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# Marin/Sonoma

# Mosquito and Vector Control

# District



## 2022

## Vector Surveillance Report

595 Helman Lane, Cotati, CA 94931

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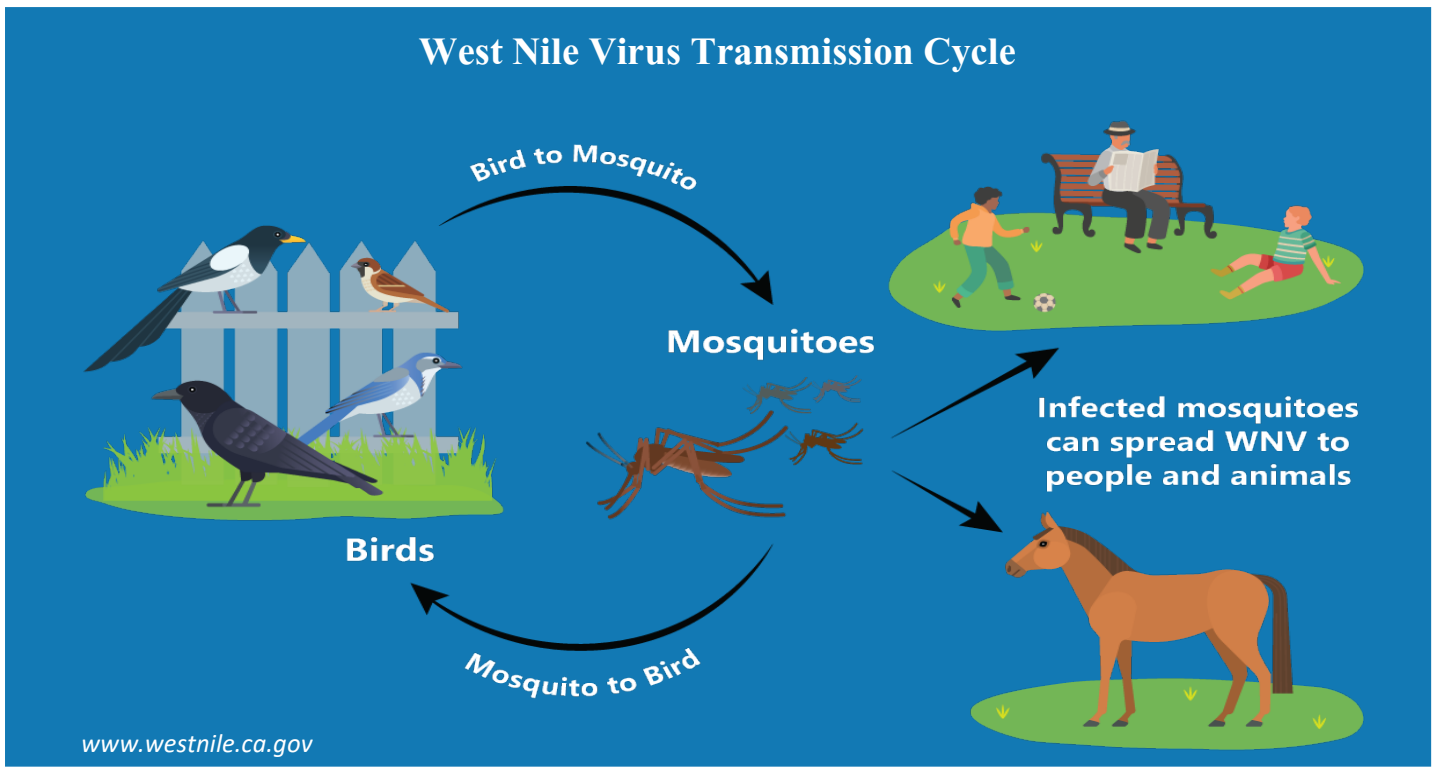
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# Laboratory Program Overview

## 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 direct critical vector control interventions to effectively and efficiently protect human health.

