Ixodes scapularis (Lyme disease vector) population interannual stability trends in long term datasets

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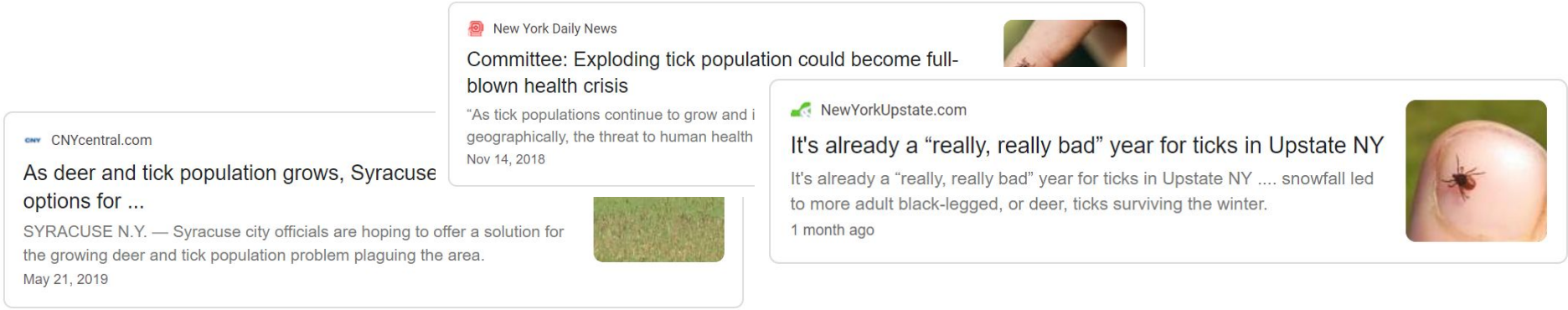
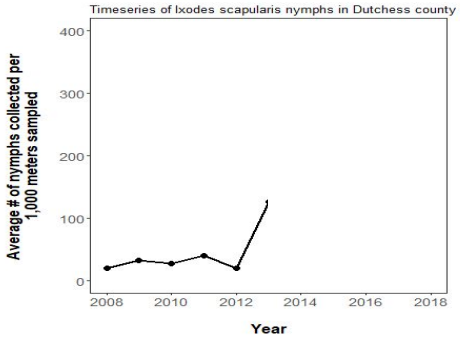
Introduction

- *Ixodes scapularis*, the deer tick, is a primary vector of Lyme disease
- Media coverage suggests that deer tick populations are increasing

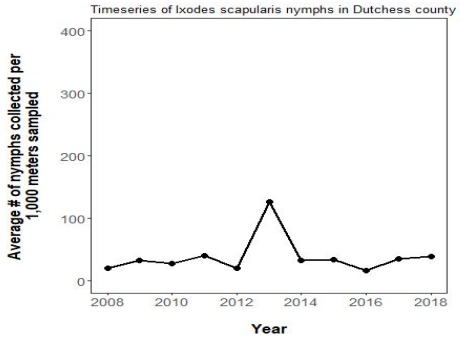


Introduction

- Short term studies may be misleading



vs



- How do short term deer tick trends compare to long term trends?

Methods

Searched for publicly available, long-term deer tick datasets

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Selected 2 datasets: a Cary Forest study (Ostfeld 2018) and Dutchess County (NY State Dept of Health Office of Public Health, 2019)

