Vector-Borne Disease Section

Annual Report

2020

California Department of PublicHealth

2020

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 the 2020 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 2020. Staff successfully adapted programs and procedures to address the challenges posed by the COVID-19 pandemic.

In 2020, West Nile virus (WNV) activity was similar to 2019, with 235 human cases reported from 26 counties; there were 11 fatalities. West Nile virus continues to pose the greatest vector-borne disease threat in California, with over 7,200 cases (320 fatal) reported since 2003. In addition to WNV activity, St. Louis encephalitis virus (SLEV) activity was detected in mosquitoes in nine counties and there were six human cases, including one fatality.

The number of travel-associated human cases of dengue (83), chikungunya (5), and Zika (5) declined in California in 2020 relative to prior years, likely reflecting the reduction in international travel due to the COVID-19 pandemic. The *Aedes* mosquito vectors of dengue, Zika, and chikungunya continued to expand their range in California in 2020. *Aedes aegypti* (yellow fever mosquito) infestations were found in six additional counties, with detections expanding from 277 cities/census designated places in 2019 to 311 in 2020. *Aedes albopictus* (Asian tiger mosquito) was detected for the first time in Shasta County in northern California. With the establishment of these vector species in 22 counties, there is the ongoing threat of local virus transmission in some regions of the state.

One human case of plague was detected in 2020 in a resident of South Lake Tahoe. VBDS conducted extensive follow-up surveillance to evaluate and mitigate risk of further plague transmission. Overall, there was evidence of plague activity in 6 of the 27 counties where surveillance was conducted. In 2020, two cases of hantavirus infection were reported from Plumas and Santa Barbara counties; both were non-fatal. Over 9% of deer mice tested from 11 counties were seropositive to Sin Nombre virus, the causative agent of hantavirus infection in the United States. In 2020, 109 flea-borne typhus cases were reported from endemic areas of southern California; 95% of these cases required hospitalization. VBDS staff investigated an unusual case of louse-borne typhus caused by *Rickettsia prowazekii* detected in a resident with probable exposure in Placer County.

Human cases of four tick-borne diseases were reported in California in 2020. Reports of Lyme disease (63) decreased relative to prior years, perhaps reflecting the decline in travel to highly endemic regions of the U.S. due to the COVID-19 pandemic; typically about one third of the reported Lyme disease cases in California are travel-associated. Seven cases of anaplasmosis were reported; all case-patients had likely exposure in California's north coastal counties.

In 2020, VBDS expanded public education through social media, digital and print materials, and developed 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 2020 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 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 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; MVMD of Santa Barbara County; NPS; Nevada County Environmental Health; Orange County MVCD; Placer MVCD; Sacramento-Yolo MVCD; San Bernardino County VCP; San Diego VCP; San Mateo County MVCD; Santa Clara County VCD; Santa Cruz County Mosquito Abatement/Vector Control; 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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Suggested Citations

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California Department of Public Health. Vector-Borne Disease Section Annual Report, 2020. Kjemtrup, AM and Kramer, V. editors. Sacramento, California, 2021. 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, 2020. California Department of Public Health, Sacramento, California, 2021. 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, 2020. California Department of Public Health, Sacramento, California, 2021. pp 4-8.

3 Tick-borne Diseases
Saunders, M and Kjemtrup, A. Chapter 3: Tick-borne Diseases. In: Vector-Borne Disease Section Annual Report, 2020. California Department of Public Health, Sacramento, California, 2021. pp 9-13.

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, 2020. California Department of Public Health, Sacramento, California, 2021. 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, 2020. California Department of Public Health, Sacramento, California, 2021. 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, 2020. California Department of Public Health, Sacramento, California, 2021. pp 26-27.

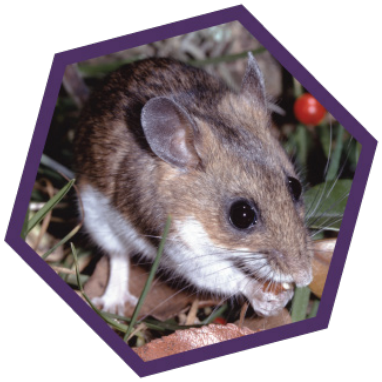
7 Public Information Materials, Publications
Nicolici, A. Chapter 7: Public Information Materials, Publications. In: Vector-Borne Disease Section Annual Report, 2020. California Department of Public Health, Sacramento, California, 2021. pp 28-29.

Program Overview

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

- Develop and implement statewide vector-borne disease prevention, surveillance, and control programs
- Design and conduct scientific investigations to further knowledge of vector-borne diseases in California
- Coordinate preparedness activities for detection and response to introduced vector-borne diseases and vectors, such as West Nile virus disease, Zika, chikungunya, dengue, and invasive *Aedes* mosquitoes
- Provide laboratory testing for vector-borne disease agents in arthropods and vertebrates
- Conduct or coordinate 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 other vector control
- 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 information, training, and educational materials to governmental agencies, the medical community, and the public
- Provide consultation on issues related to the management of ticks, 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 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 general public.

Human disease surveillance

Human cases of hantavirus infection, which includes 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) conducts environmental investigations for human cases, which may include trapping rodents and collaborating with CDPH-VRDL for testing for Sin Nombre virus (SNV), causative agent of hantavirus infection in California, to evaluate exposure circumstances and potential for additional exposure.

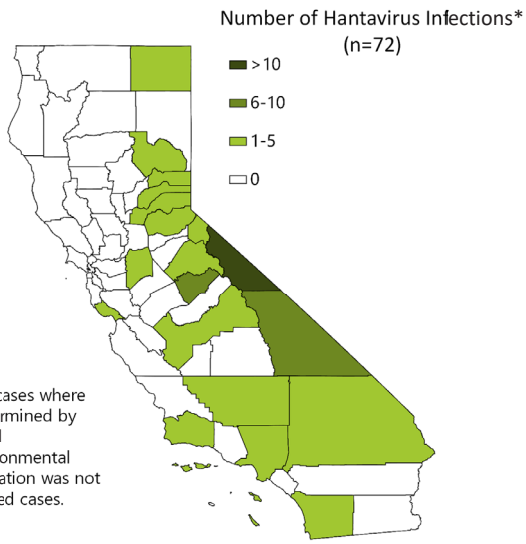
In 2020, two cases of hantavirus infection, non-HPS, were reported to CDPH from Plumas and Santa Barbara counties. Both cases were adult males. Months of illness onset were June and August. Environmental investigation was conducted for the case from Santa Barbara County. Two deer mice (*Peromyscus maniculatus*) collected from the case-patient's residence where exposure likely occurred, tested negative for SNV.

Since 1980, hantavirus infection has been diagnosed in 89 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 2020, 723 rodents (Genera: *Microtus*, *Neotoma*, *Peromyscus*, and *Reithrodontomys*) were tested for antibodies to SNV (Table 1.1). Of 662 *Peromyscus* spp. sampled, 34 (5.1%) were positive for SNV antibodies. Seroprevalence in deer mice, the primary reservoir for SNV, was 9.3% (Tables 1.1 and 1.2). At least one deer mouse was SNV antibody-positive in 5 of 11 counties sampled in 2020 (Table 1.2). SNV antibody has been detected in deer mice from 26 of 42 counties sampled in the last 10 years; prevalence ranged from 2.4% to 35.5% (average 11.7%) over that period (Table 1.2).

Additionally, 9 (20.0%) of 45 western harvest mice (*Reithrodontomys megalotis*) demonstrated reactivity to SNV (Table 1.1). None of 13 woodrats (*Neotoma* spp.) and 3 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 Sin Nombre virus assay. In California, no hantaviruses other than SNV have been shown to be pathogenic to humans.



*Represents only those cases where county of exposure determined by case-patient history, and epidemiologic and environmental evaluation. Exposure location was not obtainable for all reported cases.

Figure 1.1. Likely county of exposure for reported hantavirus infections (1980 – 2020)

Table 1.1 Serologic evidence of hantavirus (Sin Nombre) infection in California rodents, 2011 - 2020

		2020			2011-2020		
Species	Common name	No. tested	No. reactive	Percent	No. tested	No. reactive	Percent
Peromyscus boylii	brush mouse	93	1	1.1	680	5	0.7
Peromyscus californicus	California mouse	111	2	1.8	1,441	19	1.3
Peromyscus crinitus	canyon mouse	0	0		41	2	4.9
Peromyscus eremicus	cactus mouse	98	2	2.0	1,208	37	3.1
Peromyscus fraterculus	northern Baja mouse	0	0		1,435	13	0.9
Peromyscus maniculatus	deer mouse	311	29	9.3	4,866	568	11.7
Peromyscus truei	piñon mouse	36	0	0.0	416	3	0.7
Peromyscus spp.	unspeciated *Peromyscus*	13	0	0.0	15	0	0.0
Peromyscus spp. subtotal		662	34	5.1	10,102	647	6.4
Reithrodontomys megalotis	western harvest mouse	45	9	20.0	947	108	11.4
Neotoma spp.	woodrats	13	0	0.0	279	1	0.4
Microtus spp.	voles	3	0	0.0	151	26	17.2

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 vector-borne diseases through increased health education, vector surveillance, and public health research. CDPH-VBDS worked with YOSE and HH staff in 2020 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 2020, deer mouse surveillance was conducted in three areas of YOSE. In the Tuolumne Meadows area, 11 (39.3%) of 28 deer mice captured tested positive for SNV antibodies. This is the highest SNV seroprevalence recorded from CDPH deer mouse sampling in Tuolumne Meadows. In Yosemite Valley and Wawona, 14 deer mice tested negative for SNV antibodies. In addition to deer mouse trapping, a total of 30 buildings were evaluated for rodent activity and potential rodent-borne disease risks. HH staff provided hantavirus prevention recommendations to YOSE and its associated partners based on surveillance results and facility evaluations.

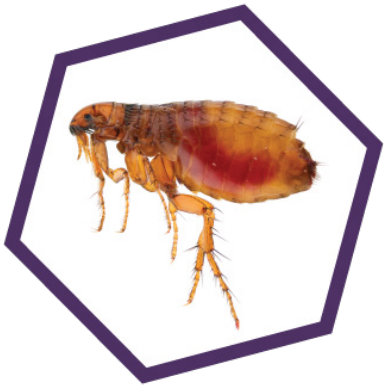
Lassen Volcanic National Park (LAVO) initiated a task agreement in 2020 for services that included hantavirus risk reduction, including facility evaluations and deer mouse surveillance, to estimate rodent abundance and SNV prevalence. In 2020, deer mouse surveillance was conducted in two areas of LAVO. At the Juniper Lake Ranger Station, one (25.0%) of four deer mice tested positive for SNV antibodies, while seven deer mice captured at LAVO Headquarters in Mineral tested negative. In addition, 12 buildings in LAVO were evaluated for rodent activity and vector-borne disease risks. HH staff provided hantavirus prevention recommendations to LAVO based on surveillance results and facility evaluations.