Since 2014, the District has conducted enhanced invasive mosquito surveillance efforts. The invasive *Aedes aegypti* and *Aedes albopictus* species have spread 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 county, 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!



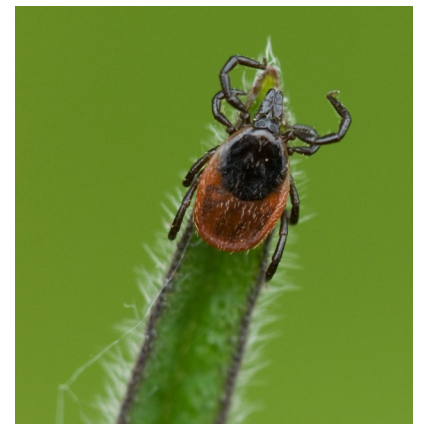
# Laboratory Program Overview

## 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 2022, the District collaborated with the California Department of Public Health to test a subset of *I. pacificus* for this bacteria.



*Ixodes pacificus* female questing

### ***Borrelia miyamotoi* in Marin and Sonoma counties**

*Borrelia miyamotoi* is a bacterium transmitted by *Ixodes pacificus*, potentially causing a relapsing fever-type illness in humans. While evidence of this bacteria has been found in ticks and human blood, there had been no confirmed human cases of *B. miyamotoi* disease in California until 2022. Since 2016, the District has tested *Ixodes pacificus* for this bacterium. The minimum infection prevalence in Marin and Sonoma counties is 1.00% in adults and 1.12% in nymphs. Additional information about testing can be found on pages five through seven of this report. The first human case of disease caused by *B. miyamotoi* in California was identified in a Marin County resident in 2022. Laboratory staff collaborated with county, state, and federal health entities to conduct follow-up. Details will be published in an upcoming article in the Emerging Infectious Diseases journal.



# Executive Summary

## Arbovirus Surveillance Program

In 2022, 87 mosquito pools\* from Marin County and 192 pools from Sonoma County were tested for WNV, SLEv, and WEEv. WNV was not detected in any mosquito pools in Sonoma or Marin County.

A total of 32 dead birds were reported, of which 23 were viable for WNV testing. One bird from Petaluma in Sonoma County tested positive for WNV. No birds submitted from Marin County tested positive.

One human case of WNV was identified in a resident of Sonoma County. Exposure likely occurred outside of the county.

\*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	<i>Culex erythrothorax</i>	47
	<i>Culex pipiens</i>	20
	<i>Culex stigmatosoma</i>	7
	<i>Culex tarsalis</i>	13
Sonoma	<i>Culex erythrothorax</i>	76
	<i>Culex pipiens</i>	39
	<i>Culex stigmatosoma</i>	38
	<i>Culex tarsalis</i>	39

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
<b>2022</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>N/A</b>

N/A indicates 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](http://westnile.ca.gov) for more info.



# Executive Summary

## Tick and Tick-Borne Disease

### Surveillance Program

In 2022, staff from the District visited nine parks in 37 sampling events, resulting in 1,302 adult *Ixodes pacificus* adults and 302 *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 and on pages 6 and 7 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 - 2022

County	Total Adults Tested	Minimum Infection Prevalence	Total Nymphs Tested	Minimum Infection Prevalence
Marin	7,378	2.01%	2,488	4.18%
Sonoma	9,026	1.56%	2,579	4.11%
Overall	16,406	1.76%	5,067	4.14%

#### *Ixodes pacificus* testing for *Borrelia miyamotoi*: 2016 - 2022

County	Total Adults Tested	Minimum Infection Prevalence	Total Nymphs Tested	Minimum Infection Prevalence
Marin	2,376	1.47%	878	1.03%
Sonoma	2,698	0.59%	736	1.22%
Overall	5,076	1.00%	1,614	1.12%

### 2022 Overview

**Marin County:** Thirteen pools of adults and four nymphs tested positive for *Borrelia burgdorferi*. Thirteen pools of adults and no nymphs tested positive for *Borrelia miyamotoi*.

