Mateo	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Santa Barbara	0	0	1	0	1	0	0	0	0	0	0.00	0.05
Santa Clara	0	0	1	0	2	10	8	1	0	1	0.05	0.12
Santa Cruz	0	0	1	0	0	0	0	0	0	0	0.00	0.04
Shasta	0	0	0	1	1	2	3	1	1	1	0.56	0.56
Sierra	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Siskiyou	0	0	0	0	0	0	1	0	0	0	0.00	0.22
Solano	0	0	0	2	1	5	1	4	1	0	0.00	0.33
Sonoma	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Stanislaus	14	12	11	26	17	33	13	26	28	15	2.71	3.66
Sutter	0	0	0	8	10	8	2	12	2	1	1.03	4.48
Tehama	0	0	1	4	5	4	5	5	2	2	3.12	4.39
Trinity	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Tulare	4	12	11	7	5	21	13	10	12	8	1.68	2.25
Tuolumne	0	0	0	0	0	0	0	0	0	1	1.83	0.18
Ventura	0	0	0	7	2	1	6	7	1	2	0.23	0.31
Yolo	2	0	0	10	6	15	8	16	6	11	4.97	3.52
Yuba	1	0	3	4	13	6	10	11	1	2	2.59	6.93
Total WNV disease	**112**	**111**	**158**	**479**	**379**	**801**	**783**	**442**	**536**	**217**	**0.55**	**1.04**
Asymptomatic Infections[a]	17	20	18	48	54	91	77	41	41	26		
Total WNV infections	**129**	**131**	**176**	**527**	**433**	**892**	**860**	**483**	**577**	**243**	**0.61**	**1.15**

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

reported compatible travel history to malaria-endemic areas including Africa (63), Asia (26), South America (3), India (3), and Central America (1). Exposure information for two case-patients was not available.

Chikungunya

Twenty-seven cases of chikungunya were reported to CDPH in 2018; 3 of these met the criteria for a confirmed case and 24 were probable (Table 4.2). Case-patients were residents of 10 California counties, 19 (70%) were female, and the median age was 40 (range, 0 to 71 years). No locally acquired cases were reported. All case-patients reported travel to chikungunya-endemic or outbreak areas including: India (9), South East Asia (5), Central America (4), North America (Mexico [3]), Caribbean (2), Asia (1), South America (1), and South Pacific (1). Exposure region was not available for one infected person.

Dengue

In 2018, 107 cases of dengue were reported to CDPH; 29 of these met the criteria for a confirmed case, and 78 were probable (Table 4.2). Case-patients were residents of 23 California counties, 49 (46%) were female, and the median age was 41 years (range, 8 to 82 years). No locally acquired cases were reported. Travel region history included: South East Asia (32), India (25), North America (Mexico [22]), Central America (8), Caribbean (7), South Pacific (6), Africa (4), and South America (3).

Zika

In 2018, 68 infections of Zika virus were reported to CDPH; 24 of these met the criteria for a confirmed infection and 44 were probable infections. Infected persons were residents of 15 counties (Table 4.2), 54 (79%) were female, and the median age was 32 years (range, 0 to 81 years). All infections were travel related. Reported travel by 65 infected individuals was to Zika-endemic or outbreak areas including: North America (Mexico [22]), Central America (12), South East Asia (17), the Caribbean (3), South America (3), and Pacific Islands (1). Exposure region was not available for six infected persons. One individual was infected through sexual contact with an infected returned traveler, and three cases were congenital infections. Thirty-six infected persons were pregnant at time of diagnosis.

Table 4.2: Reported confirmed and probable *Aedes*-transmitted diseases in humans by county, California, 2018

County	Chikungunya	Dengue	Zika	TOTAL
Alameda	3	7	7	17
Alpine	0	0	0	0
Amador	0	0	0	0
Butte	0	0	0	0
Calaveras	0	0	0	0
Colusa	0	0	0	0
Contra Costa	1	6	2	9
Del Norte	0	0	0	0
El Dorado	0	0	0	0
Fresno	0	0	0	0
Glenn	0	0	0	0
Humboldt	0	0	0	0
Imperial	0	0	0	0
Inyo	0	0	0	0
Kern	0	3	0	3
Kings	0	0	0	0
Lake	0	0	0	0
Lassen	0	0	0	0
Los Angeles	8	28	18	54
Madera	0	0	0	0
Marin	0	0	1	1
Mariposa	0	0	0	0
Mendocino	0	0	0	0
Merced	0	0	1	1
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	12	4	16
Placer	0	1	0	1
Plumas	0	0	0	0
Riverside	0	1	1	2
Sacramento	1	1	0	2
San Benito	0	1	0	1
San Bernardino	0	0	0	0
San Diego	5	9	7	21
San Francisco	1	3	9	13
San Joaquin	0	0	0	0
San Luis Obispo	0	1	0	1
San Mateo	1	7	5	13
Santa Barbara	0	0	1	1
Santa Clara	5	15	8	28
Santa Cruz	0	1	0	1
Shasta	0	1	0	1
Sierra	0	0	0	0
Siskiyou	0	0	0	0
Solano	0	2	1	3
Sonoma	0	0	2	2
Stanislaus	1	2	0	3
Sutter	0	0	0	0
Tehama	1	0	0	1
Trinity	0	0	0	0
Tulare	0	1	0	1
Tuolumne	0	1	0	1
Ventura	0	2	0	2
Yolo	0	1	1	2
Yuba	0	1	0	1
TOTAL	**27**	**107**	**68**	**202**