Table 1.2. Serologic evidence of hantavirus (Sin Nombre) infection in *Peromyscus maniculatus* in California, 2011-2020

	2020			2011-2020		
County	No. tested	No. reactive	Percent	No. tested	No. reactive	Percent
Alameda	11	0	0.0	78	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	36	8	22.2	230	49	21.3
Fresno				8	0	0.0
Glenn				10	1	10.0
Humboldt				26	0	0.0
Inyo				26	7	26.9
Kern				42	1	2.4
Lassen	4	1	25.0	42	10	23.8
Los Angeles				26	0	0.0
Marin				16	0	0.0
Mariposa	14	0	0.0	318	29	9.1
Modoc				61	10	16.4
Mono	8	0	0.0	403	143	35.5
Napa				22	3	13.6
Nevada				90	15	16.7
Orange				149	10	6.7
Placer				91	4	4.4
Plumas				105	25	23.8
Riverside				328	34	10.4
San Bernardino	10	0	0.0	152	0	0.0
San Diego	185	7	3.8	1,703	78	4.6
San Joaquin				4	0	0.0
San Mateo				174	33	19.0
Santa Barbara	2	0	0.0	12	0	0.0
Santa Clara				2	0	0.0
Santa Cruz				25	5	20.0
Shasta				110	17	15.5
Sierra				33	1	3.0
Siskiyou				73	20	27.4
Sutter				9	0	0.0
Tehama	7	0	0.0	93	18	19.4
Trinity				3	0	0.0
Tulare	3	1	33.3	14	1	7.1
Tuolumne	31	12	38.7	329	50	15.2
Ventura				13	1	7.7
Total	**311**	**29**	**9.3**	**4,866**	**568**	**11.7**

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 (VRDL) performs serology or PCR for samples requiring additional confirmation. A total of 109 cases of typhus fever were reported to CDPH in 2020. All of these were classified as probable cases according to CDPH's working surveillance definition (updated in 2020). One hundred three (95%) of the case-patients required hospitalization. Case-patients were residents of Los Angeles (90), Orange (13), San Bernardino (3), Riverside (1), San Diego (1), and Santa Barbara (1) counties. Flea-borne typhus is considered endemic in parts of Orange and Los Angeles counties.

An unusual case of louse-borne typhus, caused by *Rickettsia prowazekii*, was reported to CDPH in December 2020. Initially reported with positive *R. typhi* serology, the causative agent (*R. prowazekii*) was confirmed via PCR by the U.S. Centers for Disease Control and Prevention (CDC), Rickettsial Zoonoses Branch. In the United States, the vertebrate reservoir for *R. prowazekii* is the flying squirrel (*Glaucomys* sp.), and the disease is suspected to be transmitted though transdermal contact or inhalation of infected louse feces associated with flying squirrels and their nests. The case-patient was a resident of Contra Costa County, with likely exposure in a Placer County cabin. Environmental follow up is planned.

Plague

Human cases of plague are reportable to CDPH by local health jurisdictions. Presumptive positive test results for reported cases are confirmed by either the CDPH Microbial Diseases Laboratory (CDPH-MDL) or the CDC. 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 presence of *Yersinia pestis* bacteria, the causative agent of plague, or for presence of antibodies against *Y. pestis* in rodent blood samples, providing evidence of *Y. pestis* transmission in local rodent populations. Recreational area closures for flea control may be initiated depending on surveillance results and the estimated plague transmission risks.

One human case of plague was reported to CDPH in August 2020. The case-patient was a resident of South Lake Tahoe (El Dorado County) who was hospitalized and survived. No travel outside the Lake Tahoe Basin was noted, but the case-patient reported visiting several local recreational areas. CDPH Vector-Borne Disease Section (CDPH-VBDS) and the El Dorado County Vector Control District evaluated all potential exposure sites and conducted flea and rodent surveillance at the case-patient's residence and two of the recreational areas visited (Tallac Point and Hartoonian Trails, U.S. Forest Service Lake Tahoe Basin Management Unit). At Tallac Point, no rodents tested positive for *Y. pestis* antibodies. Of 265 total fleas collected and tested in 68 pools, five pools (1.9% minimum infection prevalence) tested positive for *Y. pestis* bacteria. (Minimum infection prevalence = number of positive pools divided by

total number of fleas tested multiplied by 100.) At Hartoonian Trails, five (19%) of 27 rodents tested positive for *Y. pestis* antibodies, but there were no positive fleas (40 pools tested, 245 total fleas). At the case-patient's residence, only deer mice were trapped and they were not tested for *Y. pestis* antibodies. Tallac Point was temporarily closed to the public in early September 2020, and CDPH-VBDS and El Dorado County VCP staff applied deltamethrin insecticide to control rodent fleas and reduce the plague transmission risk. Follow-up surveillance at Tallac Point indicated that flea control was effective as flea abundance was reduced to less than one per rodent sampled.

Animal disease surveillance (Plague)

Domestic pets

No cases of plague in domestic pets were reported in 2020.

Wild animals

The CDPH-VBDS plague surveillance program tested 422 wild rodents and 94 carnivores from 27 California counties in 2020 (Figure 2.1, Table 2.1). Serum antibodies to *Y. pestis* were observed in 20 rodents from four counties (Figure 2.1, Table 2.1). The 422 rodents tested for plague antibodies included: 297 chipmunks (*Tamias* spp.), 84 California ground squirrels (*Otospermophilus beecheyi*), 20 golden-mantled ground squirrels (*Callospermophilus lateralis*), 15 Belding's ground squirrels (*Urocitellus beldingi*), 3 Douglas squirrels (*Tamiasciurus douglasii*), 2 voles (*Microtus* spp.), and 1 woodrat (*Neotoma bryanti intermedia*). Antibodies to *Y. pestis* were detected in: seven yellow pine chipmunks (*Tamias amoenus*) from El Dorado, Nevada, and Mono counties, six shadow (Allen's) chipmunks (*Tamias senex*) from El Dorado County, three California ground squirrels from El Dorado County, two long-eared chipmunks (*Tamias quadrimaculatus*) from El Dorado County, one lodgepole chipmunk (*Tamias speciosus*) from Lassen County, and one Belding's ground squirrel from Mono County (Table 2.1). Twelve rodent carcasses were submitted from five counties and tested by the CDPH-MDL's reference bacteriology unit (Table 2.1). One chipmunk (*T. amoenus*) carcass from Placer County tested positive for *Y. pestis* bacteria. Ninety-four wild carnivores were tested for serum antibodies to *Y. pestis*, and one black bear (*Ursus americanus*) from Butte County was positive (Table 2.1). The 93 negative samples included: 73 coyotes (*Canis latrans*), 9 black bears (*Ursus americanus*), 4 mountain lions (*Puma concolor),* 2 striped skunks (*Mephitis mephitis*), 2 raccoons (*Procyon lotor*), 1 bobcat (*Lynx rufus*), 1 gray fox (*Urocyon cinereoargenteus*), and 1 red fox (*Vulpes vulpes*).

In 2020, the San Diego County Department of Environmental Health-Vector Control Program conducted independent, county-wide surveillance for plague in small mammals. None of 179 small mammals tested by San Diego County 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 934 fleas collected from sylvatic rodents or their burrows from nine counties were identified to species, combined into 285 pools, and tested for the presence of *Yersinia pestis* bacteria. Five flea pools tested PCR-positive for *Y. pestis* (Table 2.2).

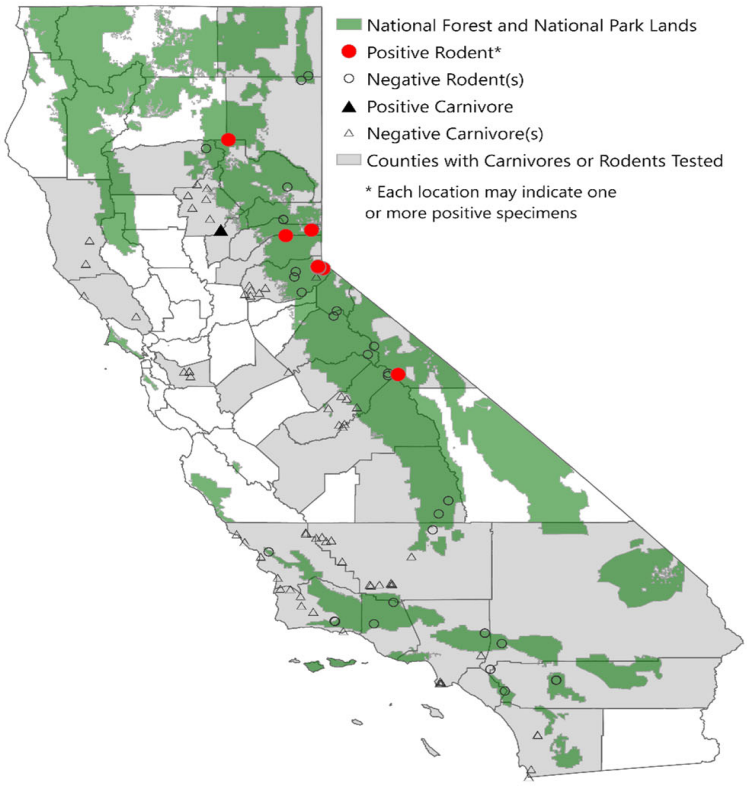


Figure 2.1. Approximate locations of carnivores or rodents that were tested by serology or culture for *Yersinia pestis*, California, 2020

Table 2.1. CDPH-VBDS plague surveillance results in wild rodents and carnivores by location, California, 2020

County / Location	Rodent blood tested by serology	Rodent carcasses tested by culture	Carnivore blood tested by serology	Positive specimens		
				Species	Titer or Pos	Month
Alpine	**1**		**0**			
Alameda	**0**		**4**			
Butte	**0**		**8**	*Ursus americanus*	1:128	September
El Dorado	**98**	**2**	**12**			
LTBMU: Fallen Leaf CG				*Tamias senex*	1:128	September
LTBMU: Fallen Leaf CG				*Tamias senex*	1:512	September
LTBMU: Fallen Leaf CG				*Tamias senex*	1:512	September
LTBMU: Fallen Leaf CG				*Tamias quadrimaculatus*	1:128	September
LTBMU: Hartoonian Trails				*Tamias amoenus*	1:64	August
LTBMU: Hartoonian Trails				*Tamias amoenus*	1:256	August
LTBMU: Hartoonian Trails				*Tamias amoenus*	1:1024	August
LTBMU: Hartoonian Trails				*Tamias amoenus*	1:1024	August
LTBMU: Hartoonian Trails				*Tamias amoenus*	1:1024	August
LTBMU: Kiva Picnic Area				*Tamias quadrimaculatus*	1:64	September
LTBMU: Kiva Picnic Area				*Otospermophilus beecheyi*	1:65	September
LTBMU: Kiva Picnic Area				*Otospermophilus beecheyi*	1:66	September
LTBMU: Kiva Picnic Area				*Tamias senex*[R]	1:512	September
LTBMU: Kiva Picnic Area				*Tamias senex*[R]	1:512	October
LTBMU: Taylor Creek Visitor Center				*Tamias senex*	1:1024	September
LTBMU: Taylor Creek Visitor Center				*Otospermophilus beecheyi*	1:64	September
Kern	**5**		**13**			
Lassen	**30**		**0**			
Lassen Volcanic NP: Juniper Lake Campground				*Tamias speciosus*	1:32	September
Los Angeles	**9**		**7**			
Madera	**32**		**8**			
Mendocino	**0**		**2**			
Modoc	**16**		**0**			
Mono	**30**		**0**			
Inyo NF: Sherwin Creek CG				*Tamias amoenus*	1:256	June
Inyo NF: Sherwin Creek CG				*Urocitellus beldingi*	1:128	June
Nevada	**22**	**2**	**0**			
Tahoe NF: Prosser Creek Reservoir				*Tamias amoenus*	1:64	July
Orange	**2**		**0**			
Placer	**17**	**4**	**0**			
Tahoe NF: Hampshire Rocks CG				*Tamias amoenus*	Pos	August
Plumas	**11**	**1**	**0**			
Riverside	**7**		**0**			
San Bernardino	**8**		**0**			
San Diego	**0**		**12**			
San Luis Obispo	**4**	**3**	**11**			
Santa Barbara	**16**		**9**			
Sierra	**42**		**0**			
Sonoma	**0**		**3**			
Stanislaus	**0**		**5**			
Tehama	**2**		**0**			
Tulare	**42**		**0**			
Tuolumne	**9**		**0**			
Ventura	**19**		**0**			
Total	**422**	**12**	**94**			

