The Wild Connection: Small Mammal Abundance as a Predictor for Tick-Borne Diseases

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Background

Small mammals play a vital role in the functioning of an ecosystem and impact human health as they are reservoir hosts for more than eighty zoonotic diseases worldwide including Lyme, anaplasmosis, and babesiosis. These pathogens recently infiltrated the Northern region of Upstate New York with the help of being carried by ticks (O'Connor et al 2021). Climate change is driving the increase of the spread of these diseases because the circumstances of their spread are interconnected with the human population, the vector, the small mammal host and its habitat, as well as the surrounding environment conditions (Gray & Ogden 2021). Species that carry Lyme and anaplasmosis can include the white-footed mouse (Peromyscus leucopus), eastern chipmunk (Tamias striatus), short-tailed shrew (Sorex brevicauda), and masked shrew (Sorex cinereus). In addition, Deer Ticks, in their nymphal stage, can carry babesiosis when they feed on these small mammals.

In this project we tested for relationships between small mammal relative abundance, the relative abundance of ticks, and the percent of ticks positive for three tick-borne diseases, and evaluated whether these patterns changed across rural, urban, and interface regions throughout Potsdam, NY. This project is a part of a larger study to observe the ecosystem connections, focusing on data from Sherman and Pitfall traps. The main questions are (Q1) how is the relative abundance of small mammals related to the relative abundance of ticks?, (Q2) how is the relative abundance of small mammals that are known disease carriers related to the percent of ticks positive for three tick-borne diseases. We hypothesized that sites with higher relative abundance of small mammals will show higher tick relative abundance, and that the relative abundance of known carriers will correlate with an increase in the percent of ticks positive for disease.

Methods

To measure small mammal abundance and check for ticks, we first randomly selected fifteen sites around Potsdam, NY; five sites in rural areas, five sites in urban areas, and five sites in the rural-urban interface (Figure 1). At each site we set a trapping array with one pitfall and four Sherman traps. Each trap type is separated by 20 meters. Pitfall traps are 3-gallon buckets that are placed in a dug-out area, ten meters from one other. Aluminum sheets are placed with wooden stakes down the center of the pits, leading the animal to unknowingly drop in the trap. The four Sherman traps were set in a 1m square and baited with peanut butter and oats.

We opened the trapping arrays for ten days each in June, July, and August. Traps were opened each night between 5:00-8:00pm and checked each morning between 7:00-9:00am. We recorded the species of each small mammal captured, and recorded data using the FieldMaps app from ArcGIS (Figure 2). This research was approved by the Institutional Animal Care and Use Committee at SUNY Potsdam (IACUC Protocol #22-S-045).

To sample ticks at our fifteen sites we used a standardized dragging protocol. Tick dragging consisted of dragging a 1m x 1m piece of light color felt (easy color to spot ticks), for 100 meters at each site, stopping to check for ticks every 20 meters (Figure 3). Ticks were sent to the University of N Texas to be tested for Lyme disease, anaplasmosis, babesiosis, and tick-borne relapsing fever.

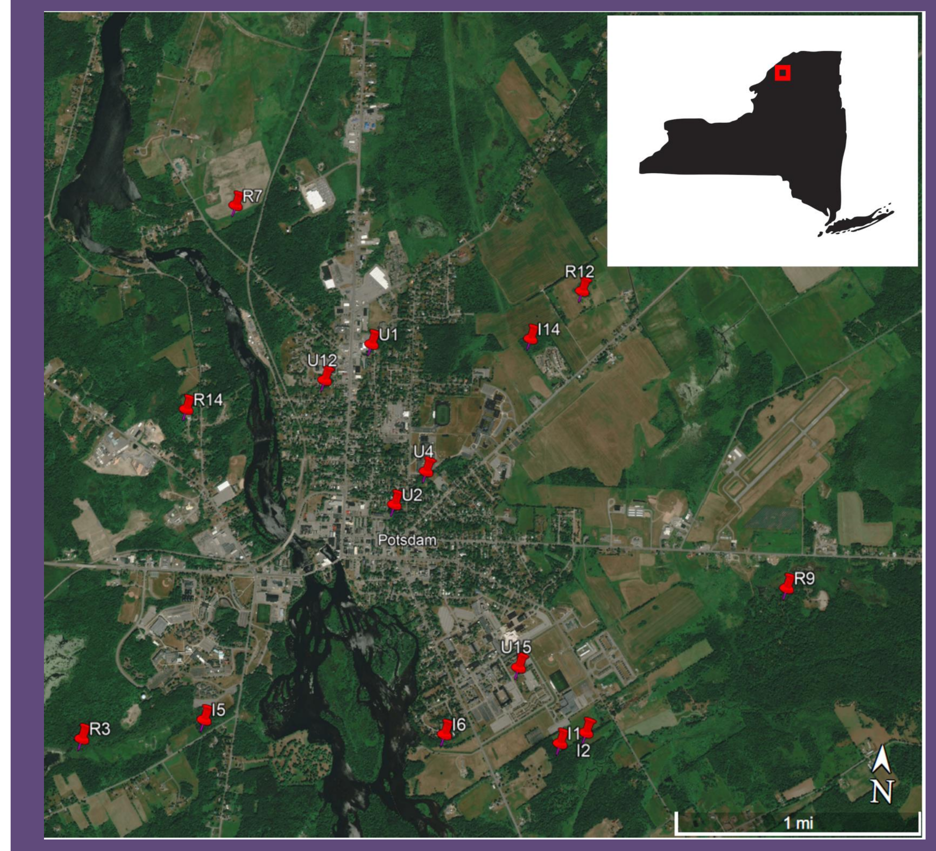

Figure 1: Map of the Study Area

Figure 2: Collection of Species

Figure 3: Tick Dragging

Results

- This project resulted in the capture of a total of 240 small mammals (Table 1), 188 of which represented one of the three species that are the main carriers of Lyme, anaplasmosis, and babesiosis: *Peromyscus spp, Tamias striatus*, and *Blarina brevicauda.*
- We tested Q1 with a simple linear regression and found that total number of carriers at a site is not a significant predictor of the relative abundance of ticks at that site ($p=.484$).
- For Q2, a simple linear regression showed that the relative abundance of the three species that are known competent carriers at a site is a weak but significant predictor for the percent of ticks positive for Lyme Disease at that site ($\beta=0.03$, $p=.043$).

Species	Common Name	Sherman Trap	Pitfall Trap
Peromyscus spp	White-footed/deer mouse	168	1
Tamius striatus	Eastern Chipmunk	23	0
Tamiasciurus hudsonicus	American Red Squirrel	5	0
Blarina brevicauda	Short-tailed Shrew	4	3
Microtus pennsylanicus	Eastern meadow vole	2	6
Parascalops breweri	Hairy-tailed mole	0	2
Sorex cinereus	Masked Shrew	1	28
Clethrionomys gapperi	Southern Red-backed vole	1	0
Napaeozapus insignis	Woodland Jumping Mouse	1	3
TOTAL		**205**	**43**

Table 1: small mammal species captured in June-July 2023, by trap type

Conclusion

The results from this section of the larger project are preliminary. It is important to note that we only captured 40 ticks and need more data, over more time to determine whether there is a stronger significant relationship between our variables. Millien et al 2023 found a "significant effect of the relative abundance of white footed mice on the abundance of infected ticks". This response variable was the percent of ticks at a site that were infected with any pathogen. Similar findings have been documented in other studies (e.g. XXXX), so we anticipate our preliminary findings to hold true in our study area as we accumulate more data.

References

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