Marin/Sonoma

Mosquito and Vector Control

District

2023

Vector Surveillance Report

595 Helman Lane, Cotati, CA 94931

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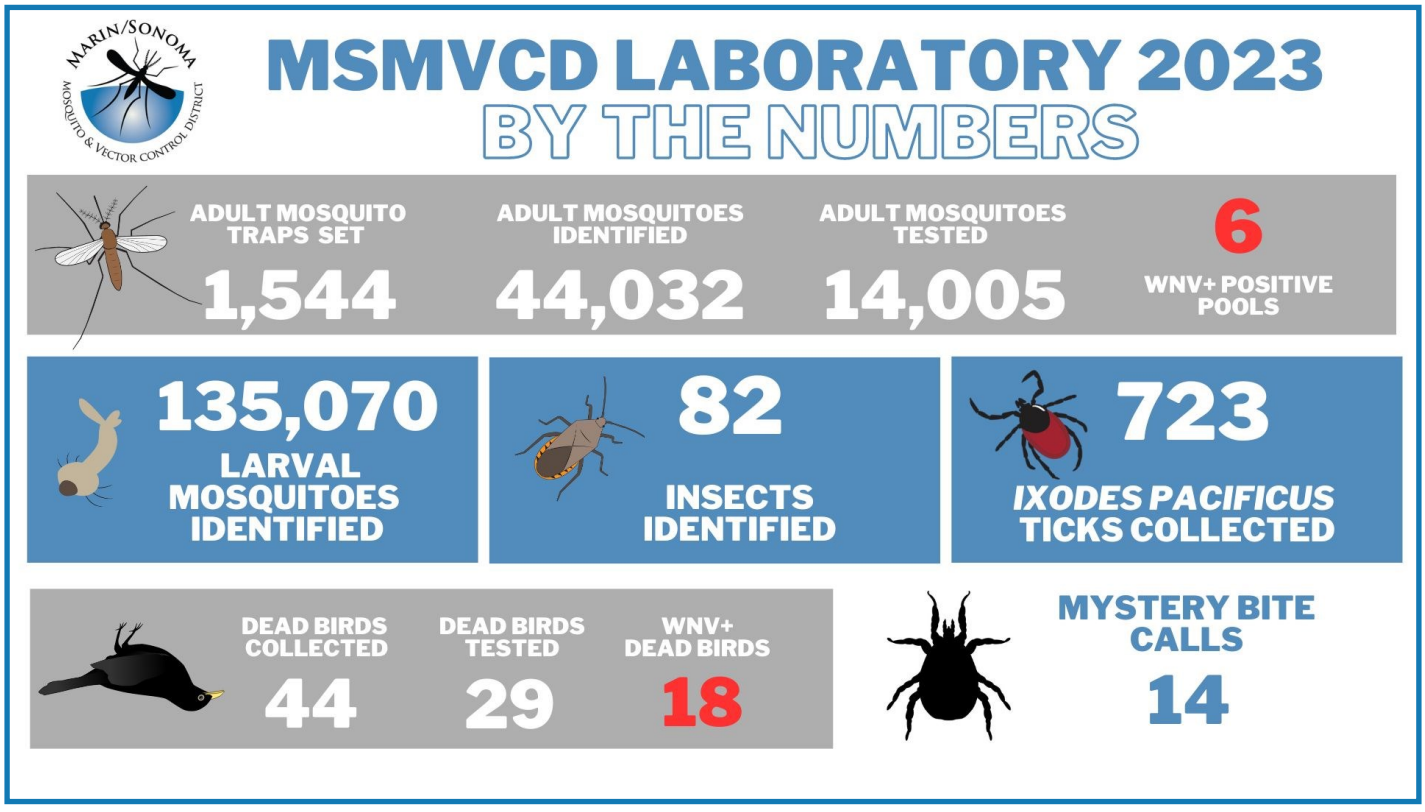
Laboratory Program Overview