CG: Campground
LTBMU: Lake Tahoe Basin Management Unit
NF: National Forest
NP: National Park
R: Same rodent (recapture) tested positive in September/October
Pos: Rodent positive for *Yersinia pestis* bacteria by culture and PCR

Table 2.2. CDPH-VBDS plague surveillance results in fleas from rodents and burrow swabs by county, California, 2020

County / Location	Flea Pools (Total # Fleas) Tested by PCR	Number Positive Pools	PCR-Positive Pools			
			Rodent Host	Flea Species	Total Fleas in Pool	Collection Date
Alpine	**1 (1)**	**0**				
El Dorado	**191 (684)**	**5**				
LTBMU: Tallac Point			*Tamias amoenus*	*Eumolpianus eumolpi*	**10**	8/20/2020
LTBMU: Tallac Point			*Tamias amoenus*	*Eumolpianus eumolpi*	**2**	8/20/2020
LTBMU: Tallac Point			*Tamias amoenus*	*Eumolpianus eumolpi*	**5**	8/20/2020
LTBMU: Tallac Point			*Tamias amoenus*	*Eumolpianus eumolpi*	**1**	8/20/2020
LTBMU: Tallac Point			*Tamias amoenus*	*Ceratophyllus ciliatus*	**1**	8/20/2020
Lassen	**5 (10)**	**0**				
Modoc	**10 (13)**	**0**				
Nevada	**26 (57)**	**0**				
Placer	**18 (56)**	**0**				
Plumas	**6 (16)**	**0**				
Sierra	**26 (91)**	**0**				
Tuolumne	**2 (6)**	**0**				
Total	**285 (934)**	**5**				

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

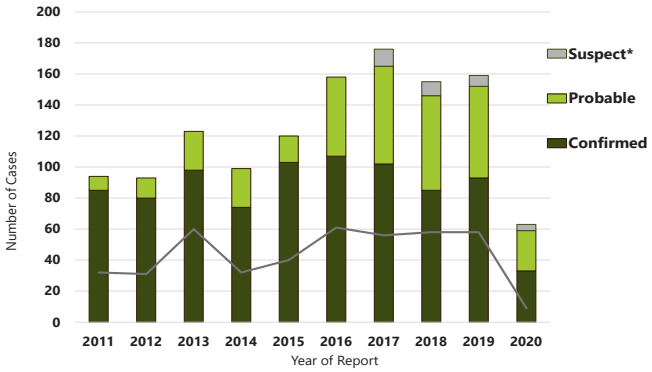
In 2020, seven cases of anaplasmosis caused by *Anaplasma phagocytophilum* were reported to the California Department of Public Health (CDPH): three met national surveillance criteria for a confirmed case and four met the criteria for a probable case. Case-patients were residents of Marin (1), San Francisco (3), and Sonoma (3) counties. Median age was 71 (range, 14 to 88 years), and six (86%) were male. Ethnicity was self-reported as non-Hispanic (3 [43%]), Hispanic (2 [29%]), or unknown (2 [29%]). All case-patients reported exposure within California, including Marin (4), Sonoma (2), and Mendocino (1) counties.

Babesiosis

One case of babesiosis caused by *Babesia microti* was reported to CDPH in 2020. The case met the national surveillance criteria for a confirmed case with *Babesia microti* DNA identified by PCR. The case-patient was a 50-year-old male resident of Los Angeles County who reported travel within the incubation period to the northeastern United States where *B. microti* is endemic.

Lyme disease

A total of 63 cases of Lyme disease caused by *Borrelia burgdorferi* were reported in 2020; 33 of these met the surveillance case definition criteria for a confirmed case, 26 were probable, and 4 were suspect cases with erythema migrans rash with exposure in California (Figure 3.1). Of the 33 confirmed cases, case-patients were residents of 18 counties, with Alameda County reporting the greatest number of cases (6) (Table 3.1). The median age of confirmed Lyme disease case-patients was 41 (range, 2.5 to 77 years) and 19 (56%) were male. Of the 16 confirmed case-patients for whom race was reported, 12 (75%) self-identified as white, 3 (19%) as Asian, and 1 (6%) as other. Erythema migrans (EM) was identified in eight (24%) confirmed case-patients, with onset of EM noted between March and July.



* 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 2011 - 2020

Between 2011 and 2020, the highest incidence of Lyme disease was in the north to central coastal counties and some northern counties with western-facing Sierra slopes (Figure 3.2). Of the 24 (38%) case-patients reporting travel history outside of their county of residence within the incubation period, 18 (29%) reported exposure outside of California, most commonly in the northeastern United States.

Spotted fever group rickettsiosis

No tick-borne spotted fever group rickettsiosis cases were reported to CDPH in 2020.

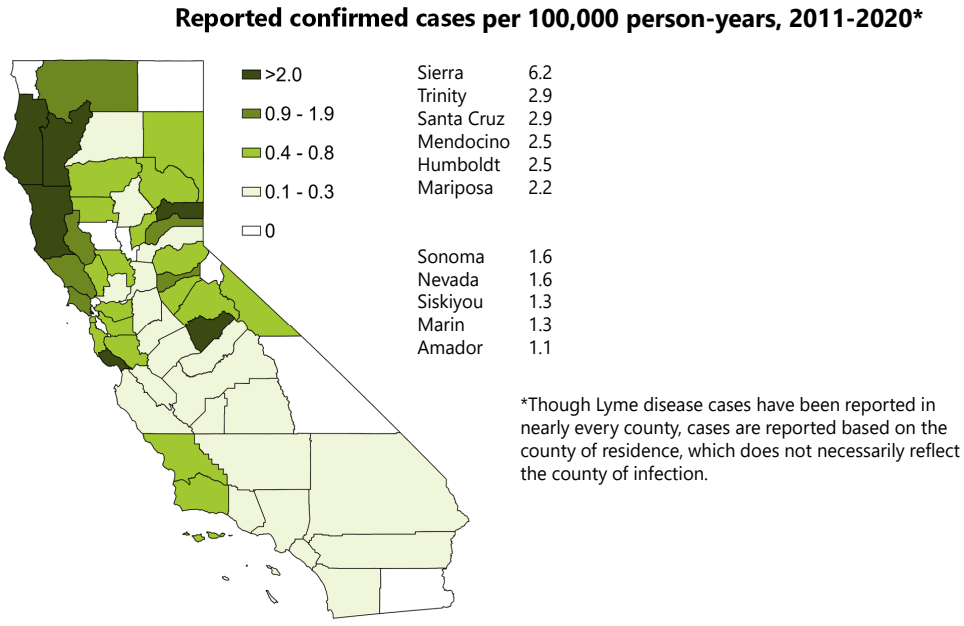


Figure 3.2. Incidence of reported confirmed Lyme disease, by county, California, 2011-2020

Tick-borne relapsing fever

Four cases of tick-borne relapsing fever (TBRF), caused by *Borrelia hermsii*, were reported to CDPH in 2020; three met CDPH working surveillance case definition criteria for a confirmed case and one met the criteria for a suspect case. Age ranges of case-patients were 8 to 82 years, and three were female. Case-patients were residents of Fresno, San Francisco, Santa Rosa, and Sonoma counties; counties where case-patients were likely exposed in the three weeks prior to illness onset were Fresno, Placer, and Lassen (2) counties.

Tick surveillance

Anaplasma phagocytophilum

In 2020, a total of 2,849 adult, 285 nymphal, and 9 larval western blacklegged ticks (*Ixodes pacificus*) were tested for the presence of *Anaplasma phagocytophilum*, the agent of anaplasmosis (Table 3.2). Statewide minimum infection prevalence (MIP — defined as the number of positive pools divided by the number of ticks tested multiplied by 100) of *A. phagocytophilum* in adult and nymphal *I. pacificus* was 0.6% and 5.6%, respectively (Table 3.2). CDPH Vector-Borne Disease Section (CDPH-VBDS), collaborating with Marin-Sonoma Mosquito and Vector Control District (MVCD) in Marin County, collected and tested 988 adult, 285 nymphal, and 9 larval western blacklegged ticks from El Dorado, Los Angeles, Marin, Mendocino, Napa, Nevada, Placer, and Yuba counties. Seven (0.7% MIP) adult and 16 (5.6% MIP) nymphal western blacklegged ticks tested positive by real-time polymerase chain reaction (RT-PCR) at CDPH-VBDS laboratory (Table 3.2). San Mateo MVCD shares data with CDPH-VBDS and reported that in 2020, their agency collected and tested 1,861 adult western blacklegged ticks in 398 pools from nine parks. Nine (0.48% MIP) of the adult tick pools were positive (Table 3.2).

Francisella tularensis

In 2020, CDPH-VBDS tested a total of 40 adult American dog ticks (*Dermacentor variabilis*) from Contra Costa and Marin counties for *Francisella tularensis*, the causative agent of tularemia. All ticks tested negative. As reported to CDPH-VBDS, San Diego Environmental Health tested 4,604 adult Pacific Coast ticks (*Dermacentor occidentalis*), 335 adult American dog ticks, and 9 adult bighorn sheep ticks (*Dermacentor hunteri*) for *F. tularensis* by RT-PCR. All ticks tested negative. Additionally, San Mateo MVCD reported to CDPH-VBDS that they tested 163 adult Pacific Coast ticks and 31 adult American dog ticks for *F. tularensis*. All ticks tested negative.

Spotted fever group rickettsiosis

In 2020, CDPH-VBDS collected and extracted DNA from 2,617 adult and one nymphal Pacific Coast ticks and two adult American dog ticks from 17 counties

Table 3.1. Reported confirmed Lyme disease cases by county of residence, California, 2011-2020