**Sonoma County:** Three pools of adults and two nymphs tested positive for *Borrelia burgdorferi*. Four pools of adults and two nymphs tested positive for *Borrelia miyamotoi*.

Visit our website at [www.msosquito.org/tick-surveillance](http://www.msosquito.org/tick-surveillance) for detailed information about cumulative tick collections at specific parks.



# 2022 Adult Tick Testing

## Tick and Tick-Borne Disease Surveillance Program

County	Park/Trail	Adults Tested (Pools)	<i>Borrelia burgdorferi</i>			<i>Borrelia miyamotoi</i>		
			Pos. Pools	2022 MIP	2008-2022 MIP	Pos. Pools	2022 MIP	2016-2022 MIP
Marin	<b>Golden Gate National Recreation Area</b>	<b>99 (27)</b>	<b>3</b>	<b>3.03%</b>	<b>2.94%</b>	<b>3</b>	<b>3.03%</b>	<b>2.94%</b>
	Marincello Trail	21 (6)	0	0.00%	0.00%	2	9.52%	9.52%
	Miwok Trail <sup>#</sup>	28 (7)	1	3.57%	3.57%	0	0.00%	0.00%
	Oakwood Valley Trail <sup>#</sup>	39 (10)	2	5.13%	5.13%	1	2.56%	2.56%
	Rhubarb Trail <sup>#</sup>	11 (4)	0	0.00%	0.00%	0	0.00%	0.00%
	<b>Marin Municipal Water District</b>	<b>68 (16)</b>	<b>2</b>	<b>2.94%</b>	<b>2.48%</b>	<b>2</b>	<b>2.94%</b>	<b>1.74%</b>
	Alex Forman Trail	61 (14)	1	1.64%	2.60%	1	1.64%	1.20%
	Sunnyside Trail	7 (2)	1	14.29%	3.90%	1	14.29%	14.29%
	<b>Mt. Burdell Open Space Preserve<sup>#</sup></b>	<b>117 (27)</b>	<b>2</b>	<b>1.71%</b>	<b>1.71%</b>	<b>1</b>	<b>0.85%</b>	<b>0.85%</b>
	Middle Burdell Fire Rd. <sup>#</sup>	36 (9)	0	0.00%	0.00%	0	0.00%	0.00%
	San Carlos Fire Rd. <sup>#</sup>	81 (18)	2	2.47%	2.47%	1	1.23%	1.23%
	<b>White Hill Open Space Preserve<sup>#</sup></b>	<b>493 (101)</b>	<b>6</b>	<b>1.22%</b>	<b>1.22%</b>	<b>7</b>	<b>1.42%</b>	<b>1.42%</b>
	Sherwood Forest Fire Rd. <sup>#</sup>	49 (10)	0	0.00%	0.00%	0	0.00%	0.00%