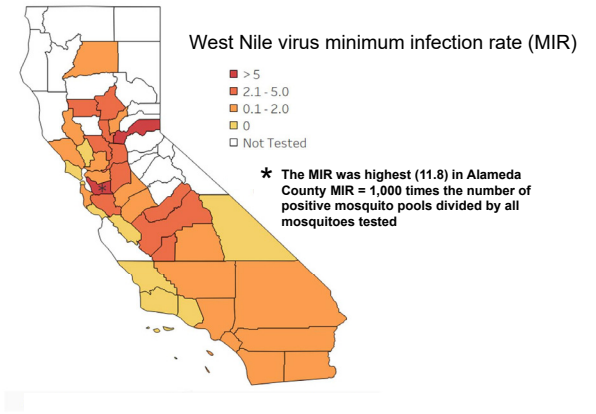


Figure 4.2. West Nile virus minimum infection rate of *Culex* spp. mosquitoes, by county, California, 2018

Mosquito surveillance

In 2018, a total of 1,220,033 mosquitoes (43,874 pools) collected in 38 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 RNA (Table 4.3).

West Nile virus was detected in 1,963 mosquito pools from 29 counties, and St. Louis encephalitis virus was detected in 387 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 1.6; the MIR was highest (11.8) in Alameda 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). West Nile virus was identified from five *Culex* species (*Cx. erythrothorax*, *Cx. pipiens*, *Cx. quinquefasciatus*, *Cx. stigmatosoma*, and *Cx. tarsalis*) (Table 4.4). St. Louis encephalitis virus was identified from five *Culex* species (*Cx. erythrothorax*, *Cx. pipiens*, *Cx. quinquefasciatus*, *Cx. stigmatosoma*, and *Cx. tarsalis*). In 2018, the first detection of WNV in mosquitoes was from a *Cx. quinquefasciatus* pool collected in San Bernardino County on April 25. The last detection of WNV in mosquitoes was from a *Cx. quinquefasciatus* pool collected in Los Angeles County on November 20.

Table 4.3. West Nile virus (WNV) positive mosquito pools and minimum infection rate, by county, California, 2018

County	No. mosquitoes tested[a]	No. mosquito pools tested	WNV positive pools[a]	WNV Minimum Infection Rate[b]
Alameda	1,267	147	15	11.8
Alpine	0			
Amador	0			
Butte	18,927	405	48	2.5
Calaveras	0			
Colusa	0			
Contra Costa	23,142	689	17	0.7
Del Norte	0			
El Dorado	0			
Fresno	49,441	1,731	119	2.4
Glenn	1,549	36	4	2.6
Humboldt	0			
Imperial	1,659	58	1	0.6
Inyo	443	11	0	0.0
Kern	31,475	764	48	1.5
Kings	8,648	292	22	2.5
Lake	11,610	575	4	0.3
Lassen	0			
Los Angeles	122,328	3,390	75	0.6
Madera	16,589	398	55	3.3
Marin	2,977	143	0	0.0
Mariposa	0			
Mendocino	0			
Merced	12,679	539	12	0.9
Modoc	0			
Mono	0			
Monterey	0			
Napa	2,295	129	0	0.0
Nevada	0			
Orange	125,173	4,586	96	0.8
Placer	42,823	2,484	230	5.4
Plumas	0			
Riverside	166,498	4,969	36	0.2
Sacramento	94,701	4,994	300	3.2
San Benito	242	33	0	0.0
San Bernardino	49,507	2,712	12	0.2
San Diego	8,858	1,081	3	0.3
San Francisco	410	14	0	0.0
San Joaquin	121,092	3,422	533	4.4
San Luis Obispo	1,601	39	0	0.0
San Mateo	1,296	131	2	1.5
Santa Barbara	1,969	57	0	0.0
Santa Clara	1,938	195	5	2.6
Santa Cruz	3,084	231	0	0.0
Shasta	18,906	700	8	0.4
Sierra	0			
Siskiyou	0			
Solano	12,162	378	3	0.2
Sonoma	13,232	506	1	0.1
Stanislaus	76,761	1,900	111	1.4
Sutter	7,370	202	28	3.8
Tehama	0			
Trinity	0			
Tulare	118,600	3,888	77	0.6
Tuolumne	0			
Ventura	2,079	46	0	0.0
Yolo	40,903	1,839	90	2.2
Yuba	5,799	160	8	1.4
Total	**1,220,033**	**43,874**	**1,963**	**1.6**

[a] Tested by Davis Arboviral Research 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, 2018