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	TOTAL	Incidence per 100,000 person-years
Alameda	2	4	0	3	11	8	12	4	8	6	58	0.36
Alpine	0	0	0	0	0	0	0	0	0	0	0	0.00
Amador	0	0	1	0	2	0	0	0	0	1	4	1.06
Butte	0	0	0	1	0	2	0	0	1	0	4	0.19
Calaveras	0	0	0	0	1	0	1	0	1	0	3	0.66
Colusa	0	0	0	0	0	0	0	0	0	0	0	0.00
Contra Costa	1	4	5	2	4	6	12	10	2	2	48	0.44
Del Norte	0	0	0	0	0	0	0	0	0	0	0	0.00
El Dorado	0	2	0	2	2	1	2	0	0	0	9	0.48
Fresno	1	4	0	1	1	1	0	1	1	0	10	0.10
Glenn	0	0	0	1	0	0	0	0	1	0	2	0.69
Humboldt	5	4	4	4	6	4	3	1	2	0	33	2.46
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	0	1	1	0	0	1	0	3	0.03
Kings	0	0	1	0	0	1	0	0	0	0	2	0.13
Lake	0	0	0	0	1	1	0	0	3	1	6	0.93
Lassen	0	0	0	0	0	1	0	0	0	0	1	0.31
Los Angeles	8	2	17	6	6	1	3	2	3	0	48	0.05
Madera	1	0	0	0	0	0	0	0	0	1	2	0.13
Marin	1	3	6	5	5	3	0	1	8	0	32	1.25
Mariposa	0	1	1	1	1	0	0	0	0	0	4	2.21
Mendocino	3	4	0	1	0	1	1	1	10	1	22	2.50
Merced	1	0	0	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	1	0	0	0	0	0	0	0	1	0.73
Monterey	1	1	1	0	0	1	0	0	1	0	5	0.12
Napa	1	1	0	2	2	2	0	1	0	1	10	0.73
Nevada	6	2	1	1	1	2	0	2	1	0	16	1.63
Orange	6	0	0	0	0	1	0	0	0	0	7	0.02
Placer	1	2	1	0	0	2	3	0	0	0	9	0.24
Plumas	0	0	0	1	0	0	0	0	0	0	1	0.52
Riverside	4	0	2	1	1	3	1	1	1	2	16	0.07
Sacramento	1	2	0	0	0	1	1	3	2	0	10	0.07
San Benito	0	0	0	0	1	0	0	0	0	0	1	0.17
San Bernardino	2	0	1	0	1	0	0	0	2	0	6	0.03
San Diego	8	7	8	8	9	7	1	8	0	2	58	0.18
San Francisco	1	2	5	0	0	0	11	14	10	3	46	0.54
San Joaquin	0	1	0	1	0	1	0	1	3	0	7	0.10
San Luis Obispo	0	1	5	3	3	1	1	1	3	2	20	0.73
San Mateo	0	1	3	6	5	5	4	0	2	1	27	0.36
Santa Barbara	3	0	6	0	4	8	3	3	2	1	30	0.68
Santa Clara	11	4	13	5	10	11	7	5	2	3	71	0.38
Santa Cruz	8	5	5	6	8	7	15	10	11	3	78	2.92
Shasta	1	1	0	0	0	0	0	0	0	1	3	0.17
Sierra	0	1	0	0	0	0	0	1	0	0	2	6.22
Siskiyou	0	1	1	0	1	1	1	1	0	0	6	1.34
Solano	0	0	0	0	0	3	2	2	0	1	8	0.19
Sonoma	6	12	7	11	12	11	8	8	5	0	80	1.64
Stanislaus	0	0	0	0	1	1	3	2	0	0	7	0.13
Sutter	0	0	0	0	0	0	0	0	0	0	0	0.00
Tehama	0	0	0	0	0	3	1	0	0	0	4	0.62
Trinity	2	1	0	1	0	0	0	0	0	0	4	2.92
Tulare	0	1	0	0	1	1	0	0	4	0	7	0.15
Tuolumne	0	0	0	0	1	0	0	0	1	0	2	0.36
Ventura	0	3	2	0	0	3	3	2	2	0	15	0.18
Yolo	0	1	1	0	1	1	3	0	0	0	7	0.33
Yuba	0	2	0	1	0	0	0	0	0	1	4	0.53
TOTAL	**85**	**80**	**98**	**74**	**103**	**107**	**102**	**85**	**93**	**33**	**860**	**0.22**

to test for spotted fever group *Rickettsia* spp. (SFGR), including the 364D strain, the causative agent of Pacific Coast tick fever. Testing will be performed as part of an ongoing study of the distribution of SFGR spp. in California. Orange County MVCD tested 28 Pacific Coast tick adults for *Rickettsia rickettsii*, the causative agent of Rocky Mountain spotted fever at their laboratory. All ticks tested negative.

Borrelia spirochetes

Borrelia burgdorferi sensu lato

In 2020, local, state, and federal agencies, in collaboration with CDPH-VBDS, collected 11,209 adult, 1,442 nymphal, and 49 larval western blacklegged ticks from 25 counties to test for *Borrelia burgdorferi*, the causative agent of Lyme disease. Collection and testing data for western blacklegged ticks are collated by CDPH-VBDS. From the counties where ticks were tested individually, the overall prevalence of *B. burgdorferi* sensu lato was 0.5% in adult ticks and 8.0% 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 tested by local vector control agencies in pools were tested by RT-PCR. In the counties where ticks were tested in pools, the adult MIP was 0.8% and nymphal MIP was 4.5% (Table 3.4). All larval ticks tested negative. In addition, one *Ixodes spinipalpus* nymph from Marin county tested positive for *B. burgdorferi* sensu lato at the CDPH-VBDS laboratory.

Borrelia miyamotoi

In 2020, of the western blacklegged ticks collected, 8,895 adult, 1,442 nymphal, and 49 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 3,800 individually tested adults and 689 individually tested nymphs, 18 (0.5%) and 10 (1.5%), respectively, tested positive (Table 3.3). Of the 5,095 adult ticks tested in 1,038 pools and 753 nymphs tested in 380 pools, 31 (0.6% MIP) and 6 (1.6% MIP), respectively, tested positive (Table 3.4).

Coinfection in ticks

In 2020, two (0.05% MIP) *Ixodes pacificus* adults (out of 3,800) from Marin and Placer counties tested positive for both *Borrelia burgdorferi* sensu lato and *B. miyamotoi* by RT-PCR at CDPH-VBDS (Table 3.3). Additionally, one western blacklegged tick nymph from Marin County tested positive for both *B. miyamotoi* and *Anaplasma phagocytophilum*, for a statewide infection prevalence of 0.5% (one positive out of 204 nymphs tested statewide).

Western blacklegged ticks can be vectors of multiple pathogens. In 2020, two adult and one nymphal western blacklegged tick tested positive for more than one pathogen at CDPH-VBDS. The two adults were coinfected with *B. burgdorferi* s.l. and *B. miyamotoi*. The nymph was coinfected with *A. phagocytophilum* and *B. miyamotoi*.

Table 3.2. Infection prevalence and minimum infection prevalence of *Anaplasma phagocytophilum* in *Ixodes pacificus* ticks, California, 2020

	No. Ticks Tested (pools)[a]			Positive *A. phagocytophilum*				
County	Adults	Nymphs	Larvae	Adults (IP/MIP[b])	Nymphs (IP/MIP)	Larvae (IP/MIP)	Collected by	Laboratory
El Dorado	90	45		1 (1.0)	1 (2.2)		CDPH, VBDS	CDPH, VBDS
Los Angeles	344						CDPH, VBDS	CDPH, VBDS
Marin	541 (472)	233	9	5 (0.92)	15 (6.4)		CDPH, VBDS; Marin-Sonoma MVCD	CDPH, VBDS
Mendocino	11	2		1 (9.1)			CDPH, VBDS	CDPH, VBDS
Napa	2						CDPH, VBDS	CDPH, VBDS
Nevada		2					CDPH, VBDS	CDPH, VBDS
San Mateo	1,861 (398)			9 (0.48)			San Mateo MVCD	San Mateo MVCD
Placer		2					CDPH, VBDS	CDPH, VBDS
Yuba		1					CDPH, VBDS	CDPH, VBDS
Total	**2,849 (398)**	**285**	**9**	**16 (0.6)**	**16 (5.6)**	**0**		

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] if no pools listed then ticks were tested individually.

[b] Infection prevalance is the number of individually tested ticks positive divided by the number of ticks tested multiplied by 100; minimum infection prevalance is the number of positive pools divided by the number of ticks tested multiplied by 100.

Mammal surveillance

Francisella tularensis

CDPH-VBDS collaborates with CDPH Microbial Diseases Laboratory to test mammals for *Francisella tularensis*, the agent of tularemia, by serology, DFA, PCR, and culture. Mammals may be tested for tularemia in response to reported human cases or for environmental risk assessment including specific carcass testing requests. In 2020, 12 small mammals were tested from El Dorado (2), Nevada (2), Placer (4), Plumas (1), and San Luis Obispo (3) counties. All mammals tested negative.

Table 3.3. Infection prevalence of *Borrelia burgdorferi* sensu lato and *Borrelia miyamotoi* spirochetes in *Ixodes pacificus* ticks, California, 2020

County	No. Ticks Tested			Positive *B. burgdorferi*		Positive *B. miyamotoi*		Positive Coinfection	Collected by	Laboratory
	Adults	Nymphs	Larvae*	Adults (IP)[a]	Nymphs (IP)	Adults (IP)	Nymphs (IP)	Adults (IP)		
Butte		9							CDPH, VBDS	CDPH, VBDS
Contra Costa	42	19		1 (2.4)					CDPH, VBDS	CDPH, VBDS
Del Norte	22								CDPH, VBDS	CDPH, VBDS
El Dorado	90	182	40	6 (6.7)	16 (8.8)				CDPH, VBDS	CDPH, VBDS
Humboldt	7								CDPH, VBDS	CDPH, VBDS
Kern	15								CDPH, VBDS	CDPH, VBDS
Los Angeles	605								CDPH, VBDS	CDPH, VBDS
Marin	575	245	9	8 (1.4)	33 (13.5)	10 (1.7)	8 (3.3)	1 (0.2)	CDPH, VBDS; Marin-Sonoma MVCD	CDPH, VBDS; Marin-Sonoma MVCD
Mendocino	11	2							CDPH, VBDS	CDPH, VBDS
Napa	211					2 (1.0)			CDPH, VBDS	CDPH, VBDS
Nevada		137			5 (3.7)		1 (0.7)		CDPH, VBDS	CDPH, VBDS
Orange	205								CDPH, VBDS; Orange County MVCD	CDPH, VBDS; Orange County MVCD
Placer	96	91		1 (1.0)	1 (1.1)	2 (2.1)	1 (1.1)	1 (1.0)	CDPH, VBDS	CDPH, VBDS
Riverside	192								CDPH, VBDS	CDPH, VBDS
San Bernardino	215								CDPH, VBDS	CDPH, VBDS
San Diego	166								CDPH, VBDS	CDPH, VBDS
San Luis Obispo	343					1 (0.3)			CDPH, VBDS	CDPH, VBDS
Santa Barbara	270								CDPH, VBDS	CDPH, VBDS
Sonoma	457			4 (0.9)		3 (0.7)			CDPH, VBDS	CDPH, VBDS
Stanislaus	45								CDPH, VBDS	CDPH, VBDS
Tulare	45								CDPH, VBDS	CDPH, VBDS
Ventura	188								CDPH, VBDS	CDPH, VBDS
Yuba		4							CDPH, VBDS	CDPH, VBDS
Total	**3,800**	**689**	**49**	**20 (0.5)**	**55 (8.0)**	**18 (0.5)**	**10 (1.5)**	**2 (0.05)**		

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] 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.

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

Abbreviations:

CDPH-VBDS, California Department of Public Health, Vector-Borne Disease Section; 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, 2020

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]		
Alameda	874 (223)	753 (380)	18 (2.1)	34 (4.5)	8 (0.9)	6 (1.6)	Alameda County DEH	Alameda County DEH
Butte	630 (126)		6 (1.0)		2 (0.3)		Butte County MVCD	Placer MVCD
Marin	255 (57)		8 (3.1)		5 (2.0)		Marin-Sonoma MVCD	Marin-Sonoma MVCD
Sacramento*	1973 (438)		17 (0.9)		n/a		Sacramento-Yolo MVCD	Sacramento-Yolo MVCD
San Diego	1125 (158)						County of San Diego VCP	County of San Diego VCP
San Mateo	1861 (398)		10 (0.5)		13 (0.7)		San Mateo MVCD	San Mateo MVCD
Sonoma	350 (76)		2 (0.6)		3 (0.9)		Marin-Sonoma MVCD	Marin-Sonoma MVCD
Yolo*	341 (83)		1 (0.3)		n/a		Sacramento-Yolo MVCD	Sacramento-Yolo MVCD
Total	**7,409 (1,559)**	**753 (380)**	**62 (0.8)**	**34 (4.5)**	**31 (0.6)**	**6 (1.6)**		

[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] 5,095 (1,038) adult ticks tested for *Borrelia miyamotoi.*

Abbreviations:

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

4 Mosquito-borne Diseases

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

Human disease surveillance

West Nile virus

Serological diagnosis of human infection with West Nile virus (WNV) and other arboviruses was performed at the California Department of Public Health (CDPH) Viral and Rickettsial Disease Laboratory (VRDL), local public health laboratories, and commercial laboratories. Local and commercial laboratories tested for WNV using an IgM enzyme immunoassay (EIA) and/or an IgM immunofluorescence assay (IFA). Specimens 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 screening assays performed by blood and organ donation centers.

