A Retrospective View of NJDOH's Inaugural State-Wide Tick Surveillance Program

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Introduction

According to the Centers for Disease Control and Prevention, New Jersey has recorded 10% of the country's tick-borne disease (TBD) cases over the last 30 years. In 2023, NJ recorded 7,691 cases of TBD including Lyme disease, anaplasmosis, babesiosis, and ehrlichiosis. In NJ there are five species of tick that have the potential to transmit pathogens with 12 tick-borne pathogens (TBP) of public health concern targeted for statewide surveillance. They are the lone star tick (*Amblyomma americanum*), the recently established Gulf Coast tick (*Amblyomma maculatum*), the American dog tick (*Dermacentor variabilis*), the invasive longhorned tick (*Haemaphysalis longicornis*) and the blacklegged tick (*Ixodes scapularis*). In 2018 the NJ State Assembly introduced legislation requiring existing NJ County Mosquito Control Agencies (CMCA) to begin development of tick control measures. Although this legislation did not pass, NJPHEAL moved forward with the development of a tick surveillance program. Built upon resources and infrastructure developed by the New Jersey mosquito-borne vector screening program and with funding provided by the CDC. Here we describe a retrospective view of that program's inaugural years, focusing on the challenges faced, the results of the first two years, and the long-term goals moving forward.

Methodology

Program Goals

- Surveillance objectives as defined by the NJ Tick Surveillance Recommendation document
  - Classifying county status for ticks of public health concern: reported, established, or no data available for all 21 counties
  - Classifying county status for the presence of specific pathogens of medical concern: present, absent, or no data available
  - Generating estimates for local density of host-seeking or infected nymphs or adults and for local prevalence of specific pathogen by species and life stage
  - Documenting host-seeking phenology of tick life stages in strategic locations across the state
  - Establishing long-term, longitudinal surveillance data to measure changes over time
  - Conducting targeted surveillance to address priority issues

Infrastructure Goals

- Providing funding for interested counties to participate in tick collection and submission
- Providing training via webinars and in person field work on proper techniques for collection, identification, and submission of tick specimens
- Establishing collection sites and site guidelines

Laboratory Goals

- Establishing submission guidelines for receipt and processing of tick specimens
- Processing and extracting RNA and DNA from ticks for either in lab real time polymerase chain reaction (qPCR) testing or submission to the CDC for further characterization
- Developing in house qPCR assays for the detection of TBPs of public health concern

Program Results

Site Selection & Submissions:

- 7 CMCAs actively participated in tick surveillance. NJDOH collected ticks from the remaining 13 counties, for a total of 144 collection sites statewide.
- CMCAs were asked to sample two sites per year to establish population density and 10 additional sites per year during peak nymphal and adult seasons to establish pathogen prevalence
- Monmouth County performs its own tick surveillance

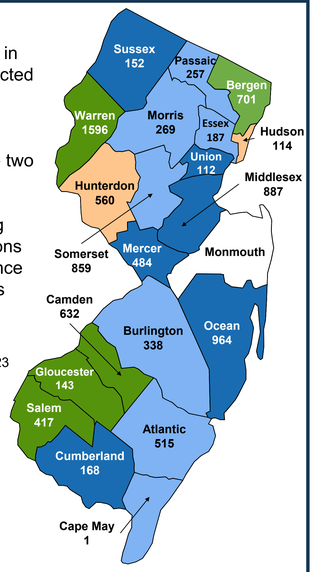


Figure 1: Number of pools collected and collection status of each county 2022-2023

CMCA (Funded)
CMCA (Voluntary)
2 Years State Collections
1 Year State Collections

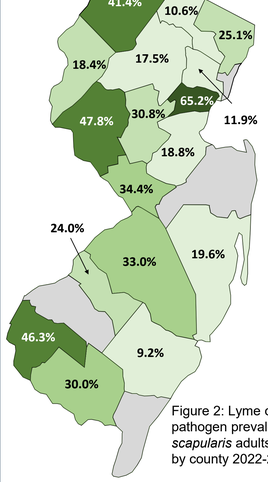


Figure 2: Lyme disease pathogen prevalence in *I. scapularis* adults and nymphs by county 2022-2023

Presence, Prevalence, & Population:

- ≥ 1 positive tick indicates pathogen presence within a county
- ≥ 50 ticks per life stage and county establish pathogen prevalence
- Data generated is publicly available on the NJ Vector-Borne Disease Dashboard which can be accessed through the QR code in the resources section

Training:

- CMCA's were trained in flagging, dragging, and sweeping methods of tick collection
- In 2018, Rutgers University sponsored the "Tick Blitz" a statewide tick collection event which provided training in tick collection to CMCA's
- Additional supplementary in person and webinar training was performed on a per county basis.
- In May 2024 New Jersey will hold the first state-wide training since 2018

Figure 3: Jim Occi collects longhorn tick larva from a flag in Middlesex County. The flag is made of modified PVC piping with sewn flannel fabric for easy removal and washing. Image by Renee Ebersole

Laboratory Results

In House Assay Development:

- A total of 11 TBP were selected due to the prevalence and the impact on public health, divided into 6 qPCR panels
- 3 of the qPCR panels were multiplexed combining TBP that appear within the same species to streamline the processing
- Primer and probe sequences for each pathogen were obtained from literature and sourced from Integrated DNA Technologies.
- PCR cycle conditions were established empirically.