Mosquito Species	No. Pools Tested	No. Mosquitoes	WNV +	Minimum Infection Rate[a]
***Culex* species**				
Cx. erythrothorax	1,281	44,477	3	0.1
Cx. pipiens	8,636	194,798	485	2.5
Cx. quinquefasciatus	16,949	496,372	419	0.8
Cx. stigmatosoma	956	11,552	9	0.8
Cx. tarsalis	14,975	463,707	1,047	2.3
Cx. thriambus	115	300	0	0.0
Culex species	33	255	0	0.0
All *Culex*	**42,945**	**1,211,461**	**1,963**	**1.6**
***Anopheles* species**				
An. franciscanus	8	32	0	0.0
An. freeborni	6	71	0	0.0
An. hermsi	19	170	0	0.0
All *Anopheles*	**33**	**273**	**0**	**0.0**
***Aedes* species**				
Ae. aegypti	491	2,631	0	0.0
Ae. albopictus	1	11	0	0.0
Ae. bicristatus	1	6	0	0.0
Ae. melanimon	2	2	0	0.0
Ae. notoscriptus	1	1	0	0.0
Ae. sierrensis	3	31	0	0.0
Ae. squamiger	6	64	0	0.0
Ae. taeniorhynchus	1	1	0	0.0
Ae. vexans	17	465	0	0.0
Ae. washinoi	18	701	0	0.0
All *Aedes*	**541**	**3,913**	**0**	**0.0**
Other species				
Culiseta incidens	264	3,111	0	0.0
Culiseta inornata	64	389	0	0.0
Culiseta particeps	18	669	0	0.0
Psorophora columbiae	1	6	0	0.0
Unknown	8	211	0	0.0
All other	**355**	**4,386**	**0**	**0.0**

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

The first detection of SLEV in mosquitoes was from a *Cx. quinquefasciatus* pool collected in Tulare County on June 5. The last detection of SLEV in mosquitoes was from a *Cx. tarsalis* pool collected in Riverside County on October 10.

Animal surveillance

Chicken serosurveillance

In 2018, 27 local mosquito and vector control agencies in 25 counties maintained 110 sentinel chicken flocks (Table 4.6). Blood samples were collected from chickens every other week and tested for antibodies to SLEV, WNV, and WEEV by an EIA at the CDPH Vector-Borne Disease Section (CDPH-VBDS) laboratory. Positive samples were confirmed at the CDPH-VBDS laboratory by IFA or western blot. Samples with inconclusive results were tested by PRNT at the CDPH-VRDL.

Of 10,124 chicken blood samples tested, 163 seroconversions to WNV were detected among 43 flocks in 16 counties (Tables 4.6, 4.8). Statewide, 20% 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 2018, the first WNV seroconversions were detected in Contra Costa County on July 2, and the last WNV seroconversions were detected on November 13 in Los Angeles County. In addition, one SLEV seroconversion was detected among one flock in Merced County on August 17 (Table 4.5).

Dead bird surveillance for West Nile virus

In 2018, the WNV hotline and website received 8,216 dead bird reports from the public in 53 counties (Table 4.7). Oral swabs from dead bird carcasses were tested either at the DART laboratory or at one of 12 local agencies by RT-qPCR. Of the 2,286 carcasses deemed suitable for testing, WNV was detected in 501 (22%) carcasses from 21

Table 4.5. Infections with St. Louis encephalitis virus in humans, mosquito pools, and sentinel chickens, by county, California, 2018

County	Humans	Mosquito Pools[1]	Sentinel Chickens
Fresno	1	56	NT
Imperial	0	3	NT
Kern	1	65	NT
Kings	0	30	NT
Los Angeles	2	1	0
Madera	0	14	NT
Merced	0	0	1
Riverside	0	56	NT
Stanislaus	1	0	NT
Tulare	0	162	NT
State Totals	**5**	**387**	**1**

NT= no samples tested

[1]Positive mosquito pools included *Cx. quinquefasciatus* (263 pools), *Culex tarsalis* (102 pools), *Cx. pipiens* (15 pools), *Cx. stigmatosoma* (6 pools), and *Cx. erythrothorax* (1 pool)

Table 4.6. Results of testing sentinel chickens for West Nile virus (WNV), by county, California, 2018

County	No. flocks	No. chickens[a]	No. WNV positive flocks	WNV positive sera
Alameda	2	10	0	0
Alpine	0			
Amador	0			
Butte	7	44	7	37
Calaveras	1	10	0	0
Colusa	1	10	1	6
Contra Costa	5	50	3	16
Del Norte	0			
El Dorado	0			
Fresno	0			
Glenn	1	10	0	0
Humboldt	0			
Imperial	0			
Inyo	0			
Kern	0			
Kings	0			
Lake	2	12	1	1
Lassen	0			
Los Angeles	28	206	6	30
Madera	0			
Marin	0			
Mariposa	0			
Mendocino	0			
Merced	8	48	5	16
Modoc	0			
Mono	0			
Monterey	0			
Napa	1	11	0	0
Nevada	4	24	0	0
Orange	0			
Placer	2	12	1	4
Plumas	0			
Riverside	0			
Sacramento	2	10	2	5
San Benito	1	10	1	1
San Bernardino	0			
San Diego	0			
San Francisco	0			
San Joaquin	0			
San Luis Obispo	0			
San Mateo	2	14	0	0
Santa Barbara	5	35	0	0
Santa Clara	8	57	3	8
Santa Cruz	2	20	0	0
Shasta	7	51	2	4
Sierra	0			
Siskiyou	0			
Solano	3	36	3	7
Sonoma	0			
Stanislaus	0			
Sutter	5	35	4	20
Tehama	3	30	1	1
Trinity	0			
Tulare	0			
Tuolumne	0			
Ventura	5	51	0	0
Yolo	3	24	2	5
Yuba	2	14	1	2
Total	**110**	**834**	**43**	**163**

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

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 2018, the first WNV positive dead bird was an American crow reported from Santa Clara County on January 3, and the last WNV positive dead bird was an American crow reported from Orange County on December 19.