West Nile virus remains the greatest vector-borne disease threat in California, with over 7,000 cases, including over 300 fatalities, reported since 2003. *Culex pipiens, Cx. quinquefasciatus,* and *Cx. tarsalis* are the most widespread and common vectors of this virus in California.

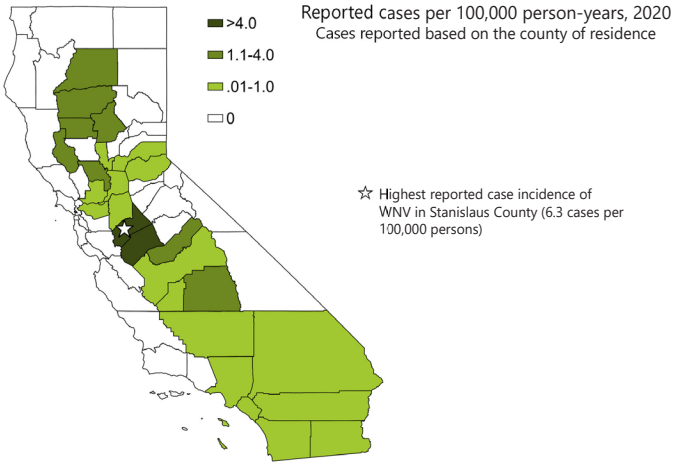


Figure 4.1. Incidence of reported human cases of West Nile virus, by county, California, 2020

In 2020, a total of 235 symptomatic and 28 asymptomatic infections with WNV were identified, which was a slight increase compared to the total number of infections (243) reported in both 2018 and 2019 (Table 4.1). Of the 235 clinical cases, 179 (76%) were classified as West Nile neuroinvasive disease (e.g., encephalitis, meningitis, acute flaccid paralysis, or other neurologic dysfunction) and 56 (24%) were classified as West Nile non-neuroinvasive disease. Case-patients were residents of 26 counties and 149 (63%) were male. Incidence was highest (6.3 cases per 100,000 persons) in Stanislaus County (Table 4.1, Figure 4.1). The median age of neuroinvasive cases was 61 years (range, 9 to 91 years) and among non-neuroinvasive cases, the median age was 60 years (range, 23 to 93 years). The median age of the 11 WNV-associated fatalities was 68 years (range, 37 to 89 years). Dates of symptom onset for all reported cases ranged from June 2 to December 21.

Table 4.1. Reported WNV human cases by county of residence, California, 2011-2020

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2020 incidence per 100,000 person-years	10 year incidence per 100,000 person-years
Alameda	0	2	0	1	0	0	1	0	1	0	0.00	0.03
Alpine	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Amador	1	0	0	0	0	1	0	1	1	0	0.00	1.06
Butte	3	10	24	24	53	21	4	12	5	4	1.90	7.61
Calaveras	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Colusa	0	3	2	3	1	2	0	0	1	0	0.00	5.48
Contra Costa	3	4	5	5	1	4	4	4	1	4	0.35	0.30
Del Norte	0	0	0	0	0	0	0	0	0	0	0.00	0.00
El Dorado	1	0	1	0	0	1	0	0	0	1	0.52	0.21
Fresno	9	24	8	43	8	14	13	14	51	10	0.98	1.90
Glenn	1	7	9	10	19	6	0	2	0	1	3.40	18.71
Humboldt	0	0	0	0	0	0	0	1	0	0	0.00	0.08
Imperial	0	1	0	1	1	0	3	0	3	1	0.53	0.53
Inyo	0	0	0	0	0	0	4	0	0	0	0.00	2.15
Kern	18	25	25	11	11	17	30	13	28	8	0.87	2.03
Kings	1	3	1	4	0	8	5	0	3	2	1.30	1.76
Lake	0	1	0	1	2	1	0	1	0	2	3.12	1.25
Lassen	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Los Angeles	58	163	151	253	286	151	277	43	31	90	0.88	1.48
Madera	2	3	3	3	4	6	2	4	3	6	3.79	2.28
Marin	0	0	2	0	1	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	0	1	2	0	0	0	0	0	0.00	0.34
Merced	1	13	0	1	1	0	10	2	10	12	4.23	1.76
Modoc	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Mono	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Monterey	0	1	0	0	0	1	0	1	0	0	0.00	0.07
Napa	0	0	1	0	0	0	0	1	0	0	0.00	0.14
Nevada	0	0	0	0	2	0	0	1	0	0	0.00	0.31
Orange	10	42	10	263	92	32	33	9	5	17	0.53	1.61
Placer	1	12	6	7	0	7	0	9	1	2	0.50	1.11
Plumas	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Riverside	7	19	35	14	127	11	32	15	12	10	0.41	1.15
Sacramento	4	29	11	10	4	25	6	15	4	7	0.45	0.74
San Benito	0	0	0	0	0	0	0	0	0	0	0.00	0.00
San Bernardino	4	33	13	21	54	8	57	9	7	3	0.14	0.96
San Diego	0	1	0	11	42	20	2	2	3	1	0.03	0.25
San Francisco	0	1	1	0	0	0	1	0	0	0	0.00	0.03
San Joaquin	5	13	8	9	2	13	14	14	7	2	0.26	1.12
San Luis Obispo	0	0	0	0	0	0	0	0	2	0	0.00	0.07
San Mateo	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Santa Barbara	1	0	1	0	0	0	0	0	0	0	0.00	0.04
Santa Clara	1	0	2	10	8	1	0	1	1	0	0.00	0.12
Santa Cruz	1	0	0	0	0	0	0	0	0	0	0.00	0.04
Shasta	0	1	1	2	3	1	1	1	0	2	1.12	0.67
Sierra	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Siskiyou	0	0	0	0	1	0	0	0	0	0	0.00	0.22
Solano	0	2	1	5	1	4	1	0	1	1	0.23	0.36
Sonoma	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Stanislaus	11	26	17	33	13	26	28	15	16	35	6.28	3.94
Sutter	0	8	10	8	2	12	3	1	1	1	0.99	4.57
Tehama	1	4	5	4	5	5	2	2	0	2	3.07	4.61
Trinity	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Tulare	11	7	5	21	13	10	12	8	24	7	1.46	2.46
Tuolumne	0	0	0	0	0	0	0	1	0	0	0.00	0.18
Ventura	0	7	2	1	6	7	1	2	2	0	0.00	0.33
Yolo	0	10	6	15	8	16	6	11	1	4	1.80	3.47
Yuba	3	4	13	6	10	11	1	2	0	0	0.00	6.34
Total WNV disease	**158**	**479**	**379**	**801**	**783**	**442**	**553**	**217**	**225**	**235**	**0.59**	**1.07**
Asymptomatic Infections[a]	18	48	54	91	77	41	47	26	18	28		
Total WNV infections	**176**	**527**	**433**	**892**	**860**	**483**	**600**	**243**	**243**	**263**	**0.65**	**1.19**

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

St. Louis encephalitis virus

Six symptomatic cases of St. Louis encephalitis virus (SLEV) infection were identified in 2020. Five (83%) cases presented with neuroinvasive disease and one (17%) fatality was reported. Case-patients were residents of four counties (Table 4.5) and five (83%) were male. The median age was 75 years (range, 45 to 90 years), and dates of symptom onset ranged from July 20 to October 1.

Malaria

In 2020, 42 confirmed cases of malaria were reported to CDPH. Case-patients were residents of 16 California counties and 20 (48%) were male. The median age was 32 years (range, 2 to 77 years). Of the 36 cases for which the *Plasmodium* species was determined, 21 were *P. falciparum*, 10 *P. vivax*, 3 *P. malariae,* and 2 *P. ovale*. Thirty-five case-patients reported compatible travel history to malaria-endemic areas including Africa (27) and Asia (8). Exposure information for seven case-patients was not available.

Chikungunya

Five cases of chikungunya were reported to CDPH in 2020; all of these met the criteria for a probable case (Table 4.2). Case-patients were residents of five California counties, 3 (60%) were male, and the median age was 48 (range, 23 to 59 years). No locally acquired cases were reported. All case-patients reported travel to chikungunya-endemic or outbreak areas including India (2), the Caribbean (2), and Africa (1).

Dengue

In 2020, 83 cases of dengue were reported to CDPH; 11 of these met the criteria for a confirmed case and 72 were probable (Table 4.2). Case-patients were residents of 26 California counties, 44 (53%) were female, and the median age was 48 (range, 6 to 87 years). No locally acquired cases were reported. Travel region history included North America (Mexico [52]), South East Asia (12), India (2), South Pacific (4), Caribbean (5), South America (3), and Africa (2). Exposure region was not available for three infected persons.

Zika

In 2020, five infections of Zika virus were reported to CDPH; all of these met the criteria for probable infections. Infected persons were residents of

Table 4.2. Reported confirmed and probable *Aedes*-transmitted diseases in humans by county, California, 2020

County	Chikungunya	Dengue	Zika	TOTAL
Alameda	0	5	1	6
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	1	0	2
Del Norte	0	0	0	0
El Dorado	0	1	0	1
Fresno	0	1	0	1
Glenn	0	0	0	0
Humboldt	0	1	0	1
Imperial	0	0	0	0
Inyo	0	0	0	0
Kern	0	1	0	1
Kings	0	0	0	0
Lake	0	0	0	0
Lassen	0	0	0	0
Los Angeles	1	24	2	27
Madera	0	0	0	0
Marin	0	1	0	1
Mariposa	0	0	0	0
Mendocino	0	0	0	0
Merced	0	1	0	1
Modoc	0	0	0	0
Mono	0	0	0	0
Monterey	0	0	0	0
Napa	0	2	0	2
Nevada	0	0	0	0
Orange	1	8	1	10
Placer	0	0	0	0
Plumas	0	0	0	0
Riverside	0	3	0	3
Sacramento	0	1	0	1
San Benito	0	0	0	0
San Bernardino	1	3	0	4
San Diego	0	1	0	1
San Francisco	0	1	1	2
San Joaquin	0	2	0	2
San Luis Obispo	0	0	0	0
San Mateo	0	4	0	4
Santa Barbara	0	0	0	0
Santa Clara	1	7	0	8
Santa Cruz	0	1	0	1
Shasta	0	0	0	0
Sierra	0	0	0	0
Siskiyou	0	0	0	0
Solano	0	0	0	0
Sonoma	0	4	0	4
Stanislaus	0	2	0	2
Sutter	0	3	0	3
Tehama	0	0	0	0
Trinity	0	0	0	0
Tulare	0	1	0	1
Tuolumne	0	0	0	0
Ventura	0	3	0	3
Yolo	0	1	0	1
Yuba	0	0	0	0
TOTAL	**5**	**83**	**5**	**93**

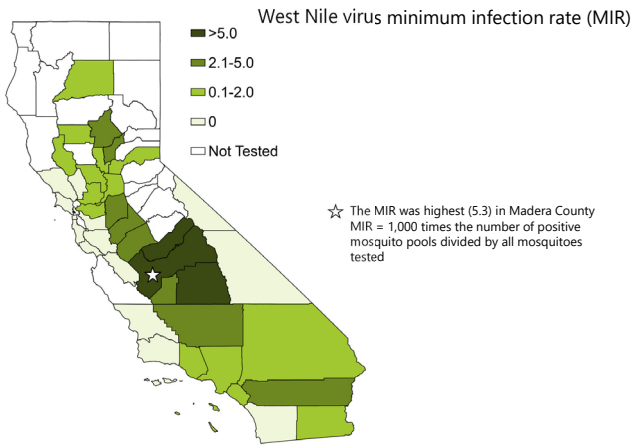


Figure 4.2. West Nile virus minimum infection rate of *Culex* spp. mosquitoes, by county, California, 2020

four counties (Table 4.2), all were female, and the median age was 37 years (range, 34 to 44 years). All infections were travel related. Reported travel by four infected individuals was to Zika-endemic or outbreak areas including North America (Mexico [1]), the Caribbean (1), Central America (1) and India (1). Exposure region was not available for one infected person.