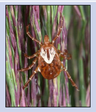
Ixodes scapularis		*Dermacentor variabilis*	*Haemaphysalis longicornis*		*Amblyomma americanum*		*Amblyomma maculatum*
IS Multiplex	Powassan Singleplex	*R. rickettsii* Singleplex	HV-BV Duplex	*R. rickettsii* Singleplex	*AA* Triplex	HV-BV Duplex	*R. parkeri* Singleplex
B. burgdorferi *B. miyamotoi* *B. microti* *A. phagocytophilum* Powassan Virus		*R. rickettsii*	*R. rickettsii* Heartland Virus Bourbon Virus		*E. ewingii* *E. chaffeensis* *R. rickettsii* Heartland Virus Bourbon Virus		*R. parkeri*
							

Table 1: Each column represents the tick species, their respective qPCR assays, the targeted TBPs of interest, and a picture of the tick species.

Submission Guidelines:

- Guidelines were established based on laboratory processing capabilities to meet the goals of establishing pathogen detection/ prevalence in participating counties
- Participating CMCAs can submit a maximum of 1,250 specimens per year regardless of species
- To calculate prevalence and population density CMCA's are encourage to collect at least 25 adult and 25 nymphal specimens of each species per site
- Engorged, attached, and larval tick specimens are not accepted for testing

Tick Pool Submission Guidelines (# of ticks per pool)		
Species	Adult	Nymph
I. scapularis *A. maculatum*	1	1
D. variabilis *H. longicornis*	1	Up to 5
A. americanum	Up to 5	Up to 10

Table 2: Pooling guidelines were based on several factors. First, species exhibiting lower rates of pathogen prevalence can be pooled in higher numbers. Second, the qPCR assays are required to be precise and sensitive enough to detect all pathogens of interest within pooled specimens.

StateWide Infection Rate of Tick Pools					
I. scapularis		*A. americanum*		*A. maculatum*	
B. burgdorferi	25.3%	*E. ewingii*	4.1%	*R. parkeri*	27.8%
B. microti	10.7%	*E. chaffeensis*	6.5%		
B. miyamotoi	2.5%	*R. rickettsii*	0%		
A. phagocytophilum	4.8%	Heartland Virus	0.1%		
Powassan Virus	0.4%	Bourbon Virus	0.1%		

Table 3: Laboratory results representing the percentage infection rate of all adult and nymphal ticks by species and pathogen. Only 36 pools of *A. maculatum* were tested. No positive pools were detected for *D. variabilis* and *H. longicornis*

Findings:

- The pathogen prevalence for *I. scapularis* lines up with historic precedence in NJ (Narvaez et al., 2023) (Egizi et al., 2018)
- Adult and nymphal *I. scapularis* showed a high rate of co-infection for both *B. microti* and *B. burgdorferi*, 6.03%. This aligns with historic rates seen in literature (Diuk-Wasser et al., 2016)

Conclusions

Program Accomplishments:

- Development of qPCR panels proven reliable and robust in the detection of TBPs of interest
- Generation of pathogen presence and prevalence data which is publicly available online
- *I. scapularis*, the species of greatest public health concern in NJ has presence data in 19 of 21 counties and prevalence data for 17 of 21 counties.
- Establishment of 144 collection sites statewide
- Developing Tick Surveillance Recommendation and Submission Guidelines documents

Works In Progress:

- Continue to establish new sites, onboard and train existing CMCA's, and seek additional funding to expand the program and collections
- Continue to build out the database to meet the surveillance objectives set forth in the Tick Surveillance Recommendations document
- Update the Tick Surveillance Recommendations and Submission Guidelines documents to adjust to the program as it grows in scale

Future Goals:

- Develop sequencing assays for specific TBP's building a database of temporal and geographic variation
- Utilize the dataset to define the relationship between tick to human transmission of tick-borne pathogens
- Utilize the dataset to increase public outreach and increase public awareness of tick prevention measures

References

- Diuk-Wasser MA, Vannier E, Krause PJ. Coinfection by Ixodes Tick-Borne Pathogens: Ecological, Epidemiological, and Clinical Consequences. Trends Parasitol. 2016 Jan;32(1):30-42. doi: 10.1016/j.pt.2015.09.008. Epub 2015 Nov 21. PMID: 26613664; PMCID: PMC4713283.
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- Narvaez ZE, Rainey T, Puelle R, Khan A, Jordan RA, Egizi AM, Price DC. Detection of multiple tick-borne pathogens in *Ixodes scapularis* from Hunterdon County, NJ, USA. Curr Res Parasitol Vector Borne Dis. 2023 Aug 21;4:100140. doi: 10.1016/j.crpvbd.2023.100140. PMID: 37680762; PMCID: PMC10481180.

Resources

← Scan here for NJ vector borne dashboard

← Scan here for a PDF copy of this poster

← Scan here for a PDF copy of our qPCR assay development poster

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