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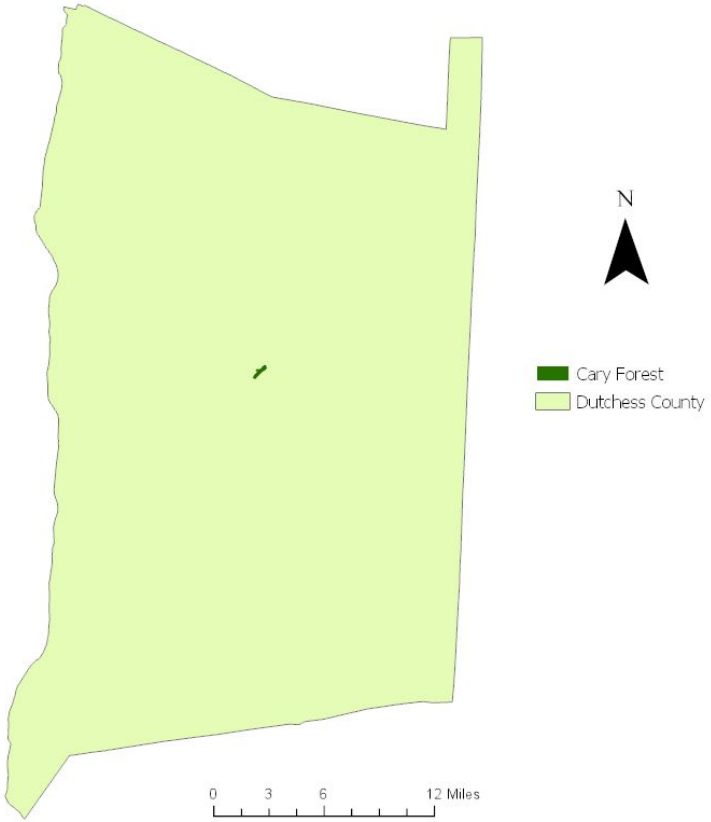

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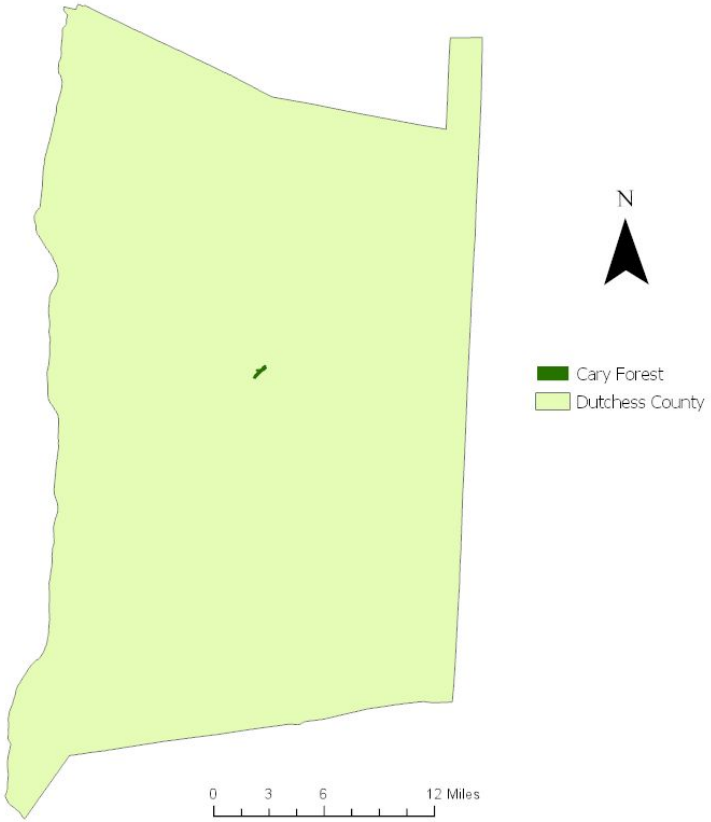
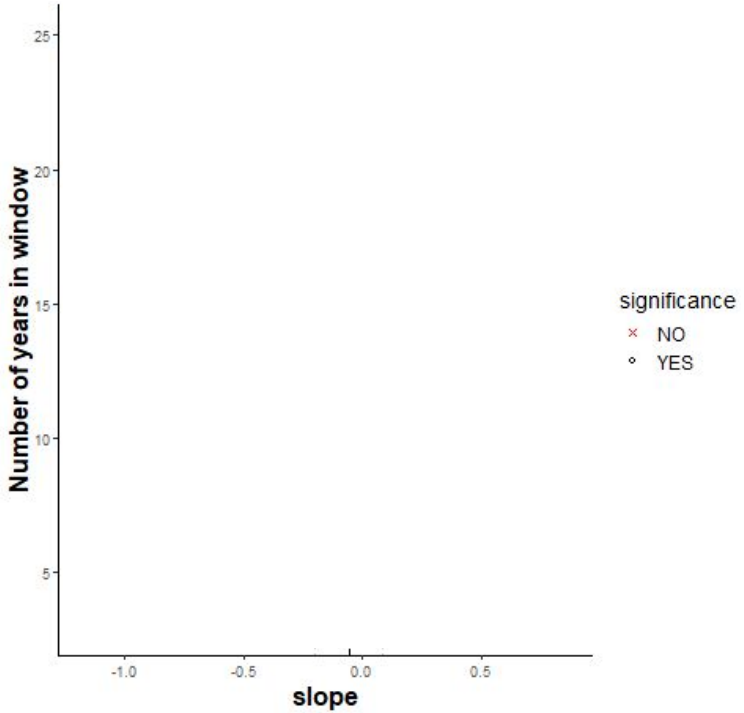
Selected 2 datasets: a Cary Forest study (Ostfeld 2018) and Dutchess County (NY State Dept of Health Office of Public Health, 2019)