	Unspecified Trail <sup>#</sup>	14 (3)	1	7.14%	7.14%	0	0.00%	0.00%
	White Hill Trail <sup>#</sup>	430 (88)	5	1.16%	1.16%	7	1.63%	1.63%
	<b>Total</b>	<b>777 (171)</b>	<b>13</b>	<b>1.67%</b>	<b>2.01%</b>	<b>13</b>	<b>1.67%</b>	<b>1.47%</b>
Sonoma	<b>Foothill Regional Park</b>	<b>27 (8)</b>	<b>0</b>	<b>0.00%</b>	<b>0.97%</b>	<b>0</b>	<b>0.00%</b>	<b>0.66%</b>
	Oakwood Trail	12 (3)	0	0.00%	1.02%	0	0.00%	0.00%
	Pond A Trail	12 (3)	0	0.00%	0.00%	0	0.00%	0.00%
	Three Lakes Trail	0 (0)	N/A	N/A	0.00%	N/A	N/A	0.00%
	Westside Trail	3 (2)	0	0.00%	1.82%	0	0.00%	0.00%
	<b>Riverfront Regional Park</b>	<b>12 (6)</b>	<b>1</b>	<b>8.33%</b>	<b>8.57%</b>	<b>0</b>	<b>0.00%</b>	<b>0.00%</b>
	Lake Trail	2 (2)	0	0.00%	0.00%	0	0.00%	0.00%
	Unspecified Trail	10 (4)	1	10.00%	10.00%	0	0.00%	0.00%
	<b>Spring Lake Regional Park</b>	<b>237 (52)</b>	<b>1</b>	<b>0.42%</b>	<b>0.87%</b>	<b>4</b>	<b>1.69%</b>	<b>1.66%</b>
	Nature Trail	237 (52)	1	0.42%	1.01%	4	1.69%	1.69%
	<b>Stillwater Cove Regional Park<sup>#</sup></b>	<b>112 (31)</b>	<b>0</b>	<b>0.00%</b>	<b>0.00%</b>	<b>0</b>	<b>0.00%</b>	<b>0.00%</b>
	Beach Trail <sup>#</sup>	13 (6)	0	0.00%	0.00%	0	0.00%	0.00%
	Canyon Trail <sup>#</sup>	1 (1)	0	0.00%	0.00%	0	0.00%	0.00%
	Cove Trail <sup>#</sup>	1 (1)	0	0.00%	0.00%	0	0.00%	0.00%
	Stillwater Bluff Trail <sup>#</sup>	97 (23)	0	0.00%	0.00%	0	0.00%	0.00%
	<b>Trione-Annadel State Park</b>	<b>137 (29)</b>	<b>1</b>	<b>0.73%</b>	<b>2.29%</b>	<b>0</b>	<b>0.00%</b>	<b>0.79%</b>
	Lawndale Trail	125 (26)	0	0.00%	0.80%	0	0.00%	0.87%
	Richardson Trail	4 (1)	0	0.00%	0.00%	0	0.00%	0.00%
	Spring Creek Trail	8 (2)	1	12.5%	12.50%	0	0.00%	0.00%
	Steve's Trail <sup>#</sup>	0 (0)	N/A	N/A	N/A	N/A	N/A	N/A
<b>Total</b>	<b>525 (126)</b>	<b>3</b>	<b>0.57%</b>	<b>1.56%</b>	<b>4</b>	<b>0.76%</b>	<b>0.59%</b>	