Programs and Activities

The laboratory at the Marin/Sonoma Mosquito and Vector Control District (the District) contributes to the District's mission of protecting the health and welfare of the communities it serves in many ways. This includes monitoring the species distribution and abundance of vectors and vector-borne diseases, evaluating the efficacy of mosquito control materials and equipment, and providing support for operations staff in surveillance and control. On a regular basis, laboratory staff are busy working on a number of projects and activities. Operations staff bring in larval samples daily for the laboratory to identify, helping the District to know where and when different species are active, and when it is time to institute source reduction and/or treat sources with a larvicide. Members of the public also submit photos and specimens of insects for laboratory staff to identify. This year the District processed 82 submissions. In addition, laboratory staff work closely with the District's Rodent Control Specialist on unique cases involving mystery biting incidents, with particular attention to the tropical rat mite, as they can cause a significant issue for the public. The infographic below shows the extensive work completed by the laboratory in 2023.



Laboratory Program Overview

Arbovirus Surveillance Program

The Marin/Sonoma Mosquito and Vector Control District (the District) maintains a multifaceted surveillance program for arboviruses, including West Nile virus (WNv), St. Louis encephalitis virus (SLEv), and western equine encephalitis virus (WEEv). The District utilizes active and passive surveillance techniques to detect and quantify the density of mosquito populations and the intensity of virus transmission in the region. This information is then used to predict areas of elevated disease risk and inform critical vector control interventions to effectively and efficiently protect human health.

Since 2014, the District has conducted enhanced invasive mosquito surveillance efforts. The invasive species *Aedes aegypti* and *Aedes albopictus* have expanded their range throughout California, reaching closer to our county borders every year. These mosquitoes are aggressive daytime biters, and can make it virtually impossible to enjoy outdoor activities. They can also transmit diseases that our native mosquitoes cannot, making them a potential threat to public health. Neither species has been found in Marin or Sonoma counties, but we need your help! Call if you're being bitten by any mosquitoes, and make sure to let us know if it's during the daytime!

Adult Mosquito Traps

Encephalitis Vector Survey Trap
CO^2 and light attract adult mosquitoes

Gravid Trap
Nutrient rich water attracts female mosquitoes that are looking to lay eggs

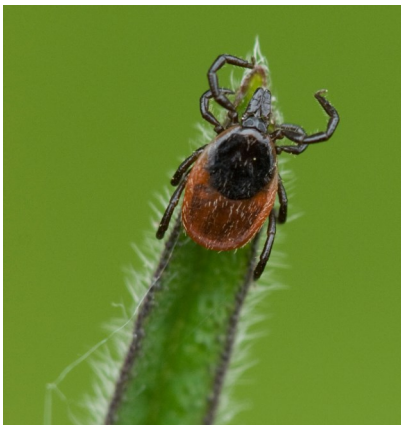
BG Sentinel Trap
CO^2 and a scented lure attract adult mosquitoes

Laboratory Program Overview

Tick and Tick-Borne Disease Surveillance Program

Throughout the year, District laboratory staff collect ticks of different species and life stages from trails in state, regional, and local parks and recreation areas around Marin and Sonoma counties. Ticks are collected by dragging a one meter square flannel flag on the ground and in the vegetation along trails. Collected specimens are identified and separated by species, sex, and life stages to be tested for pathogens when appropriate. The three main species collected by the District are *Dermacentor occidentalis* (the Pacific Coast tick), *Dermacentor variabilis* (the American dog tick), and *Ixodes pacificus* (the western black-legged tick).

Ixodes pacificus is the common tick species in the area that can transmit *Borrelia burgdorferi*, the bacterium that causes Lyme disease. Adults and nymphs of this species are tested for this pathogen, as well as *Borrelia miyamotoi,* which is a bacteria that causes a relapsing fever-type illness. This bacteria has been found in *I. pacificus* throughout the state, including in Marin and Sonoma counties. In 2022, California's first human case of disease linked to *B. miyamotoi* was identified in Marin County. *I. pacificus* also transmits the human pathogen *Anaplasma phagocytophilum*. In 2023, the District collaborated with the California Department of Public Health to test a subset of *I. pacificus* for this bacteria.