Models:

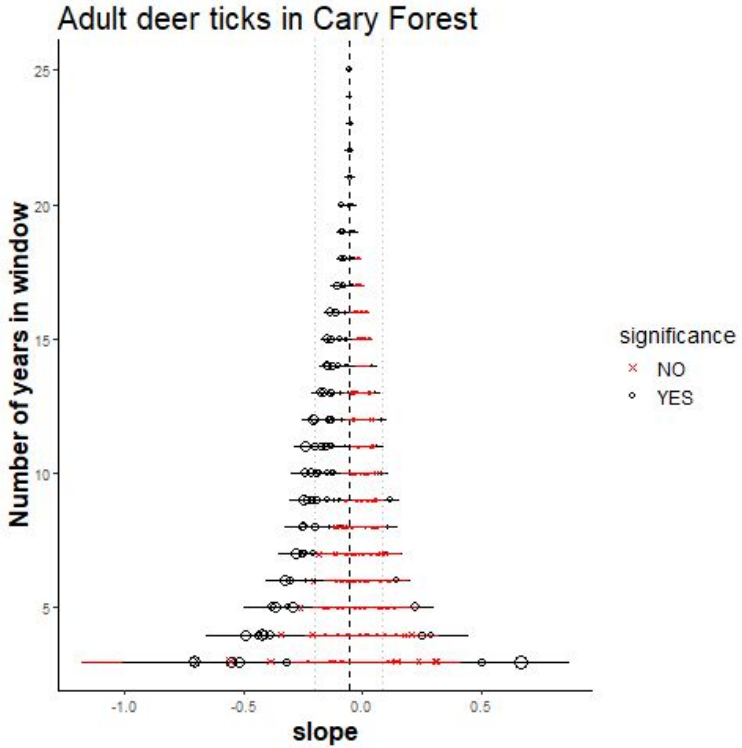
- ‘bad breakup’ algorithm (Bahlai 2019)
- ‘dynamic shift detector’ (Bahlai & Zipkin 2019)