Mosquito surveillance

In 2020, a total of 1,312,989 mosquitoes (48,332 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, WEEV, and/or WNV viral RNA (Table 4.3).

West Nile virus was detected in 2,628 mosquito pools from 28 counties, and SLEV was detected in 510 mosquito pools from 9 counties (Tables 4.3, 4.5, 4.8). Statewide, the minimum infection rate (MIR)—defined as the number of infected mosquito pools divided by the total number of mosquitoes tested multiplied by 1,000— of WNV in all mosquitoes tested was 2.0; the MIR was highest (5.3) 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). West Nile virus was identified from five *Culex* species (*Cx. erythrothorax*, *Cx. pipiens*, *Cx. quinquefasciatus*, *Cx. stigmatosoma*, and *Cx. tarsalis*) (Table 4.4), and St. Louis encephalitis virus was identified from four *Culex* species

Table 4.3. West Nile Virus (WNV) positive mosquito pools and minimum infection rate, by county, California, 2020

County	No. mosquitoes tested[a]	No. mosquito pools tested	WNV positive pools[a]	WNV Minimum Infection Rate[b]
Alameda	173	63	0	0.0
Alpine	0			
Amador	0			
Butte	21,870	464	28	1.3
Calaveras	0			
Colusa	0			
Contra Costa	14,288	471	13	0.9
Del Norte	0			
El Dorado	0			
Fresno	86,440	2,602	322	3.7
Glenn	812	17	3	3.7
Humboldt	0			
Imperial	1,932	135	3	1.6
Inyo	845	19	0	0.0
Kern	30,816	775	83	2.7
Kings	20,071	628	87	4.3
Lake	12,195	580	12	1.0
Lassen	0			
Los Angeles	142,326	3,968	437	3.1
Madera	14,520	467	77	5.3
Marin	632	42	0	0.0
Mariposa	0			
Mendocino	0			
Merced	20,416	756	42	2.1
Modoc	0			
Mono	0			
Monterey	0			
Napa	5,366	199	2	0.4
Nevada	0			
Orange	147,797	5,084	326	2.2
Placer	35,854	2,022	58	1.6
Plumas	0			
Riverside	194,849	5,640	64	0.3
Sacramento	68,426	4,799	115	1.7
San Benito	464	28	0	0.0
San Bernardino	64,646	3,142	13	0.2
San Diego	15,036	1,694	2	0.1
San Francisco	156	15	0	0.0
San Joaquin	83,747	2,664	260	3.1
San Luis Obispo	4,950	108	0	0.0
San Mateo	2,539	274	0	0.0
Santa Barbara	2,275	121	1	0.4
Santa Clara	21,609	1937	8	0.4
Santa Cruz	1,100	59	0	0.0
Shasta	21,870	690	25	1.1
Sierra	0			
Siskiyou	0			
Solano	16,029	530	8	0.5
Sonoma	9,159	346	0	0.0
Stanislaus	81,834	2,235	351	4.3
Sutter	9,200	257	20	2.2
Tehama	0			
Trinity	0			
Tulare	102,401	3,114	189	1.8
Tuolumne	0			
Ventura	1,685	36	0	0.0
Yolo	47,901	2,167	77	1.6
Yuba	6,760	184	2	0.3
Total	**1,312,989**	**48,332**	**2,628**	**2.0**

[a] Tested by University of California at Davis Center for Vectorborne Diseases 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, 2020

Mosquito Species	No. Pools Tested	No. Mosquitoes	WNV +	Minimum Infection Rate[a]
***Culex* species**				
Cx. erraticus	1	1	0	0.0
Cx. erythrothorax	1,479	55,949	7	0.1
Cx. pipiens	9,664	180,857	462	2.6
Cx. quinquefasciatus	18,658	567,183	1,320	2.3
Cx. restuans	1	1	0	0.0
Cx. stigmatosoma	1,185	13,907	13	0.9
Cx. tarsalis	16,329	486,394	826	1.7
Cx. territans	1	16	0	0.0
Cx. thriambus	75	149	0	0.0
All *Culex*	**47,393**	**1,304,457**	**2,628**	**2.0**
***Anopheles* species**				
An. franciscanus	14	110	0	0.0
An. freeborni	1	37	0	0.0
An. hermsi	5	96	0	0.0
All *Anopheles*	**20**	**243**	**0**	**0.0**
***Aedes* species**				
Ae. aegypti	503	2,272	0	0.0
Ae. albopictus	3	58	0	0.0
Ae. melanimon	7	62	0	0.0
Ae. nigromaculis	1	7	0	0.0
Ae. sierrensis	1	3	0	0.0
Ae. taeniorhynchus	1	30	0	0.0
Ae. washinoi	2	100	0	0.0
All *Aedes*	**518**	**2,532**	**0**	**0.0**
Other species				
Culiseta incidens	322	4,362	0	0.0
Culiseta inornata	32	234	0	0.0
Culiseta melanura	1	7	0	0.0
Culiseta particeps	32	1,029	0	0.0
Unknown	14	125	0	0.0
All other	**401**	**5,757**	**0**	**0.0**

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

(*Cx. pipiens*, *Cx. quinquefasciatus*, *Cx. stigmatosoma*, and *Cx. tarsalis*). In 2020, the first detection of WNV in mosquitoes was from a *Cx. quinquefasciatus* pool collected in Tulare County on May 15, and the last detection was from a *Cx. quinquefasciatus* pool collected in Los Angeles County on November 13. The first detection of SLEV in mosquitoes was from a *Cx. tarsalis* pool collected in Riverside County on May 19, whereas the last detection was from a *Cx. quinquefasciatus* pool collected in Fresno County on October 29.

Animal surveillance

Chicken serosurveillance

In 2020, 26 local mosquito and vector control agencies in 23 counties maintained 95 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 the CDPH-VRDL.

Of 6,302 chicken blood samples tested, 144 seroconversions to WNV were detected among 47 flocks in 17 counties (Tables 4.6, 4.8). Statewide, 22% 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 2020, the first WNV seroconversion was detected in Merced County on July 2, and the last WNV seroconversions were detected in Los Angeles and Ventura counties on November 12. No SLEV seroconversions were detected in 2020.

Table 4.5. Infections with St. Louis encephalitis virus in humans, mosquito pools, and sentinel chickens, by county, California, 2020

County	Humans	Mosquito Pools[1]	Sentinel Chickens
Fresno	3	233	NT
Imperial	0	10	NT
Kern	0	31	NT
Kings	0	11	NT
Madera	1	17	NT
Riverside	0	159	NT
San Joaquin	1	2	NT
Stanislaus	1	2	NT
Tulare	0	45	0
State Totals	**6**	**510**	**0**

NT= no samples tested

[1]Positive mosquito pools included *Cx. quinquefasciatus* (322 pools), *Culex tarsalis* (178 pools), *Cx. pipiens* (5 pools), and *Cx. stigmatosoma* (5 pools)

Table 4.6. Results of testing sentinel chickens for West Nile (WNV) virus, by county, California, 2020

County	No. flocks	No. chickens[a]	No. WNV positive flocks	WNV positive sera
Alameda	3	21	0	0
Alpine	0			
Amador	0			
Butte	7	42	7	23
Calaveras	1	10	1	2
Colusa	1	10	0	0
Contra Costa	4	24	3	7
Del Norte	0			
El Dorado	0			
Fresno	0			
Glenn	1	6	1	2
Humboldt	0			
Imperial	0			
Inyo	0			
Kern	0			
Kings	0			
Lake	2	12	1	2
Lassen	0			
Los Angeles	28	197	12	38
Madera	0			
Marin	0			
Mariposa	0			
Mendocino	0			
Merced	8	48	6	14
Modoc	0			
Mono	0			
Monterey	0			
Napa	0			
Nevada	2	12	0	0
Orange	0			
Placer	0			
Plumas	0			
Riverside	0			
Sacramento	3	15	1	4
San Benito	1	8	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	4	26	0	0
Santa Clara	0			
Santa Cruz	2	12	0	0
Shasta	6	40	2	3
Sierra	0			
Siskiyou	0			
Solano	3	21	1	4
Sonoma	0			
Stanislaus	0			
Sutter	5	35	5	26
Tehama	3	30	2	5
Trinity	0			
Tulare	1	10	1	10
Tuolumne	0			
Ventura	5	53	1	1
Yolo	2	10	1	1
Yuba	1	7	1	1
Total	**95**	**663**	**47**	**144**

[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 2020, the California WNV and Dead Bird Call Center and website received 5,850 dead bird reports from the public in 50 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 1,685 carcasses deemed suitable for testing, WNV was detected in 343 (20.4%) carcasses from 21 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 2020, the first WNV positive dead bird was an American Crow reported from Santa Clara County on February 3, and the last WNV positive dead bird was an American Crow reported from Orange County on December 14.

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 2020, West Nile virus infection was detected in 20 horses from 13 counties (Table 4.8). Six of the horses died or were euthanized as a result of their infection.

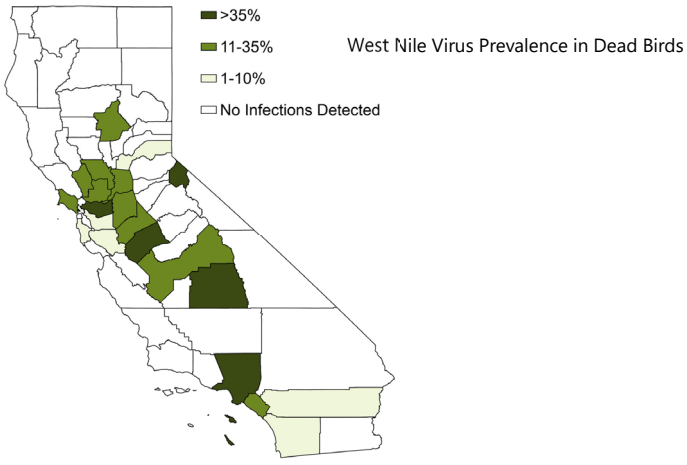


Figure 4.3. Prevalence of West Nile virus infection in dead birds, California, 2020

Table 4.7. Dead birds reported, tested, and positive for West Nile virus, by county, California, 2020

County	Reported	Tested[a]	Positive	%
Alameda	378	117	8	6.8
Alpine	2	2	1	50
Amador	4	0		
Butte	48	12	4	33.3
Calaveras	1	0		
Colusa	1	0		
Contra Costa	501	61	22	36
Del Norte	0			
El Dorado	31	13	0	0
Fresno	194	16	5	31.3
Glenn	1	0		
Humboldt	7	2	0	0
Imperial	1	0		
Inyo	0			
Kern	9	1	0	0
Kings	9	0		
Lake	12	7	0	0
Lassen	0			
Los Angeles	863	200	102	51
Madera	16	0		
Marin	32	3	1	33.3
Mariposa	0			
Mendocino	2	0		
Merced	73	5	2	40
Modoc	0			
Mono	1	0		
Monterey	19	4	0	0
Napa	13	3	1	33.3
Nevada	24	2	0	0
Orange	548	225	47	20.9
Placer	138	57	3	5.3
Plumas	2	0		
Riverside	150	31	2	6.5
Sacramento	709	318	91	28.6
San Benito	2	0		
San Bernardino	67	11	0	0
San Diego	197	111	1	0.9
San Francisco	51	6	0	0
San Joaquin	159	38	4	10.5
San Luis Obispo	16	2	0	0
San Mateo	244	85	1	1.2
Santa Barbara	23	4	0	0
Santa Clara	486	152	7	4.6
Santa Cruz	79	18	0	0
Shasta	20	1	0	0
Sierra	0			
Siskiyou	0			
Solano	83	28	3	10.7
Sonoma	62	7	0	0
Stanislaus	178	12	4	33.3
Sutter	37	11	0	0
Tehama	5	0		
Trinity	0			
Tulare	54	12	5	41.7
Tuolumne	1	1	0	0
Ventura	61	18	0	0
Yolo	211	88	29	33
Yuba	25	1	0	0
Totals	**5,850**	**1,685**	**343**	**20.4**