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 2018, West Nile virus infection was detected in 11 horses from eight counties (Table 4.8). Six of the horses died or were euthanized as a result of their infection.

Invasive mosquito surveillance

Invasive *Aedes* mosquitoes have been detected in California since 2011 when *Ae. albopictus*, also known as the Asian tiger mosquito, was re-discovered in Los Angeles County. *Aedes aegypti*, also known as the yellow fever mosquito, was later detected in Fresno, Madera, and San Mateo counties in 2013, followed in 2014 by *Ae. notoscriptus*, native to Australia, in Los Angeles County. All three species 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 *Aedes albopictus* can serve as a vector of these arboviruses. In Australia, *Ae. notoscriptus* is an important urban vector of dog

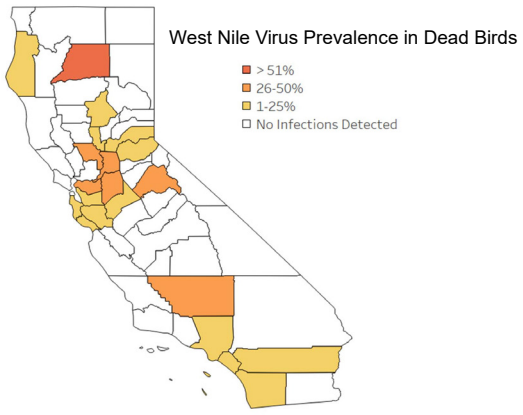


Figure 4.3. Prevalence of West Nile virus infection in dead birds, California, 2018

Table 4.7. Dead birds reported, tested, and positive for West Nile virus, by county, California, 2018

County	Reported	Tested[a]	Positive	(%)
Alameda	344	80	20	(25.0)
Alpine	0			
Amador	16	1	0	(0)
Butte	102	30	4	(13.3)
Calaveras	8	0		
Colusa	7	1	0	(0)
Contra Costa	711	45	13	(28.9)
Del Norte	3	1	0	(0)
El Dorado	94	22	2	(9.1)
Fresno	162	4	0	(0)
Glenn	6	0		
Humboldt	24	5	1	(20.0)
Imperial	1	0		
Inyo	2	0		
Kern	43	3	1	(33.3)
Kings	14	2	0	(0)
Lake	21	7	0	(0)
Lassen	0			
Los Angeles	839	92	19	(20.7)
Madera	13	2	0	(0)
Marin	59	1	0	(0)
Mariposa	0			
Mendocino	10	0		
Merced	55	1	0	(0)
Modoc	0			
Mono	0			
Monterey	34	4	0	(0)
Napa	19	4	0	(0)
Nevada	26	5	0	(0)
Orange	518	389	18	(4.6)
Placer	465	214	44	(20.6)
Plumas	2	0		
Riverside	166	32	6	(18.8)
Sacramento	1,542	554	241	(43.5)
San Benito	9	1	0	(0)
San Bernardino	154	20	0	(0)
San Diego	186	90	1	(1.1)
San Francisco	56	3	0	(0)
San Joaquin	208	42	16	(38.1)
San Luis Obispo	23	6	0	(0)
San Mateo	409	127	5	(3.9)
Santa Barbara	34	6	0	(0)
Santa Clara	700	237	56	(23.6)
Santa Cruz	132	46	2	(4.3)
Shasta	37	9	5	(55.6)
Sierra	1	0		
Siskiyou	1	0		
Solano	134	15	0	(0)
Sonoma	113	13	0	(0)
Stanislaus	151	8	1	(12.5)
Sutter	76	24	4	(16.7)
Tehama	18	4	0	(0)
Trinity	2	0		
Tulare	61	10	0	(0)
Tuolumne	13	2	1	(50.0)
Ventura	97	15	0	(0)
Yolo	253	92	41	(44.6)
Yuba	42	17	0	(0)
Totals	**8,216**	**2,286**	**501**	**(21.9)**