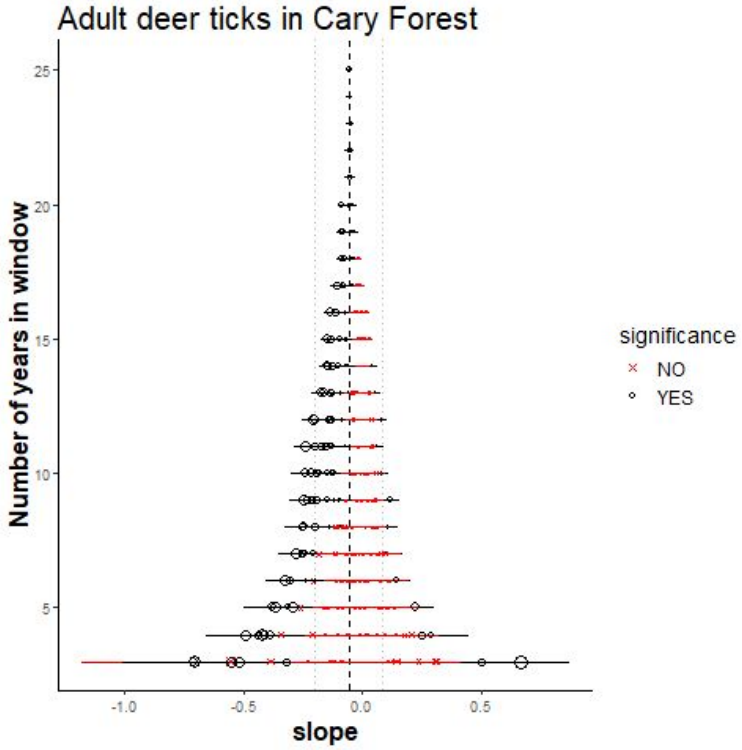
Results

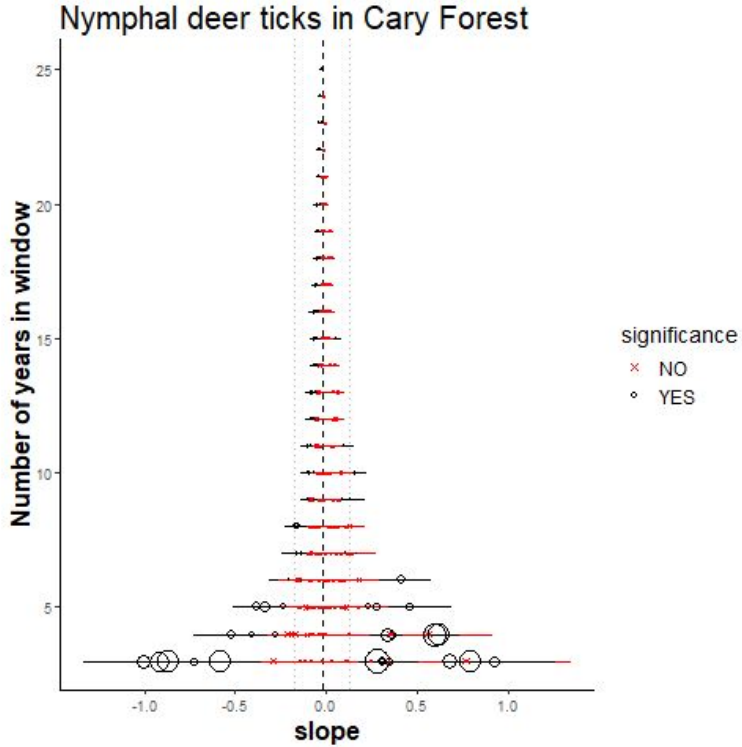

Number of years in window
25
20
15
10
5
-1.0
-0.5
0.0
0.5
slope
significance
NO
YES