Ixodes pacificus female questing

Tick species of Marin and Sonoma counties

Dermacentor occidentalis
Pacific Coast tick

Dermacentor variabilis
American dog tick

Ixodes pacificus
Western black-legged tick

Arbovirus Surveillance

Arbovirus Surveillance Program

In 2023, 158 mosquito pools* from Marin County and 530 pools from Sonoma County were tested for WNv, SLEv, and WEEv. WNv was detected in six mosquito pools in Sonoma County. No mosquito pools tested positive in Marin County.

A total of 44 dead birds were collected, of which 29 were suitable for WNv testing. Sixteen birds from Sonoma County and two birds from Marin County tested positive.

One human case of SLEv was identified in a resident of Marin County and one human WNv case was identified in a resident of Sonoma County. Exposure in both cases occurred outside California.

*Female mosquitoes of the same species collected in the same trap are pooled by species (up to 50 per tube) to be tested for the presence of WNv, SLEv, and WEEv.

County	Species	# of Pools
Marin	*Culex erythrothorax*	54
	Culex pipiens	7
	Culex stigmatosoma	13
	Culex tarsalis	84
Sonoma	*Culex erythrothorax*	50
	Culex pipiens	68
	Culex stigmatosoma	86
	Culex tarsalis	326

WNv detection 2004 - 2023

Year	Humans	Dead Birds	Mosquito Pools*	Sentinel Chickens
2004	0	72	1	0
2005	1	92	0	0
2006	1	29	5	0
2007	1	23	1	0
2008	0	12	2	0
2009	0	N/A	0	0
2010	0	N/A	0	0
2011	0	N/A	2	0
2012	0	28	3	1
2013	2	46	5	3
2014	0	43	12	3
2015	1	14	12	0
2016	0	13	2	N/A
2017	0	6	1	N/A
2018	0	0	1	N/A
2019	0	0	0	N/A
2020	0	1	0	N/A
2021	0	1	2	N/A
2022	0	1	0	N/A
2023	**1**	**18**	**6**	**N/A**

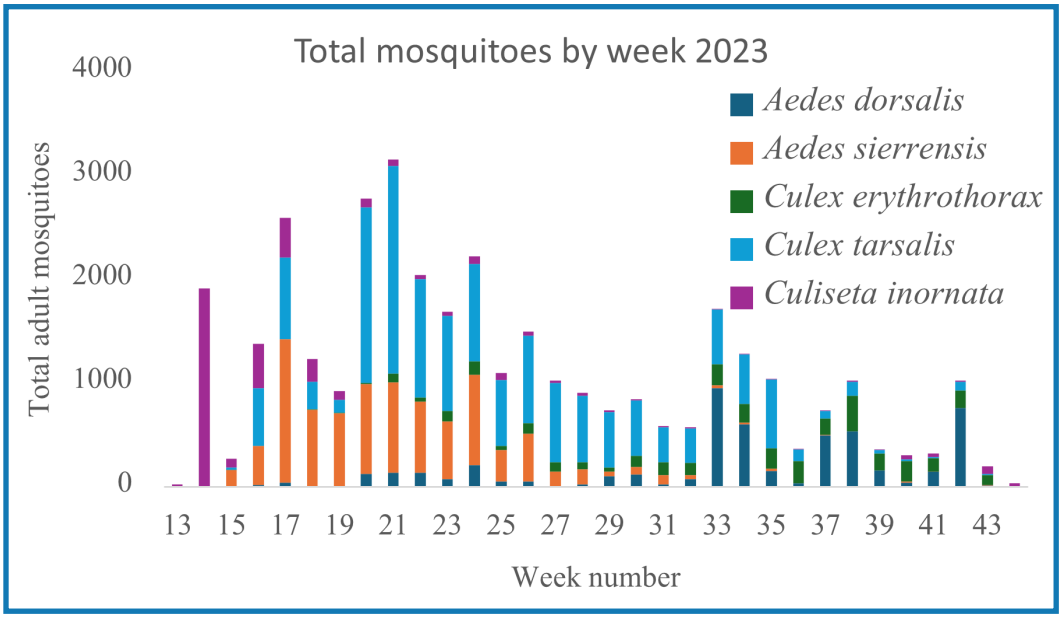
N/A indicates that testing was not conducted

West Nile Virus Dead Bird Hotline

The California Department of Public Health runs a hotline that residents from any county in the state can call when they find a dead bird. If you find one, please let them know! When birds are the right species in the right conditions, the District can have them tested for WNv. Visit westnile.ca.gov for more info.