[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, 2018

County	Humans[a]	Horses	Dead Birds	Mosquito Pools	Sentinel Chickens
Alameda	0	0	20	15	0
Alpine	0	0	NT	NT	NT
Amador	1	1	0	NT	NT
Butte	18	0	4	48	37
Calaveras	0	0	NT	NT	0
Colusa	0	0	0	NT	6
Contra Costa	5	0	13	17	16
Del Norte	0	0	0	NT	NT
El Dorado	0	0	2	NT	NT
Fresno	15	0	0	119	NT
Glenn	2	0	NT	4	0
Humboldt	1	0	1	NT	NT
Imperial	0	0	NT	1	NT
Inyo	0	0	NT	0	NT
Kern	14	1	1	48	NT
Kings	0	0	0	22	NT
Lake	1	0	0	4	1
Lassen	0	0	NT	NT	NT
Los Angeles	47	0	19	75	30
Madera	4	0	0	55	NT
Marin	0	0	0	0	NT
Mariposa	0	0	NT	NT	NT
Mendocino	0	0	NT	NT	NT
Merced	2	2	0	12	16
Modoc	0	0	NT	NT	NT
Mono	0	0	NT	NT	NT
Monterey	1	0	0	NT	NT
Napa	1	0	0	0	0
Nevada	1	0	0	NT	0
Orange	12	0	18	96	NT
Placer	9	1	44	230	4
Plumas	0	0	NT	NT	NT
Riverside	16	0	6	36	NT
Sacramento	17	3	241	300	5
San Benito	0	0	0	0	1
San Bernardino	10	0	0	12	NT
San Diego	2	0	1	3	NT
San Francisco	0	0	0	0	NT
San Joaquin	15	1	16	533	NT
San Luis Obispo	0	0	0	0	NT
San Mateo	0	0	5	2	0
Santa Barbara	0	0	0	0	0
Santa Clara	1	0	56	5	8
Santa Cruz	0	0	2	0	0
Shasta	1	1	5	8	4
Sierra	0	0	NT	NT	NT
Siskiyou	0	0	NT	NT	NT
Solano	0	0	0	3	7
Sonoma	0	0	0	1	NT
Stanislaus	18	1	1	111	NT
Sutter	1	0	4	28	20
Tehama	3	0	0	NT	1
Trinity	0	0	NT	NT	NT
Tulare	8	0	0	77	NT
Tuolumne	1	0	1	NT	NT
Ventura	2	0	0	0	0
Yolo	12	0	41	90	5
Yuba	2	0	0	8	2
State Totals	**243**	**11**	**501**	**1,963**	**163**

[a]Includes asymptomatic infections detected through blood bank screening

NT= no samples tested

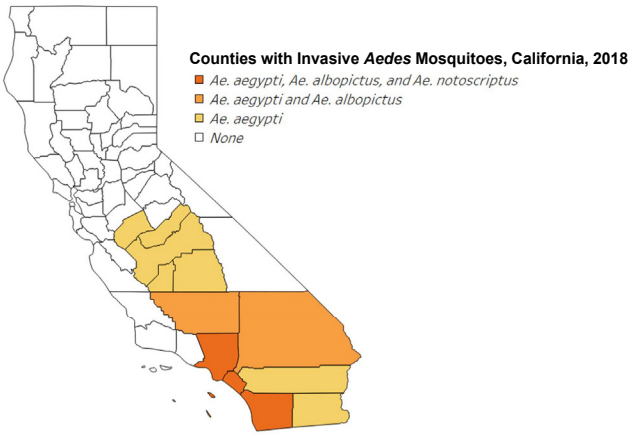


Figure 4.4. Invasive *Aedes* mosquito detections, by county, California, 2018

heartworm and has been found infected with Ross River and Barmah Forest viruses.

Since 2011, local vector control agencies have detected *Ae. aegypti* and *Ae. albopictus* mosquitoes in 247 cities or census-designated places (CDP) in 14 counties; populations of *Ae. aegypti* and *Ae. albopictus* are considered established in 12 and 5 counties, respectively (Figure 4.4). In 2018, *Ae. aegypti* and *Ae. albopictus* were discovered in 58 and 3 new cities and CDPs, respectively. *Aedes notoscriptus* continued to spread in Los Angeles and Orange counties, and was discovered in San Diego County for the first time, with detections in a total of 32 cities. Local vector control agencies with invasive *Aedes* have incorporated *Aedes*-specific traps, such as ovicups, Biogents sentinel traps, and autocidal gravid ovitraps, into surveillance programs. Agencies responded to travel-associated human cases of *Aedes*-borne arboviruses, such as Zika, to minimize the potential for local transmission in areas with established populations of *Ae. aegypti* or *Ae. albopictus*. Education and outreach programs have been intensified with emphasis on the public's role in helping minimize invasive *Aedes* habitat on private property and personal protection measures against mosquito bites. In 2018, a total of 2,631 *Ae. aegypti* and 11 *Ae. albopictus* tested negative for dengue, chikungunya, Zika, and WNV (Table 4.4).

VBDS performs molecular and microplate pesticide resistance testing on *Ae. aegypti* mosquitoes. Molecular assays detect genetic mutations that may confer resistance to pyrethroids and pyrethrins while microplate assays measure enzyme activity and target-site insensitivity associated with resistance to pyrethroids and organophophates. In 2018, over 4,100 *Ae. aegypti* from 11 counties were submitted by local vector control agencies to VBDS for resistance testing. Molecular resistance profiles of *Ae. aegypti* from the Central Valley showed nearly 100% resistant genes, whereas samples from southern California had combinations of both resistant and susceptible genes. Microplate assays indicated 20-56% of submitted *Ae. aegypti* had elevated enzyme activity and/or target-site insensitivity both in the Central Valley and southern California. Local vector control agencies may use these findings to assist with adulticide selection in situations requiring rapid knock-down of adult *Ae. aegypti*.

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) cost-share agreement include:

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

This report briefly reviews activities carried out under the agreement by the California Department of Public Health, Vector-Borne Disease Section (CDPH-VBDS) and local collaborators in 2018. 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.

