COMPARING STABILITY TRENDS IN LONG TERM DEER TICK POPULATION DATASETS

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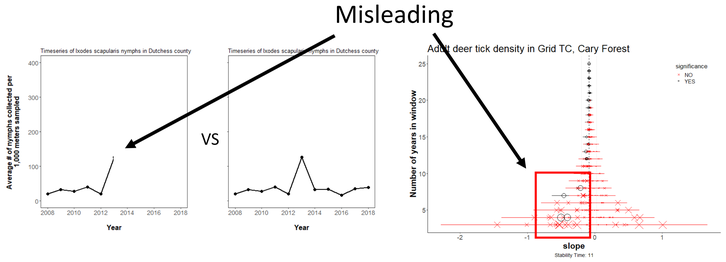
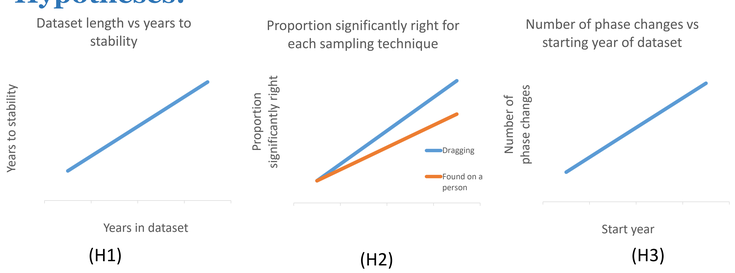
Introduction

Ixodes scapularis, the deer tick, is a primary vector of Lyme disease, making it a critical public health concern. Yet many biology studies are only a few years long, which may be associated with misleading inferences when projected into the future.

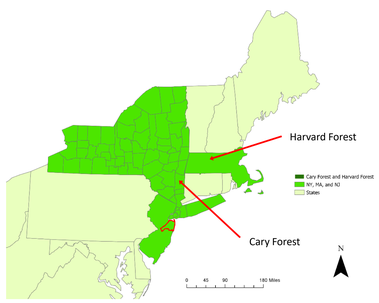


Objective: how do sampling method, timing, and study length affect patterns inferred in long-term deer tick datasets?

Hypotheses:



Methods



Comparing geographical scale of the datasets (Created in ArcGIS)

Data Collection

We compiled 133 public *Ixodes scapularis* datasets that were 9+ years and recorded tick density or count from NY, MA, and NJ with two sampling methods – standardized (dragging) and opportunistic (found on a person).

Data Analysis - Then we ran the 'bad breakup' algorithm (1). This splits long-term datasets into different lengths to examine whether the truncated datasets would reach the same conclusions. We recorded years to reach stability and proportion significant right and wrong (relationships that match/do not match direction of slope). We also ran the regime shift detector (2) – which determines when large, sudden changes (3) in tick density/counts occurred within datasets.

Results

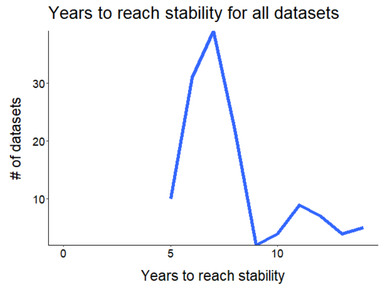


Fig1A: Line chart showing years to reach stability for all datasets. Most of our datasets reached stability within 5 to 10 years. In addition, we found none of the datasets reached stability under 5 years.

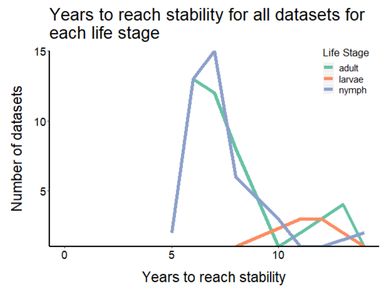


Fig1B: Line chart showing years to reach stability for all datasets for each life stage. We found significant differences in time to stability between adults and larvae (t = -5.1721, p = 0.000186) and nymphs and larvae (t = -5.755, p = 0.0001107).

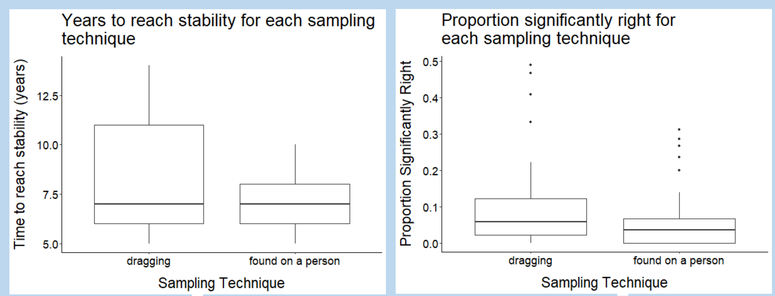


Fig2A: Boxplot showing years to stability grouped by sampling technique. We found significant differences in time to stability between standardized and opportunistic tick sampling (t = 4.1311, p = 6.451e-05).

Fig2B: Boxplot showing proportion significantly right by sampling technique. We found no significant difference in the proportion significantly right between standardized and opportunistic tick sampling (t = -1.9102, p = 0.05892).