Adult mosquitoes in 2023

Adult Mosquito Surveillance Program

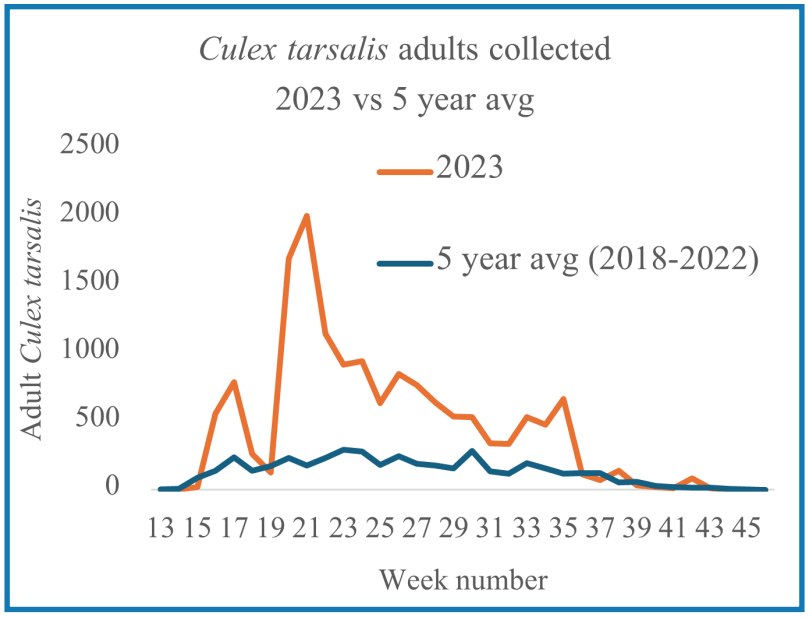


DID YOU KNOW

Different mosquito species are active at different times of the year! This depends on the temperature, the water they lay their eggs in, and many other factors. The graph to the left shows how the species composition of our five most abundant species changed between April and November of last year.

Culex tarsalis: the western encephalitis mosquito

In 2023, the District collected more *Culex tarsalis* adults per trap than any other *Culex* species. As the primary vector of WNv, this species is of significant public health importance. The larvae are ubiquitous in agricultural, commercial, man-made, and natural sources, and can withstand a higher salt concentration than other *Culex* species. The substantial rains in the winter of 2023 provided even more habitat for these mosquitoes to lay their eggs. When excessive rain floods salt marshes, the water can become dilute enough for *Cx. tarsalis* to thrive. This is likely what happened in 2023, leading to higher than normal larval and adult counts.



Executive Summary

Tick and Tick-Borne Disease Surveillance Program

In 2023, staff from the District visited 10 parks in 25 sampling events, resulting in 540 *Ixodes pacificus* adults and 183 *I. pacificus* nymphs collected for testing. A multiplex real-time polymerase chain reaction (PCR) assay was used to test these ticks for two bacteria: *Borrelia burgdorferi* (the causative agent of Lyme disease) and *Borrelia miyamotoi* (a related bacterium that can cause a relapsing fever-type illness). Nymphal ticks were tested individually, while adult ticks were pooled by collection date, location, and sex. A maximum of five ticks were placed in each pool. In previous years, nymphal ticks were tested in pools as well. Therefore overall infection prevalences for both counties are presented below as Minimum Infection Prevalence (MIP).