2018 U.S. Forest Service Highlights

- VBDS biologists conducted 17 facility evaluations for hantavirus risk in 2018, up from 11 in the previous year (Table 5.1).
- Rodent trapping showed the highest hantavirus seroprevalence, 26 (17%) of 151 deer mice from USFS lands, since 2009 (Table 5.3).
- Tick collection and testing occurred on a majority of the forests in the Region (12 of 18). Five Forests showed evidence of tick-borne disease pathogens (Table 5.3).
- Only 3 (18%) of 17 Forests where plague surveillance and testing occurred showed evidence of plague activity, down from 7 R5 Forests with plague activity in 2017 (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 CDPH-VBDS Cost-Share Agreement, 2018

National Forest	Disease Risks Addressed	Facility Evaluation	Presentation Audiences	Forest Locations Visited[a]
Angeles/ San Gabriel Mountain National Monument	Hantavirus; Plague; Tick-borne diseases	Oak Flat Fire Station		Chantry Flat Recreation Area and Roberts Camp Cabins; Gabrileno, Manzanita, South Fork and Sturtevent Falls trails; Los Alamos, Oak Flat and Table Mountain campgrounds
Cleveland	Hantavirus; Plague; Tick-borne diseases	El Cariso Hot Shot Compound, and Dripping Springs, Lake Henshaw, Oak Grove, and San Juan Fire Stations		Blue Jay Campground; Black Canyon Campground, Holy Jim Canyon, Inaja Memorial Picnic Area, San Juan, Santa Ysabel Truck, and Secret Canyon trails
Eldorado	Hantavirus; Plague; Tick-borne diseases	Leek Springs Fire Lookout, Lumberyard Fire Station		Gerogetown, Pacific, and Placerville ranger stations; Black Oak Group, Dru Barner, Ponderosa Cove Group, and Stumpy Meadows campgrounds, Stumpy Meadows Picnic Area; Fleming Meadow Trail, and FS Road 11N65
Inyo	Hantavirus; Plague; Tick-borne diseases		Bishop All-Employee Appreciation Day and Safety Meeting	Supervisor's Office, Mt. Whitney Ranger District and the Eastern Sierra Visitor Center; Aspen, Big Bend, Coldwater, Ellery Lake, Four Jeffrey, Gull Lake, Junction, June Lake, Lake George, Minaret Falls, Oh! Ridge, Pumice Flat, Red's Meadow, Reversed Creek, Saddlebag Lake, Silver Lake,Tioga Lake and Twin Lakes, Upper Soda Springs campgrounds, Woods Lodge; Tamarack Lodge, Olancha Pass Trailhead
Klamath	Hantavirus; Plague			Ball Mountain Lookout and Juanita Lake Campgroun
Lake Tahoe Basin Management Unit	Hantavirus; Plague; Tick-borne diseases		California Land Management (concessionaire)	LTBMU Supervisors Office; Tallac Historical Site, Taylor Creek Visitor Center, Fallen Leaf, Kaspian and William Kent campgrounds
Lassen	Hantavirus; Plague			Hat Creek Guard Station and Group Camp
Los Padres	Hantavirus; Plague; Tick-borne diseases			Mt. Pinos and Ojai, Santa Barbara Ranger District Offices; Cerro Alto, Figueroa, Freemont, Los Prietos, Paradise, Sage Hill Group, Upper Oso, and Wheeler Gorge campgrounds; Falls, First Crossing, Live Oak, Lower Oso, and White Rock day use areas; Cerro Alto, Chorro Grande, Potrero John, Rinconada and Red Rock trails
Mendocino	Plague;Tick-borne diseases			(see Table 5.3)
Modoc	Hantvirus	Long Bell Guard Station		
Plumas	Hantavirus; Plague; Tick-borne diseases	Crocker Guard Station; Laufman Ranger Station, and Swiss Cabin		Black Mountain Fire Lookout and Frenchman Work Station; Hutchins Group, Laufman, Mill Creek, Sly Creek and Sundew campgrounds; Big Cove, Chilcoot, Cottonwod, Cottonwood Springs Group, Frenchman, Haven Lake, Gold Lake, Goose Lake, Grasshopper Flat, Grizzly, Lakes Basin, Lightning Tree, Mallard Cove, Spring Creek, and Snag Lake campgrounds
San Bernardino	Plague; Tick-borne diseases		Forest Leadership at the Lytle Creek Community Center	Boulder Basin and Dark Canyon campgrounds; Kenworthy Ranger Station and Lake Hemet, Middle Fork Lytle Creek, South Fork and Pacific Crest trails; Penstock Road, San Sevaine Road
Sequoia	Hantavirus; Plague; Tick-borne diseases		Kern River Ranger District, Redwood Meadow Campground Concession staff	Headquarters, Long Meadow Group, Redwood Meadow, and Tillie Creek campgrounds and recreation sites along the Kern River; Johnsondale Work Center, Cedar Creek Campground, South Fork Wildlife Area, Upper and Lower Rincon, and Whiskey Flat trails
Shasta-Trinity	Plague; Tick-borne disease			Hirz Bay Campground
Sierra	Plague; Tick-borne diseases			Indian Flat Day Use Area
Six Rivers	Hantavirus; Plague	Gasquet Ranger District and Brush Mountain Fire Lookout		
Stanislaus	Hantavirus; Plague	Alpine Ranger Station, Dorrington Fire Station	Calveras Ranger District, Camp Wolfboro	Forest Headquarters; Summit Ranger District Headquarters, Strawberry Barracks, Lodgepole Campground, and Marmot Picnic Area; New Spicer Reservoir, Rocky Point, Sandy Flat, Stanislaus River, Union Reservoir (East and West), Baker, Boulder Flat, Brightman Flat, Camp Liahona Alp, Camp Jack Hazard, Cascade Creek, Clark Fork, Clark Fork Horse Camp, Dardanelles, Deadman, Eagle Meadow, Eureka Valley, Meadowview, Mill Creek, Niagara Creek, Peaceful Pines, Pigeon Flat, Pinecrest, Pioneer Trail Group, and Sand Flat Alp campgrounds, Columns of the Giants, Crabtree, Disaster Creek, Gianelli, Kennedy Meadows, Niagara Rim 4x4, Saint Mary's Pass, Sonora Pass, and Spicer Meadowtrailheads; Cottonwood and Douglas picnic areas and trailhead
Tahoe	Hantavirus; Plague; Tick-borne diseases	Hobart Work Station	Sierraville, Truckee, and Yuba River Ranger Districts	Goose Meadows, Granite Flat, Grouse Ridge, Logger, and Silver Creek campgrounds, Grouse Ridge Lookout; Ahart, Aspen, Berger Creek, Big Bend Group, Black Bear Group, Bowman Lake, Bullard's Bar Reservoir, Carr-Feeley Lake, Cold Creek, Coyote Group, Dark Day, Diablo, East Meadow, Findley, Fir Top, French Meadows, Gates Group (all sites), Hampshire Rocks, Horse Camp, Indian Springs, Jackson Creek, Lindsey Lake, Lakeside, Lewis, Little Lasier Meadows, Lower and Upper Little Truckee, Pack Saddle, Pass Creek, Prosser, and Prosser Ranch Group, Rucker Lake, Salmon Creek, Sardine Lake, Schoolhouse, Skillman Horse, Silver Tip Group, White Cloud and Woodcamp campgrounds, Emerald Pools and Hobart Mills trailheads, Big Trees, Fuller Lake, McGuire and Packer Lake picnic areas, Prosser Hill OHV area, and Sagehen Creek Trail