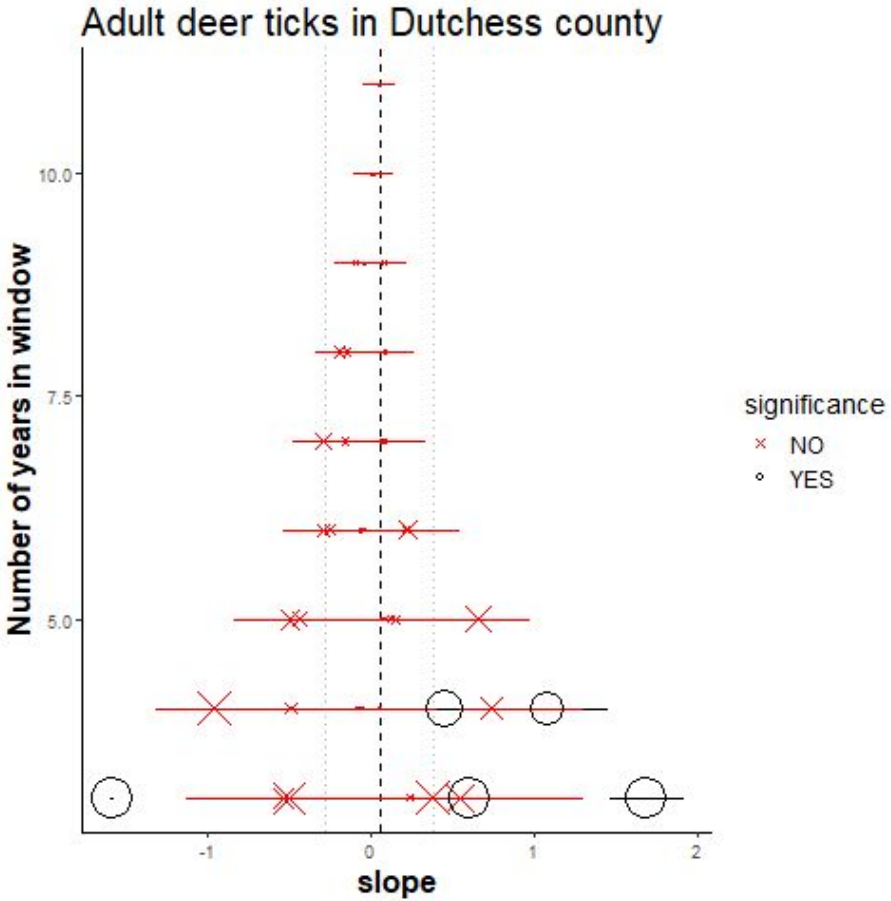
Results

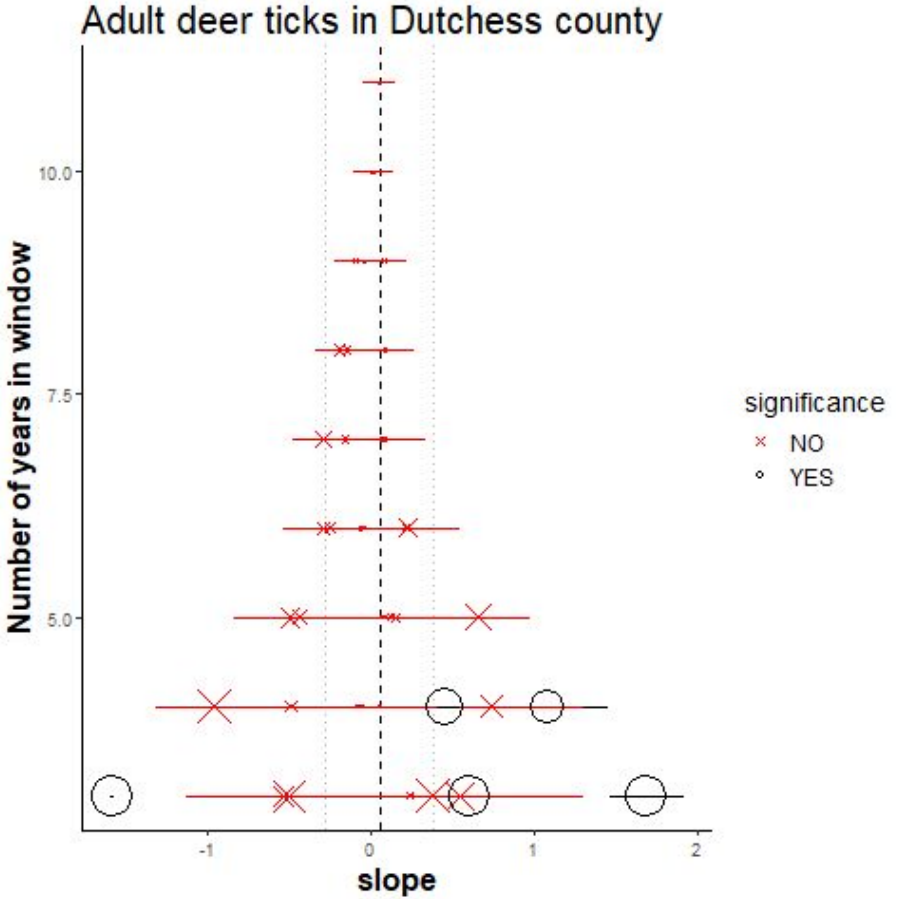

Adult deer ticks in Cary Forest
Number of years in window
25
20
15
10
5
-1.0
-0.5
0.0
0.5
slope
significance
NO
YES