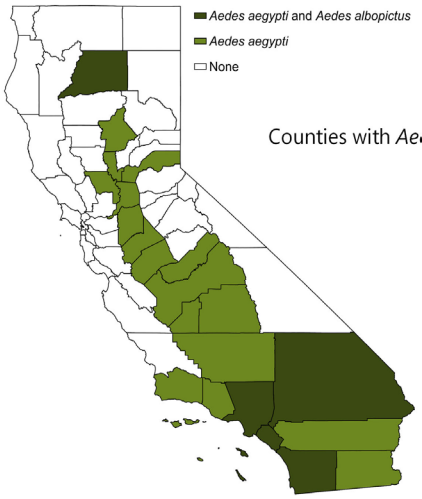
[a] Tested by the University of California Davis Arboviral Research and Training or local mosquito/vector control agency

Table 4.8. Infections with West Nile virus in humans, horses, dead birds, mosquito pools, and sentinel chickens, by county, California, 2020

County	Humans[a]	Horses	Dead Birds	Mosquito Pools	Sentinel Chickens
Alameda	0	0	8	0	0
Alpine	0	0	1	NT	NT
Amador	0	2	NT	NT	NT
Butte	4	1	4	28	23
Calaveras	0	0	NT	NT	2
Colusa	0	0	NT	NT	0
Contra Costa	4	0	22	13	7
Del Norte	0	0	NT	NT	NT
El Dorado	1	0	0	NT	NT
Fresno	12	0	5	322	NT
Glenn	1	1	NT	3	2
Humboldt	0	0	0	NT	NT
Imperial	1	0	NT	3	NT
Inyo	0	0	NT	0	NT
Kern	10	0	0	83	NT
Kings	2	1	NT	87	NT
Lake	2	0	0	12	2
Lassen	0	0	NT	NT	NT
Los Angeles	98	0	102	437	38
Madera	6	0	NT	77	NT
Marin	0	0	1	0	NT
Mariposa	0	0	NT	NT	NT
Mendocino	0	0	NT	NT	NT
Merced	14	1	2	42	14
Modoc	0	1	NT	NT	NT
Mono	0	0	NT	0	NT
Monterey	0	0	0	NT	NT
Napa	0	0	1	2	NT
Nevada	0	1	0	NT	0
Orange	19	0	47	326	NT
Placer	2	0	3	58	NT
Plumas	0	0	NT	NT	NT
Riverside	12	2	2	64	NT
Sacramento	9	1	91	115	4
San Benito	0	0	NT	0	1
San Bernardino	4	1	0	13	NT
San Diego	1	0	1	2	NT
San Francisco	0	0	0	0	NT
San Joaquin	4	4	4	260	NT
San Luis Obispo	0	0	0	0	NT
San Mateo	0	0	1	0	0
Santa Barbara	0	0	0	1	0
Santa Clara	1	0	7	8	NT
Santa Cruz	0	0	0	0	0
Shasta	2	0	0	25	3
Sierra	0	0	NT	NT	NT
Siskiyou	0	0	NT	NT	NT
Solano	1	1	3	8	4
Sonoma	0	0	0	0	NT
Stanislaus	38	3	4	351	NT
Sutter	1	0	0	20	26
Tehama	2	0	NT	NT	5
Trinity	0	0	NT	NT	NT
Tulare	7	0	5	189	10
Tuolumne	0	0	0	NT	NT
Ventura	0	0	0	0	1
Yolo	5	0	29	77	1
Yuba	0	0	0	2	1
State Totals	**263**	**20**	**343**	**2,628**	**144**

[a]Includes asymptomatic infections detected through blood bank screening

NT= no samples tested



Counties with *Aedes* mosquitoes, California, 2020

Figure 4.4. Invasive *Aedes* mosquito detections, by county, California, 2020

Invasive mosquito surveillance

Three species of invasive *Aedes* mosquitoes were detected and 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 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 311 cities or census-designated places (CDP) in 24 counties; populations of *Ae. aegypti* and *Ae. albopictus* are considered established in 22 and 4 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.

In 2020, *Aedes aegypti* mosquitoes were discovered for the first time in 23 new cities, 11 CDP, and six counties: Butte, Santa Barbara, Shasta, Sutter, Ventura, and Yolo. *Aedes albopictus* were newly discovered in one city, one CDP, and in Shasta County. Local vector control agencies with invasive *Aedes* continue improving *Aedes*-specific surveillance. Efforts increasingly focused on public education and outreach programs with emphasis on the public's role in helping minimize invasive *Aedes* habitat on private property and the use of personal protection measures against mosquito bites. Agencies responded to travel-associated human cases of *Aedes*-borne arboviruses, such as Zika, 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*. A total of 14,066 *Ae. aegypti* and 128 *Ae. albopictus* were tested for chikungunya, dengue, and Zika viruses; all were negative.

5 U.S. Forest Service Cost-Share Agreement

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

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

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

This report briefly reviews activities carried out under the agreement by the California Department of Public Health, Vector-Borne Disease Section (CDPH-VBDS) and local collaborators in 2020. 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. COVID-19 travel restrictions in 2020 affected the availability of CDPH-VBDS biologists to conduct some facility assessments, education, and surveillance activities.

2020 U.S. Forest Service Highlights

- CDPH-VBDS biologists responded to a confirmed human case of bubonic plague in a South Lake Tahoe resident who was likely exposed to the bacterium *Yersinia pestis* on the Lake Tahoe Basin Management Unit (Table 5.2).
- Three (25%) of 12 Forests where plague surveillance and testing occurred showed evidence of plague activity, slightly lower than the 31% R5 Forests with plague activity in 2019 (Table 5.3).
- Nocturnal rodents showed a continued high hantavirus seroprevalence: 9 (16%) of 58 deer mice from USFS lands tested positive, slightly lower than the seroprevalence (23%) in 2019 (Table 5.3).
- Over 2,000 total ticks were collected from seven Forests in 2020 including 1,289 *Ixodes pacificus* and 775 *Dermacentor* spp. A subset of *I. pacificus* ticks were tested for *Borrelia* spp. (Table 5.3).
- CDPH provided virtual safety training to numerous Forests (Table 5.1).
- CDPH-VBDS provided the R5 Safety Officer and Inyo National Forest leadership with a CDC-developed guide to differentiating symptoms of hantavirus pulmonary syndrome and COVID-19 (Table 5.2).

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, 2020

National Forest	Disease Risks 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 Office; Mount Oak Campground; Jackson Lake Picnic Area; Chantry Flat Recreation Area; Sturtevent Falls trail
Cleveland	Hantavirus; Plague; Tick-borne diseases			Supervisor's Office; Descanso, Palomar and Trabuco Ranger District Offices; Blue Jay, Dripping Springs campgrounds; Fry Creek, Maple Springs, Observatory, San Juan, and Wildhorse trails
Eldorado	Hantavirus; Plague; Tick-borne diseases	Laufman Fire Station, Leek Springs Lookout		Supervisor's Office; Amador, Georgetown, Pacific, and Placerville Ranger District and Nursery Offices; Big Silver Group and Silver Creek Group and Wolf Creek-Alpine campgrounds; Fleming Meadow Trail System, Leek Springs Fire Lookout; Lumberyard Fire Station
Inyo	Hantavirus; Plague; Tick-borne diseases		Video safety presentation, new employee orientation	Supervisor's Office; Mammoth Lakes, Mono Lake, and Mt. Whitney Ranger District Offices; Interagency Visitor Center; Agnew Meadows, Aspen, Big Bend, Big Springs, Deadman (Upper and Lower), Ellery Lake, Glass Creek, Hartley Springs, Junction, June Lake, Minaret Falls, New Shady Rest, Obsidian Flat, Pumice Flat, Red's Meadow, Saddlebag Lake, Sherwin Creek Campground, Oh! Ridge, Reversed Creek, Rush Creek, Sawmill Walk-in, Tioga Lake and Upper Soda Springs campgrounds; long-term leased lands near Hilton Creek
Klamath				Supervisor's Office; Goosenest Happy Camp/Oak Knoll, Salmon/Scott River Ranger District Offices
Lake Tahoe Basin Management Unit	Plague			LTBMU Supervisors Office; Tallac Historical Site; Taylor Creek Visitor Center; Kiva Picnic Area; Tallac Point; Fallen Leaf, Kaspian, Meeks Bay, and William Kent campgrounds; Hartoonian Trails
Lassen	Plague			Supervisor's Office; Almanor, Eagle Lake, and Hat Creek Ranger District Offices;
Los Padres	Hantavirus; Plague; Tick-borne diseases			Supervisor's Office; Mt. Pinos, Ojai, Santa Barbara, and Santa Lucia Ranger District Offices; Cerro Alto, Chuchupate, Freemont, Los Prietos, Paradise, Upper Oso, and Wheeler Gorge campgrounds; Falls, First Crossing, Live Oak, Lower Oso, and White Rock day use areas; Aliso, Cerro Alto, Cold Springs, Jesuita, Deal, Gene Manzana, Marshall-Piedra Blanca, Potrero John, Rinconada, Romero, Snyder, and Wheeler Gorge Nature trails
Mendocino	Plague			Supervisors Office; Grindstone Ranger District Office
Modoc	Plague			Supervisor's Office; Big Valley, Devil's Garden, Doublehead, Devil's Garden, and Warner Mountain Ranger Districts; Blue Lake and Patterson Guard Station campgrounds
Plumas	Hantavirus; Plague; Tick-borne diseases		Remote safety presentation on plague and hantavirus	Supervisor's Office; Beckwourth, Feather River, and Mt. Hough Ranger District Offices; Big Cove, Frenchman, Gold Lake, Goose Lake, Grasshopper Flat, Grizzley, Haven Lake, Lighting Tree, Snag Lake, and Spring Creek campgrounds; Gray Eagle Creek and Smith Lake trails
San Bernardino	Hantavirus; Plague; Tick-borne diseases			Supervisor's Office, Front Country, Mountaintop, and San Jacinto Ranger District Offices; Kenworthy Ranger Station; Applewhite, Barton Flats, Fern Basin, Hart Bar, Holcomb Valley, Marion Mountain, Pineknot, San Gorgonio and Serrano campgrounds; Bonita Falls, Middle Fork Lytle Creek, Momyer-Alger Creek, Pacific Crest Trail (Deep Creek and Swarthout Canyon areas), Pipe Creek, and South Fork and trails; Penstock Rd.
Sequoia	Hantavirus; Plague; Tick-borne diseases			Supervisor's Office; Kern River, and Western Divide Ranger District Offices; Blackrock Ranger Station; Hot Springs Work Center; Cedar Creek, Fairview, Fish Creek, Headquarters, Horse Meadow, Leavis Flat, Limestone, and Tillie Creek, and Troy Meadow campgrounds, and recreation sites along the Kern River and Kern Plateau; Lower Rincon Trail; South Fork Wildlife Area; Landers Meadow
Shasta-Trinity				Supervisor's Office; Shasta, South Fork, and Trinity River Management Units; Whiskeytown-Shasta Trinity NRA
Sierra	Plague			North Fork
Six Rivers	Tick-borne diseases			Supervisor's Office; Lower Trinity, Mad River, and Orleans Ranger District Offices; Smith River National Recreation Area Office; Old South Kelsey and Paradise trails
Stanislaus	Plague			Supervisor's Office; Calaveras, Groveland, Mi-Wok, and Summit Ranger District Offices; Baker, Big Meadow, Boulder Flat, Brightman Flat, Clark Fork, Clark Fork Horse Camp, Dardanelles, Deadman, Eureka Valley, Meadowview, New Spicer Reservoir Pigeon Flat, Pinecrest, Sand Flat, Sandy Flat, and Stanislaus River campgrounds; Arnot Creek, Clark Fork, Disaster Creek, Kennedy Meadows, Saint Mary's Pass, and Sonora Pass Spicer Meadow trailheads; Cottonwood and Douglas picnic areas; Columns of the Giants; Donnell Vista Point; Cascade Creek OHV Registration Site
Tahoe	Hantavirus; Plague; Tick-borne diseases	Yuba River Ranger District Work Center	Video safety presentations: American River, Sierraville, Truckee, and Yuba River Ranger Districts	Supervisor's Office; American River, Sierraville, Truckee, and Yuba River Ranger District Offices; Yuba River Work Center; Big Bend Group, Boca, Boca Rest, Boyington Mill, Bullards Bar Reservoir, Chapman Creek, Diablo, East Meadow, Goose Meadows, Granite Flat, Hampshire Rocks, Indian Springs, Lakeside, Prosser, Prosser Hill OHV, Packsaddle, Pass Creek, Prosser Ranch, Salmon Creek, Sardine Lake, Silver Creek, Skillman Horse, White Cloud, and Woodchuck campgrounds; Donner Camp and Packer Lake Picnic Sites; Sand Pond Day Use Area; Lochleven Trailhead