[a] Locations visited by VBDS biologists and not already listed under facility evaluation.

Table 5.2: Unique services and findings, performed by the California Department of Public Health under the United States Forest Service Activities (Region 5), CDPH-VBDS Cost-Share Agreement, 2018

National Forest	Unique Services/ Unusual Findings
Angeles / San Gabriel Mountain National Monument	Selected Chantry Flat Recreation Area as a long-term tick surveillance site for Southern California.
Cleveland	Conducted numerous hantavirus facility evaluations across the Forest. Detected *Borrelia burgdorferi* and *Rickettsii philipii* in ticks collected from Holy Jim Canyon.
Eldorado	Tick testing detected *Borrelia miyamotoi*, an emerging pathogen, from Flaming Meadow as well as *Borrelia burgdorferi* sensu lato from western blacklegged (*Ixodes pacificus)* adult and nymphal ticks collected from Forest Service road 11N65.
Inyo	Advised Forest Leadership of media interest in hantavirus pulmonary syndrome (HPS) case from Bodie State Historic Park and higher than usual (>35%) Sin Nombre virus (SNV) seroprevalence found in deer mice (*Peromyscus maniculatus*) in Mono County. Leadership was advised to remind USFS personnel of elevated hantavirus risk. Ensured campground concessionaires in the Mammoth Lakes area were aware of active plague at Lake George Campground as well as steps to mitigate personal risk and risk to campers in the area.
Lake Tahoe Basin Management Unit	Conducted follow-up plague surveillance at Fallen Leaf campground including flea pool testing to ensure no active plague was circulating in the rodent and flea populations.
Los Padres	Upon request, and in response to an OSHA report received by the Santa Barbara Ranger District, provided general rodent exclusion information, hantavirus risk reduction measures, and contact information for the California State Parks Safety Officer who has experience with similar OSHA reports.
Modoc	Conducted hantavirus surveillance and facility evaluation at Long Bell Guard Station. One (20%) of five *P. maniculatus* was positive for antibodies to SNV, causative agent for HPS. A report of findings was submitted to the District Ranger, Forest Safety Officer, and concerned parties at R5.
Plumas	VBDS biologists conducted plague and hantavirus surveillance at Mill Creek Campground. Three (20%) of 15 rodents, and 1 (33%) of 3 deer mice were positive for *Yersinia pestis* (causative agent of plague) and SNV, respectively. All fleas (23 pools) tested negative for *Y. pestis* bacteria. Test results were communicated to the District leadership.
San Bernardino	Adult tick surveillance along San Sevaine Road provided the first evidence of *Borrelia burgdorferi* sensu lato infection in western blacklegged ticks in the Transverse Range. Forest leadership attended a presentation on the vector-borne diseases likely found on the Forest and methods for staff to reduce risk of exposure.
Sequoia	Biologists conducting adult tick surveillance on the Kern River Ranger District: collected 541 *Ixodes* spp. and *Dermacentor* spp. ticks.
Sierra	A ground squirrel carcass submitted for pathogen testing was negative for *Y. pestis* and *Franciscella tularensis* (tularemia).
Six Rivers	Despite an overall elevated SNV seroprevalence from Forests around the State (15% vs. 9.5% long-term), 16 deer mice tested from two locations on the Six Rivers were all negative for evidence of exposure to SNV.
Stanislaus	Sin Nombre virus surveillance at locations on the Forest found nearly twice the seroprevalence (17%) as the long-term state average (9.5%).
Tahoe	Three western blacklegged ticks from Dark Day Campground Trail, tested positive for *B. burgdorferi* sensu lato.
R5 (District Level)	Held annual meeting with Region 5 leadership. Collaborated with the Region to standardize the CDPH/VBDS web link across all R5 Forests. Consulted with the R5 liaison regarding best method of distribution for Rodent Carcass Collection magnets and postcards. Updated spatial maps of hantavirus, plague, and tick surveillance on USFS lands. Provided pre-season letter for distribution throughout Region 5. Submitted pesticide use report on USFS lands. Provided hantavirus facility risk assessment reports.