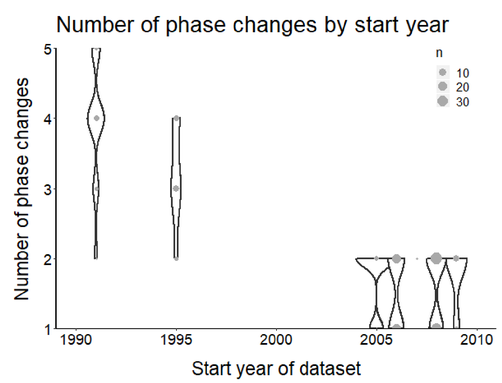


Fig3: Violin plot showing phase changes as a function of dataset start year. N is the number of datasets in a given year. We found no significant differences in phase changes based on the timing of the study (pre and post 1999, t = -11.765, p = 3.088e-13).

Discussion

Our results show the importance of long-term datasets and sampling technique for understanding deer tick populations.

Figures 1A and 1B show than none of the datasets reached stability under 5 years, indicating that studies under 5 years will not have stable patterns, supporting (H1). In addition, Figure 1B shows significant differences in stability time for sampling larvae vs adults and nymphs, providing important insight on the impact of life stage on trend patterns.

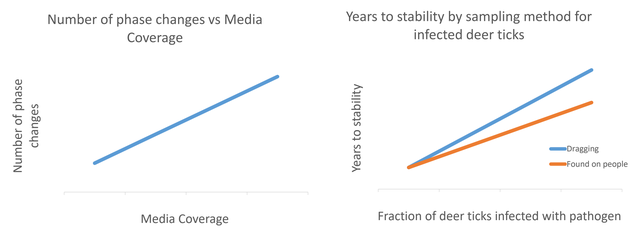
Figure 2A shows that both sampling methods may work, but dragging is likely to be more inconsistent. Figure 2B shows that there is little difference between sampling methods statistically. So overall, results may vary more dragging, but differences are not likely to be significant, contrasting (H2).

Figure 3 shows the number of phase changes not affected significantly by start year of the dataset, contrasting (H3). This indicates that start year may not be an important factor in determining when phase changes happen.

So far, our analysis has helped us find important insights to factors that affect trends in deer tick data, which in turn can aid in understanding Lyme disease trends, which is important for monitoring public health.

Future plans:

Add more datasets to test our next set of predictions:



Acknowledgments

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References

1. Bahlai, C.A. (2019). cbahlai/bad_breakup: The bad breakup Algorithm (Version v1.0). Zenodo. doi.org/10.5281/zenodo.2561051
2. Bahlai, C. A., & Zipkin, E. F. (2019). The Monarch Regime project. Retrieved from https://github.com/cbahlai/monarch_regime
3. Biggs, R., Carpenter, S. R., Brock, W. A., Stockholms universitet, & Stockholm Resilience Centre. (2009). Turning back from the brink: Detecting an impending regime shift in time to avert it. Proceedings of the National Academy of Sciences of the United States of America, 106(3), 826-831. doi:10.1073/pnas.0811729106
4. Carpenter, S. R., & Brock, W. A. (2006). Rising variance: A leading indicator of ecological transition. Ecology Letters, 9(3), 311-318. doi:10.1111/j.1461-0248.2005.00877.x
5. White, E. (2019). Minimum time required to detect population trends: The need for long-term monitoring programs. Bioscience, 69(1), 40-46. doi:10.1093/biosci/biy144
6. FALCO, R., & FISH, D. (1992). a comparison of methods for sampling the deer tick, ixodes-dammini, in a lyme-disease endemic area. Experimental & Applied Acarology, 14(2), 165-173. doi.org/10.1007/BF01219108
7. Ferrell, A., & Brinkerhoff, R. (2018). Using landscape analysis to test hypotheses about drivers of tick abundance and infection prevalence with borrelia burgdorferi. International Journal of Environmental Research and Public Health, 15(4), 737. doi:10.3390/ijerph15040737
8. Ostfeld, R. S., Levi, T., Keesing, F., Oggenfuss, K., & Canham, C. D. (2018). Tick-borne disease risk in a forest food web. Ecology, 99(7), 1562-1573. doi:10.1002/ecy.2386
9. New York State Department of Health Office of Public Health. (2019). Deer Tick Surveillance: Adults (Oct to Dec) excluding Powassan virus: Beginning 2008. https://health.data.ny.gov/Health/Deer-Tick-Surveillance-Nymphs-May-to-Sept-excludin/kibp-u2ip
10. New York State Department of Health Office of Public Health. (2019). Access Nymph Deer Tick Collection Data by County (Excluding Powassan Virus). https://health.data.ny.gov/Health/Deer-Tick-Surveillance-Nymphs-May-to-Sept-excludin/kibp-u2ip
11. Cusser, Bahlai, Swinton, Robertson, Haddad. (2018). Long-term research needed to avoid spurious and misleading trends in sustainability attributes of no-till. doi.org/10.1101/788240
12. White, E. R., & Bahlai, C. A. (2019). Experimenting with the past to improve environmental monitoring programs. doi.org/10.32942/osf.io/cz5va