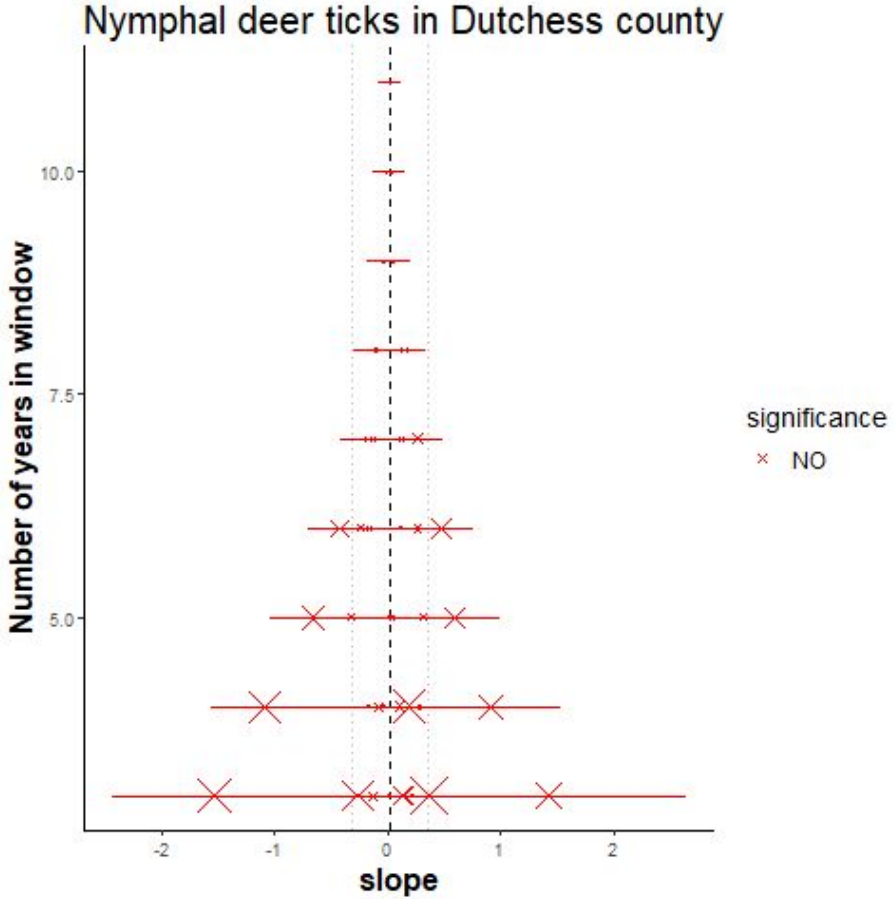
Results

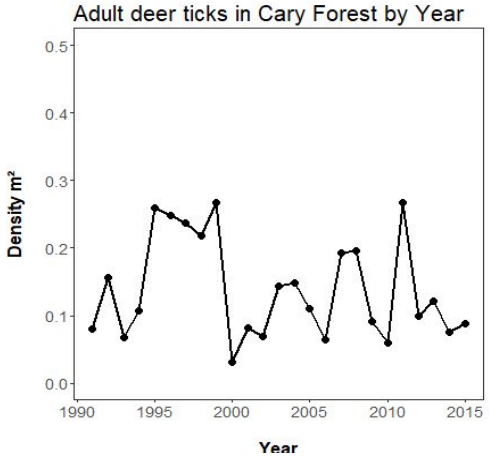

Adult deer ticks in Cary Forest
Number of years in window
25
20
15
10
5
-1.0
-0.5
0.0
0.5
slope
significance
NO
YES

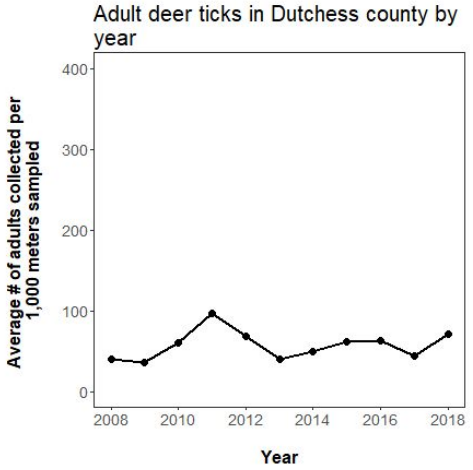

Nymphal deer ticks in Cary Forest
Number of years in window
25
20
15
10
5
-1.0
-0.5
0.0
0.5
1.0
slope
significance
NO
YES