Minimum Infection Prevalence (MIP) = (number of positive tick pools/total ticks tested)*100

***Ixodes pacificus* testing for *Borrelia burgdorferi*: 2008 - 2023**

County	Total Adults	Minimum Infection	Total Nymphs	Minimum Infection
Marin	7,704	2.05%	2,574	4.16%
Sonoma	9,242	1.56%	2,675	4.07%
Overall	16,946	1.78%	5,250	4.11%

***Ixodes pacificus* testing for *Borrelia miyamotoi*: 2016 - 2023**

County	Total Adults Tested	Minimum Infection Prevalence	Total Nymphs Tested	Minimum Infection Prevalence
Marin	2,700	1.37%	965	0.93%
Sonoma	2,914	0.65%	832	1.08%
Overall	5,614	1.00%	1,797	1.00%

2023 Overview

Marin County: Ten pools of adults and three nymphs tested positive for *Borrelia burgdorferi.* Two pools of adults tested positive for *Borrelia miyamotoi.* No nymphs tested positive for *Borrelia miyamotoi.*

Sonoma County: Three pools of adults and two nymphs tested positive for *Borrelia burgdorferi.* Three pools of adults tested positive for *Borrelia miyamotoi.* No nymphs tested positive for *Borrelia miyamotoi.*

Visit our website at *www.msmosquito.org/tick-surveillance* for detailed information about cumulative tick collections at specific parks.

2023 Adult Tick Testing

Tick and Tick-Borne Disease Surveillance Program

County	Park/Trail	Adults Tested (Pools)	*Borrelia burgdorferi*		*Borrelia miyamotoi*	
			Pos. Pools	MIP	Pos. Pools	MIP
Marin	Lomo Alto Open Space Preserve*	215 (48)	6	2.79%	2	0.93%
	Baywood Canyon Trail*	99 (22)	0	0.00%	1	1.01%
	Old White Hill Grade Fire Rd.*	116 (26)	6	5.17%	1	0.86%
	Roy's Redwoods Open Space Preserve	30 (7)	0	0.00%	0	0.00%
	Loop Trail	30 (7)	0	0.00%	0	0.00%
	Samuel P. Taylor State Park*	73 (20)	4	5.48%	0	0.00%
	Bill's Trail*	13 (5)	2	15.38%	0	0.00%
	Devil's Gulch Fire Rd.*	60 (15)	2	3.33%	0	0.00%
	Tomales Bay State Park*	6 (3)	0	0.00%	0	0.00%
	Indian Nature Trail*	6 (3)	0	0.00%	0	0.00%
	Johnstone Trail*	0	n/a	n/a	0	0.00%
	Total	**324 (78)**	**10**	**3.09%**	**2**	**0.62%**
Sonoma	Annadel State Park	3 (2)	0	0.00%	0	0.00%
	Lawndale Trail	3 (2)	0	0.00%	0	0.00%
	North Burma Trail	0	n/a	n/a	n/a	n/a
	Armstrong Redwoods State Natural Reserve*	28 (10)	1	3.57%	0	0.00%
	East Ridge Trail*	17 (6)	0	0.00%	0	0.00%
	Pool Ridge Trail*	11 (4)	1	9.09%	0	0.00%
	Doran Beach Regional Park*	0	n/a	n/a	n/a	n/a
	Unspecified Trail*	0	n/a	n/a	n/a	n/a
	North Sonoma Mountain Regional Park	12 (4)	1	8.33%	0	0.00%
	Umbrella Tree Trail	12 (4)	1	8.33%	0	0.00%
	Sonoma Valley Regional Park	173 (39)	1	0.58%	3	1.73%
	Milkmaid Trail*	101 (22)	0	0.00%	1	0.99%
	Valley of the Moon Trail*	64 (15)	1	1.56%	1	1.56%
	Woodland Star Trail*	8 (2)	0	0.00%	1	12.50%
	Sugarloaf State Park	0	n/a	n/a	n/a	n/a
	Creekside Nature Trail	0	n/a	n/a	n/a	n/a
	Total	**216 (55)**	**3**	**1.39%**	**3**	**1.39%**

Minimum Infection Prevalence (MIP) = (number of positive tick pools/total ticks tested)*100