Table 5.3. Testing results for selected vector-borne disease agents in U.S. National Forests, California, 2018

National Forest	Hantavirus		*Yersinia pestis*						Tularemia		*Borrelia* spp.[c]		*Rickettsia* spp.[d]	
	Peromyscus[a] mice		Rodents		Flea Pools		Carnivores[b]		Rodents		*Ixodes* ticks		*Dermacentor* ticks	
	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested
Angeles	0	9	0	36			0	1	0	1	0	63		
Cleveland	0	39	0	26							1	185	7	104
Eldorado	5	26	0	12			0	2			7	79		
Inyo			5	107	1	9					0	1		
Klamath	2	6	0	23			1	29						
Lake Tahoe BMU			2	32	0	20			0	2				
Lassen	0	1					0	4						
Los Padres	0	3	0	55			0	18			0	129	6	55
Mendocino							0	3			0	17	0	3
Modoc	1	4												
Plumas	5	11	3	57	0	23	0	8			0	2		
San Bernardino			0	12							1	102	15	115
Sequoia			0	22	0	1	0	2			0	30	0	10
Shasta-Trinity							0	1			0	152		
Sierra			0	1			2	15	0	1	0	38	0	2
Six Rivers	0	17	0	9										
Stanislaus	4	22	0	12			0	3						
Tahoe	9	33	0	74			0	2	0	1	3	130		
Total, all forests	**26**	**171**	**10**	**478**	**1**	**53**	**3**	**88**	**0**	**5**	**12**	**928**	**28**	**289**

[a] Deer mice (*Peromyscus maniculatus)* are the prinicipal reservoir for hantavirus. Other species of *Peromyscus* tested because they may be reservoir competent in certain circumstances

[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] Tests for *Borrelia burgdorferi,* causative agent for Lyme disease, and *Borrelia miyamotoi,* a recently recognized infectious agent for relapsing fever.

[d] Tests for spotted fever group Rickettsea including *Rickettsia philipii*, causative agent for Pacific Coast tick fever, and *R. rickettsii,* causative agent for Rocky Mountain spotted fever

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 149 continuing education events in 2018. 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 2018, 1,199 Vector Control Technicians employed at 106 local public health agencies and CDPH held 2,867 certificates (Table 6.2). The agencies included special districts, departments of county government, departments of city government, the University of California, and CDPH. Of these agencies, 75 were signatory to a cooperative agreement with CDPH in 2018.

In 2018, 909 individuals employed at 75 agencies held full certification status. In addition, 277 employees from 53 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 website dedicated to the Vector Control Technician 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 2018

Exam section	No. Exams Given	No. Passed (%)
Core	188	137 (73)
Mosquito Control	201	125 (62)
Terrestrial Invertebrate Control	134	72 (54)
Vertebrate Vector Control	103	75 (73)
Totals	**626**	**409 (65)**

Table 6.2. Vector Control Technician certificates in effect as of December 2018

	No. Certificates		
Certification Category	Full Status	Limited Status	Total
Mosquito Control	911	195	1,106
Terrestrial Invertebrate Vector Control	703	151	854
Vertebrate Vector Control	716	191	907
Totals	**2,330**	**537**	**2,867**

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 education materials in 2018

Vector-borne disease

- *Don't Give Bugs a Biting Chance* repellent toolkit (digital resources include: fact sheet for parents, resource card, web advertisements, and multiple information webpages)
- *Hantavirus Prevention* card and magnet
- *Rodent Carcass Collection for Plague Testing* card and magnet

Mosquito-borne disease

- *Don't Bring Zika Home* fact cards and bookmarks (English/Spanish)[1,2]
- *Provider Tools and Resources for Zika* (flier)[1]
- *West Nile Virus: What You Need to Know* brochure (English/Spanish)
- *Zika + Men* toolkit (English/Spanish, poster and discussion points)[1]
- *Zika 101* presentation and webpages (English/Spanish)[1]

[1]Co-created with the CDPH Maternal, Child, and Adolescent Health (MCAH) Program
[2]Designed by KP Public Affairs and Honey Agency under contract with the Zika Communications Team (including MCAH and VBDS members)

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