The Connecticut Agricultural Experiment Station
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Tracking the Ticks: The Active Tick Surveillance Program

The Active Tick Surveillance Program (ATSP) was established in Connecticut in the Spring of 2019 and continued in 2020. With an estimated 476,000 Lyme disease cases annually across the United States – along with at least 17 other tick-borne diseases currently recognized of significant medical concern – ticks, primarily the blacklegged tick (aka deer tick), *Ixodes scapularis*, are the most important arthropod vector harboring zoonotic pathogens that cause human disease. Monitoring evolving changes in tick populations and emerging new species in Connecticut is critical in the mitigation and reduction of tick-borne pathogens that influence thousands of Lyme disease and other tick-associated illnesses documented in our own state every year.

Figure 1. Life stages of *Ixodes scapularis*, Top left: Larva. Bottom left: Nymph. Center: Adult male. Right: Adult female. Ms. Jamie Cantoni, The Connecticut Agricultural Experiment Station.

The surveillance effort allows Station scientists to be proactive in their attempts to monitor shifts in presence, abundance, and distribution of native and invasive tick species, and their associated risk for potential novel pathogen and disease transmission. The ATSP, in concert with the state-supported, passive surveillance Tick Testing Program, further allows scientists to observe the prevalence of current and expanding tick-borne diseases of significant medical concern including: *Borrelia burgdorferi* (agent of Lyme disease), *Babesia microti* (babesiosis), *Anaplasma phagocytophilum* (anaplasmosis), *B. miyamotoi* (a relapsing fever Borrelia), *B. mayoni* (a new Lyme Borrelia), and the Powassan virus (Powassan encephalitis). The program elucidates a more inclusive representation of tick and pathogen abundance and distribution statewide.

Adhering to standardized guidelines

Figure 2. Adult female deer tick, *I. scapularis*, cdc.gov.

implemented by the Centers for Disease Control and Prevention, the surveillance effort is systematic in its field collection techniques as well as in laboratory procedures for pathogen detection and assessing infection rates. There are several effective methods that can be utilized for tick sampling, including flagging, dragging, walking sampling, CO_2 traps, and even collecting samples directly from a range of hosts. For the ATSP, tick collection is accomplished by dragging the vegetation with a square meter of light-colored cloth (usually canvas or flannel material) attached to a wooden dowel. It is passed over and through vegetation and grasses in a transect of known length that would be considered suitable tick habitat. Host-seeking ticks perceive the drag as an animal and potential bloodmeal, and instinctively latch onto the cloth.

Figure 3. Tick collection. Ms. Jamie Cantoni, The Connecticut Agricultural Experiment Station.

A density estimate is an important parameter in assessing infection prevalence, therefore the area of land sampled helps quantify overall infection occurrence and abundance. Each sampling transect covers an area of 750 square meters and is paced accordingly where the drag is examined for ticks approximately every 25 meters for a total of 30 sets per site. Sampling is timed to coincide with adult and nymphal seasonal and peak activity to attain the most accurate density estimates, and ensure the objectives of the surveillance effort are effectively met. From April through October, when ticks of various stages are known to be most active, specimens are collected from 40 predetermined, publicly accessible sites throughout all 8 counties in Connecticut, 5 sites per county, equating to 30,000 square meters (~7.5 acres) per sampling round.

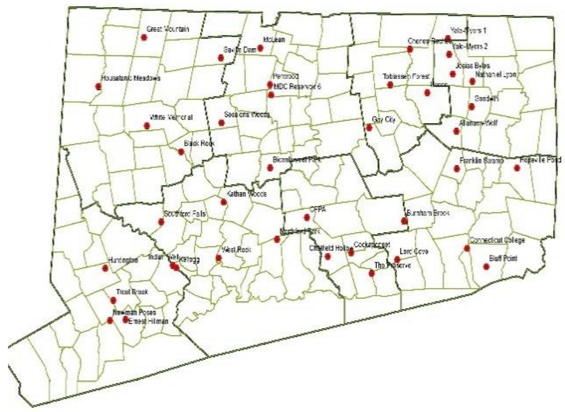

Figure 4. Map of tick dragging locations. The Connecticut Agricultural Experiment Station.

The selected sampling locations represent the type of habitat where ticks would predictably occur (i.e., forested trail systems, brush, grassland, or mixed habitat) and provides a comprehensive depiction of the abundance and distribution of ticks throughout the state. These site-specific samples are then transported back to the Station, identified, catalogued, and subsequently tested for the presence of human disease-causing agents.

Figure 5. Collected adult female lone star tick. Ms. Jamie Cantoni, The Connecticut Agricultural Experiment Station.

Variable results in distribution, abundance, and infection prevalence between surveillance cycles are not uncommon occurrences, often influenced by weather patterns and seasonal events that can affect sampling frequency as well. Each year has the possibility of yielding results in contrast to what was recorded the year prior, further supporting the need for broader surveillance across the state to monitor these changes and enhance public awareness.