[#] indicates site/trail not previously sampled

2023 Nymphal Tick Testing

Tick and Tick-Borne Disease Surveillance Program

County	Park/Trail	Nymphs Tested	*Borrelia burgdorferi*		*Borrelia miyamotoi*	
			Pos. Pools	MIP	Pos. Pools	MIP
Marin	Lomo Alto Open Space Preserve*	7	2	28.57%	0	0.00%
	Baywood Canyon Trail*	0	n/a	n/a	n/a	n/a
	Old White Hill Grade Fire Rd.*	7	2	28.57%	0	0.00%
	Roy's Redwoods Open Space Preserve	55	0	0.00%	0	0.00%
	Loop Trail	55	0	0.00%	0	0.00%
	Samuel P. Taylor State Park*	11	0	0.00%	0	0.00%
	Bill's Trail*	5	0	0.00%	0	0.00%
	Devil's Gulch Fire Rd.*	6	0	0.00%	0	0.00%
	Tomales Bay State Park*	14	1	7.14%	0	0.00%
	Indian Nature Trail*	14	1	7.14%	0	0.00%
	Johnstone Trail*	0	n/a	n/a	n/a	n/a
	Total	**87**	**3**	**3.45%**	**0**	**0.00%**
Sonoma	Annadel State Park	35	0	0.00%	0	0.00%
	Lawndale Trail	0	n/a	n/a	0	0.00%
	North Burma Trail	35	0	0.00%	0	0.00%
	Armstrong Redwoods State Natural Reserve*	37	1	2.70%	0	0.00%
	East Ridge Trail*	23	1	4.35%	0	0.00%
	Pool Ridge Trail*	14	0	0.00%	0	0.00%
	Doran Beach Regional Park*	0	n/a	n/a	n/a	n/a
	Unspecified Trail*	0	n/a	n/a	n/a	n/a
	North Sonoma Mountain Regional Park	14	1	7.14%	0	0.00%
	Umbrella Tree Trail	14	1	7.14%	0	0.00%
	Sonoma Valley Regional Park	0	n/a	n/a	n/a	n/a
	Milkmaid Trail*	0	n/a	n/a	n/a	n/a
	Valley of the Moon Trail*	0	n/a	n/a	n/a	n/a
	Woodland Star Trail*	0	n/a	n/a	n/a	n/a
	Sugarloaf State Park	10	0	0.00%	n/a	n/a
	Creekside Nature Trail	10	0	0.00%	n/a	n/a
	Total	**96**	**2**	**2.08%**	**0**	**0.00%**

Infection Prevalence (IP) = (number of positive ticks/total ticks tested)*100

[#] indicates site/trail not previously sampled

Tick Safety Tips

Tick and Tick-Borne Disease Surveillance Program

Before entering tick habitat, take the following precautions

- Consider applying an effective tick repellent to exposed skin that has one of the following EPA-registered active ingredients: DEET, picaridin, IR3535, oil of lemon eucalyptus (OLE), or para-menthane-diol (PMD).
- Consider pretreating clothing/personal outdoor equipment with a product labeled for tick protection, such as permethrin.
- It is important to read repellent and permethrin product labels carefully before applying.
- Wear light-colored clothing (making it easier to spot ticks).
- Wear long pants, long sleeves, and long socks whenever possible. This makes it more difficult for ticks to get to your skin.

While in tick habitat

- Stay on trails. Adult ticks are typically more abundant on uphill sides of trails.
- Avoid contact with nymphal habitats, including leaf litter, downed logs, and tree trunks.
- Periodically check people and animals for ticks.

After exiting tick habitat

- Check people and animals for ticks, promptly removing any that might be on clothing or skin.
- Tumble dry clothes in a dryer on high heat for 10 minutes to kill ticks.
- Shower after coming indoors and carefully check for ticks.
- Properly remove any attached ticks immediately.

How to properly remove a tick

- Ideally, use tweezers to grasp the head of the tick as close to the skin as possible.
- Pull upward with steady, even pressure. DO NOT twist or jerk the tick; this can cause the mouthparts to break off and remain in the skin. If this happens, remove the mouthparts with tweezers. If you are unable to remove the mouthparts easily with clean tweezers, leave it alone and let the skin heal.
- After removing the tick, thoroughly clean the bite area and your hands with rubbing alcohol or soap and water.
- Never crush a tick with your fingers. Dispose of a live tick by putting it in alcohol, placing in a sealed bag/container, wrapping it tightly in tape, or flushing it down the toilet.
- If redness or pain develops at the tick site, consult your physician.