[a] Most facility evaluations were suspended in 2020 due to COVID-19 restrictions

[b] Locations visited or contacted by VBDS biologists and not already listed under facility evaluation

Table 5.2: Vector-Borne Disease Related Services and Findings, USFS-CDPH Cost-Share Agreement, 2020

National Forest	Unique Services/ Unusual Findings
Angeles / San Gabriel Mountain National Monument	All 256 *Ixodes pacificus* ticks collected from the Chantry Flat Recreation Area in 2020 tested negative for *Borrelia* pathogens.
Cleveland	Responsible individuals of facilities inspected for hantavirus evaluations in previous years submitted follow-up surveys about post-surveillance recommendations and the utility of evaluations. Copies of the surveys were also provided to the R5 Safety Officer.
Eldorado	Four (36%) of 11 deer mice trapped at Big Silver Group Campground were positive for antibodies to Sin Nombre virus (SNV), causative agent for hantavirus pulmonary syndrome (HPS).Test results and recommendations were communicated to Ranger District and Forest leadership.
Inyo	Posted a plague warning sign at Sherwin Creek Campground and informed campground hosts of the potential for plague in the area after two rodents tested positive by serology for *Yersinia pestis,* causative agent for plague. Forest leadership was also informed by email of the positive test results.
Lake Tahoe Basin Management Unit	Performed environmental follow-up of a non-fatal human plague case detected in a resident of South Lake Tahoe with likely exposure from LTBMU recreation land. Based on positive rodent and flea test results confirming the presence of *Y. pestis* in the area, VBDS biologists placed insecticidal bait stations and conducted burrow treatments for flea control at several recreation areas including Kiva Picnic Area and Tallac Point. Post-treatment assessment showed flea treatments to be effective in reducing the flea abundance to less than one per rodent sampled. Communicated findings and recommendations to Management Unit leadership.
Lassen	A black bear (*Ursus americanus*), from lands adjacent to the Forest was serologically positive for *Yersinia pestis,* the causative agent of plague.
Los Padres	One (1%) of 91 *I. pacificus* ticks collected from the Cerro Alto trail was positive for *Borrelia miyamotoi*, a bacteria that causes relapsing fever; no human cases detected yet in California.
Modoc	None of the 22 yellow-pine chipmunks (*Tamias amoenus*) nor one Belding's ground squirrel (*Urocitellus beldingi*) from Blue Lake Campground and Patterson Guard Station were positive for antibodies to *Y. pestis*.
Plumas	VBDS biologists conducting routine plague surveillance at Grasshopper Flat Campground recovered a golden-mantled ground squirrel (*Callospermophilus lateralis*) carcass, which tested negative for plague and tularemia (*Franciscella tularensis*).
San Bernardino	Collected a western grey squirrel (*Sciurus griseus*) carcass for plague testing from the Forest PIO; carcass could not be tested due to a heavy maggot infestation in the carcass. Adult tick surveillance on the Forest yielded 464 total ticks comprising three species, *Dermacentor hunteri* (10), *D. occidentalis* (193), *and I. pacificus* (261).
Sequoia	One (33%) of three deer mice collected and tested from Troy Meadow Campground was positive for antibodies to Sin Nombre virus, causative agent for hantavirus pulmonary syndrome (HPS).
Stanislaus	Four rodents collected from Dardanelle Campground tested negative for antibodies to *Y. pestis*. Three flea pools tested were also negative for plague bacteria.
Six Rivers	Twenty-two *I. pacificus* ticks from Old South Kelsey and Paradise trails tested negative for *Borrelia* pathogens.
Tahoe	A chipmunk carcass collected from Hampshire Rocks Campground was positive for *Y. pestis* bacteria. Follow-up field surveillance at the campground by VBDS biologists found 17 rodents and 18 flea pools negative for *Y. pestis* antibodies or bacteria, respectively. Test results and recommendations were communicated to District and Forest leadership. A yellow-pine chipmunk sampled and tested from Prosser Creek Reservoir Campground was positive for antibodies to plague. Forest and District leadership were notified of test results.
R5 (District Level)	Held a virtual annual meeting with Region 5 Safety Officer. Provided pre-season letter for distribution throughout Region 5. Provided the R5 Safety Officer with a CDC developed guide to differentiating hantavirus pulmonary syndrome from COVID-19. Submitted pesticide use report on USFS lands. Provided additional results of facility evaluation follow-up questionnaires.

Table 5.3. Testing results for selected vector-borne disease agents in U.S. National Forests, California, 2020

National Forest	Hantavirus		*Yersinia pestis*						*Borrelia spp.*[b]	
	Peromyscus mice		rodents		flea pools		carnivores[a]		*Ixodes* ticks	
	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested	Positive	Tested
Angeles			0	9			0	3	0	256
Cleveland	0	2	0	2					0	157
Eldorado	8	36	0	8			0	1	0	75
Inyo	0	8	2	62						
Lake Tahoe BMU			16	91	5	191	0	3		
Lassen							0	2		
Los Padres	0	2	0	39					1	184
Mendocino							0	1		
Modoc			0	23	0	11				
Plumas			0	12[c]	0	6	1	1		
San Bernardino	0	5	0	11					0	244
Sequoia	1	3	0	47			0	1		
Sierra							0	1		
Six Rivers									0	22
Stanislaus			0	5	0	3				
Tahoe	0	2	2[d]	81	0	70			0	4
Total, all forests	**9**	**58**	**20**	**390**	**5**	**281**	**1**	**13**	**1**	**942**

[a] 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.

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

[c] One golden-mantled ground squirrel (*Callospermophilus lateralis*) carcass collected by VBDS biolgists, tested negative for plague and tularemia (*Franciscella tularensis*)

[d] One chipmunk carcass from Hampshire Rocks campground tested positive for plague bacteria.

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 74 continuing education events in 2020. 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 2020, 1,202 Vector Control Technicians employed at 104 local public health agencies and the CDPH held 2,921 certificates (Table 6.2). The agencies include special districts, departments of county government, departments of city government, and CDPH. Of these agencies, 73 are signatory to a cooperative agreement with CDPH.

In 2020, 927 individuals employed at 74 agencies held full certification status. In addition, 275 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 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 2020

Exam section	No. Exams Given	No. Passed (%)
Core	74	113 (65)
Mosquito Control	79	131 (60)
Terrestrial Invertebrate Control	60	90 (67)
Vertebrate Vector Control	68	91 (75)
Totals	**281**	**425 (66)**

Table 6.2. Vector Control Technician certificates in effect as of December 2020

	No. Certificates		
Certification Category	Full Status	Limited Status	Total
Mosquito Control	917	195	1,112
Terrestrial Invertebrate Vector Control	728	151	879
Vertebrate Vector Control	736	194	930
Totals	**2,381**	**540**	**2,921**

7 Public Information Materials, Publications

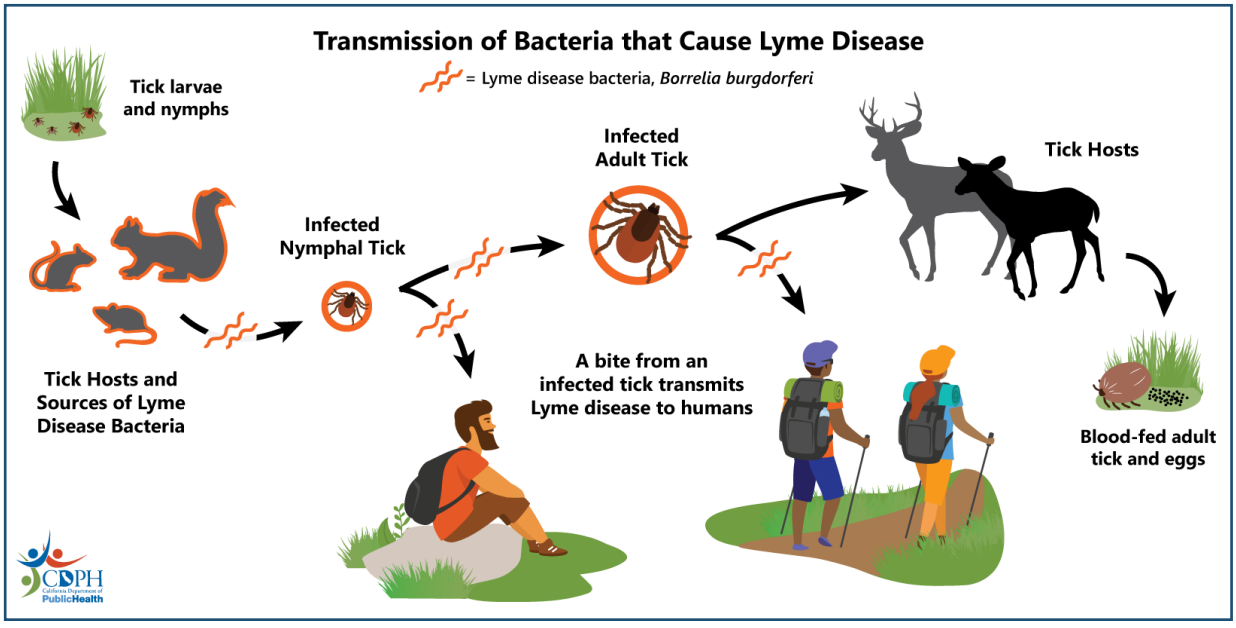
A goal of the California Department of Public Health, Vector-Borne Disease Section is to provide clear and effective information on disease prevention. This goal is pursued through approaches including presentations, development and distribution of printed and digital materials, and maintenance of websites 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 2020

- *Transmission of Bacteria that Cause Lyme Disease* (graphic)

Expanded resources in 2020

- *Westnile.ca.gov* (website)
- *Tick-Borne Diseases: Occupational Health Toolkit* (webpage)
- *Protect Yourself from Ticks Where You Work* (fact sheet)



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