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

<sup>#</sup> indicates site/trail not previously sampled



# 2022 Nymphal Tick Testing

## Tick and Tick-Borne Disease Surveillance Program

County	Park/Trail	Nymphs Tested	<i>Borrelia burgdorferi</i>			<i>Borrelia miyamotoi</i>		
			Pos. Ticks	2022 IP	2008-2022 MIP	Pos. Ticks	2022 IP	2016-2022 MIP
Marin	<b>Golden Gate National Recreation Area</b>	<b>53</b>	<b>1</b>	<b>1.89%</b>	<b>1.75%</b>	<b>0</b>	<b>0.00%</b>	<b>0.00%</b>
	Marincello Trail	0	N/A	N/A	N/A	N/A	N/A	N/A
	Miwok Trail <sup>#</sup>	0	N/A	N/A	N/A	N/A	N/A	N/A
	Oakwood Valley Trail <sup>#</sup>	53	1	1.89%	1.89%	0	0.00%	0.00%
	Rhubarb Trail <sup>#</sup>	0	N/A	N/A	N/A	N/A	N/A	N/A
	<b>Marin Municipal Water District</b>	<b>66</b>	<b>3</b>	<b>4.55%</b>	<b>4.67%</b>	<b>0</b>	<b>0.00%</b>	<b>1.92%</b>
	Alex Forman Trail	56	3	5.36%	3.98%	0	0.00%	2.20%
	Sunnyside Trail	10	0	0.00%	0.00%	0	0.00%	0.00%
	<b>Mt. Burdell Open Space Preserve<sup>#</sup></b>	<b>5</b>	<b>0</b>	<b>0.00%</b>	<b>0.00%</b>	<b>0</b>	<b>0.00%</b>	<b>0.00%</b>
	Middle Burdell Fire Rd. <sup>#</sup>	3	0	0.00%	0.00%	0	0.00%	0.00%
	San Carlos Fire Rd. <sup>#</sup>	2	0	0.00%	0.00%	0	0.00%	0.00%
	<b>White Hill Open Space Preserve<sup>#</sup></b>	<b>56</b>	<b>0</b>	<b>0.00%</b>	<b>0.00%</b>	<b>0</b>	<b>0.00%</b>	<b>0.00%</b>
	Sherwood Forest Fire Rd. <sup>#</sup>	0	N/A	N/A	0.00%	N/A	N/A	0.00%
	Unspecified Trail <sup>#</sup>	16	0	0.00%	0.00%	0	0.00%	0.00%
	White Hill Trail <sup>#</sup>	40	0	0.00%	0.00%	0	0.00%	0.00%
<b>Total</b>	<b>180</b>	<b>4</b>	<b>2.22%</b>	<b>4.18%</b>	<b>0</b>	<b>0.00%</b>	<b>1.03%</b>	
Sonoma	<b>Foothill Regional Park</b>	<b>4</b>	<b>0</b>	<b>0.00%</b>	<b>1.28%</b>	<b>0</b>	<b>0.00%</b>	<b>3.51%</b>
	Oakwood Trail	0	N/A	N/A	0.00%	N/A	N/A	N/A
	Pond A Trail	4	0	0.00%	0.00%	0	0.00%	0.00%
	Three Lakes Trail	0	N/A	N/A	0.00%	N/A	N/A	N/A
	Westside Trail	0	N/A	N/A	0.00%	N/A	N/A	N/A
	<b>Riverfront Regional Park</b>	<b>6</b>	<b>0</b>	<b>0.00%</b>	<b>0.00%</b>	<b>0</b>	<b>0.00%</b>	<b>0.00%</b>
	Lake Trail	0	N/A	N/A	N/A	N/A	N/A	N/A
	Unspecified Trail	6	0	0.00%	0.00%	0	0.00%	0.00%
	<b>Spring Lake Regional Park</b>	<b>42</b>	<b>1</b>	<b>2.38%</b>	<b>2.91%</b>	<b>1</b>	<b>2.38%</b>	<b>2.27%</b>
	Nature Trail	42	1	2.38%	2.17%	1	2.38%	2.38%
	<b>Stillwater Cove Regional Park<sup>#</sup></b>	<b>18</b>	<b>0</b>	<b>0.00%</b>	<b>0.00%</b>	<b>0</b>	<b>0.00%</b>	<b>0.00%</b>
	Beach Trail <sup>#</sup>	1	0	0.00%	0.00%	0	0.00%	0.00%
	Canyon Trail <sup>#</sup>	17	0	0.00%	0.00%	0	0.00%	0.00%
	Cove Trail <sup>#</sup>	0	N/A	N/A	0.00%	N/A	N/A	0.00%
	Stillwater Bluff Trail <sup>#</sup>	0	N/A	N/A	0.00%	N/A	N/A	0.00%
	<b>Trione-Annadel State Park</b>	<b>52</b>	<b>1</b>	<b>1.92%</b>	<b>6.19%</b>	<b>1</b>	<b>1.92%</b>	<b>2.13%</b>
	Lawndale Trail	0	N/A	N/A	0.00%	N/A	N/A	N/A
	Richardson Trail	0	N/A	N/A	N/A	N/A	N/A	N/A
	Spring Creek Trail	49	1	2.04%	4.94%	1	2.04%	2.04%
	Steve's Trail <sup>#</sup>	3	0	0.00%	0.00%	0	0.00%	0.00%
<b>Total</b>	<b>122</b>	<b>2</b>	<b>1.64%</b>	<b>4.11%</b>	<b>2</b>	<b>1.64%</b>	<b>1.22%</b>	

Infection Prevalence (IP) = (number of positive ticks/total ticks tested)\*100 Minimum Infection Prevalence (MIP) = (number of positive tick pools/total ticks tested)\*100  
<sup>#</sup> 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.