Table 1. 2019 Summary of adult and nymph blacklegged tick totals and densities per county.

County	Adult	Nymph	Total Area Dragged	Adult Density / 100 m^2	Nymph Density/ 100 m^2
Fairfield	218	76	22500	0.97	0.34
Hartford	85	34	22500	0.38	0.15
Litchfield	220	119	22500	0.98	0.53
Middlesex	52	35	22500	0.23	0.16
New Haven	176	67	22500	0.78	0.30
New London	219	80	22500	0.97	0.36
Tolland	159	213	22500	0.71	0.95
Windham	103	202	22500	0.46	0.90
Total	1232	826	180000	0.68	0.46

Table 2. 2020 Summary of adult and nymph blacklegged tick totals and densities per county.

County	Adult	Nymph	Total Area Dragged	Adult Density / 100 m^2	Nymph Density/ 100 m^2
Fairfield	61	24	26250	0.23	0.09
Hartford	114	55	26250	0.43	0.21
Litchfield	139	75	26250	0.52	0.29
Middlesex	42	89	26250	0.16	0.34
New Haven	146	175	26250	0.56	0.67
New London	293	206	26250	1.17	0.78
Tolland	192	239	26250	0.73	0.91
Windham	371	256	26250	1.41	0.97
Total	1358	1119	210000	0.65	0.53

Since the initiation of the ATSP in 2019, more than 5,200 tick specimens have been collected, identified, and screened for pathogen presence. Our findings revealed that nearly half of all adult female black-legged ticks were infected with the Lyme disease-causing bacterium, *B. burgdorferi*. However, greater risk of human infection and Lyme disease cases are associated with the much smaller and more difficult to detect nymphal stage of the blacklegged tick, where 20% tested positive for the bacterium.

In concurrence with assessing tick abundance, distribution, and infection prevalence, an additional objective initiating the surveillance effort was the premise for early discovery of new and emerging invaders on our landscape. The challenges of impending climate change and shifting environmental parameters will likely introduce a novel suite of tick species and associated pathogenic concerns. Since the rise of the active surveillance program, new detections of the lone star tick (*Amblyomma americanum*), a species indigenous to the southern U.S., and the exotic Asian longhorned tick (*Haemaphysalis longicornis*) have been confirmed in Fairfield, New Haven, and New London Counties.

Figure 6. Questing adult female lone star tick. USDA.

Table 3. 2019 Summary of percent infection in adult and nymph blacklegged ticks for five different pathogens.

Pathogen	Adults	Nymphs
Borrelia burgdorferi (Lyme disease)	45.8%	15.1%
Babesia microti (babesiosis)	13.0%	6.3%
Anaplasma phagocytophilum (anaplasmosis)	9.0%	5.0%
Borrelia miyamotoi (hard tick relapsing fever)	1.9%	1.6%
Powassan virus (Powassan encephalitis)	0.6%	0.0%

Table 4. 2020 Summary of percent infection in adult and nymph blacklegged ticks for five different pathogens.

Pathogen	Adults	Nymphs
Borrelia burgdorferi (Lyme disease)	48.2%	20.6%
Babesia microti (babesiosis)	8.6%	6.8%
Anaplasma phagocytophilum (anaplasmosis)	7.8%	4.0%
Borrelia miyamotoi (hard tick relapsing fever)	2.7%	1.1%
Powassan virus (Powassan encephalitis)	0.0%	0.4%

We gratefully acknowledge the entire Active Tick Surveillance Team at the CAES in the success of the ATSP over the last two years.

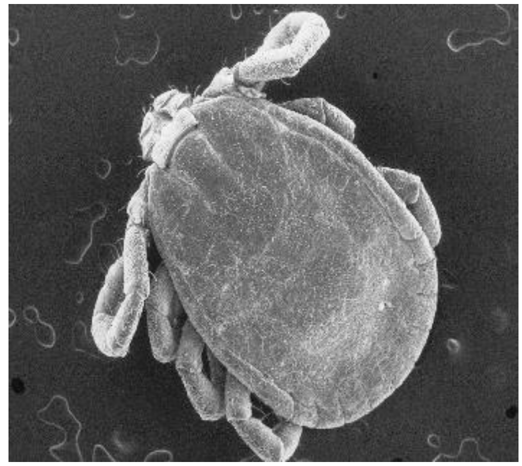

Figure 7. Scanning electron microscopy image of larval Asian longhorned tick. Ms. Jamie Cantoni, The Connecticut Agricultural Experiment Station.

Following the introduction and geographic expansion of several tick species in the state, the need to survey the spread and prevalence of new medically significant tick species in Connecticut, such as the lone star tick, Asian longhorned tick, and the recently detected Gulf Coast tick (*Amblyomma maculatum*), and assess how these emerging ticks might impact the future of pathogen occurrence in our state has been of increasing importance.

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