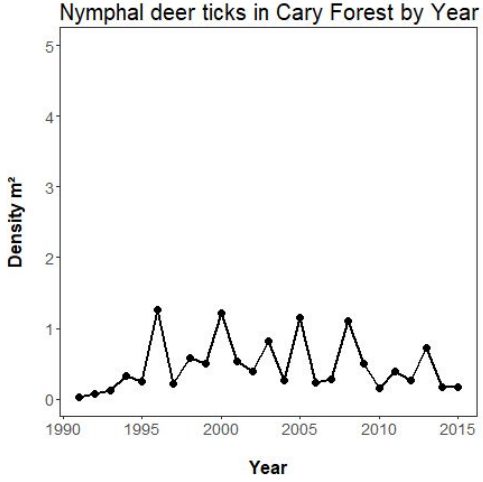

Adult deer ticks in Dutchess county
Number of years in window
10.0
7.5
5.0
-1
0
1
2
slope
significance
NO
YES

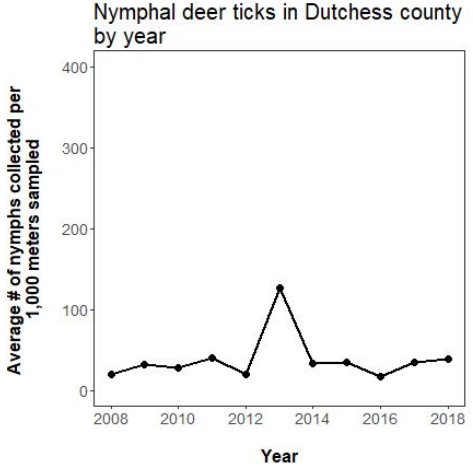

Adult deer ticks in Dutchess county
Number of years in window
10.0
7.5
5.0
-1
0
1
2
slope
significance
NO
YES

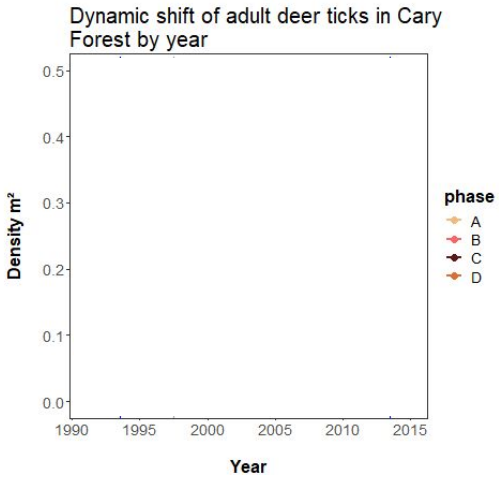

Nymphal deer ticks in Dutchess county
Number of years in window
10.0
7.5
5.0
-2
-1
0
1
2
slope
significance
NO

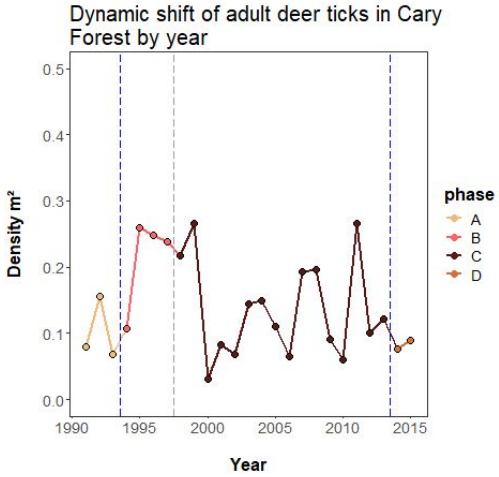

Adult deer ticks in Cary Forest by Year
Density m²
0.0
0.1
0.2
0.3
0.4
0.5
1990
1995
2000
2005
2010
2015
Year


Adult deer ticks in Dutchess county by year
Average # of adults collected per 1,000 meters sampled
0
100
200
300
400
2008
2010
2012
2014
2016
2018
Year


Nymphal deer ticks in Cary Forest by Year
Density m²
0
1
2
3
4
5
1990
1995
2000
2005
2010
2015
Year


Nymphal deer ticks in Dutchess county by year
Average # of nymphs collected per 1,000 meters sampled
0
100
200
300
400
2008
2010
2012
2014
2016
2018
Year


Dynamic shift of adult deer ticks in Cary Forest by year
Density m²
0.5
0.4
0.3
0.2
0.1
0.0
1990
1995
2000
2005
2010
2015
Year
phase
A
B
C
D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0.3
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2015
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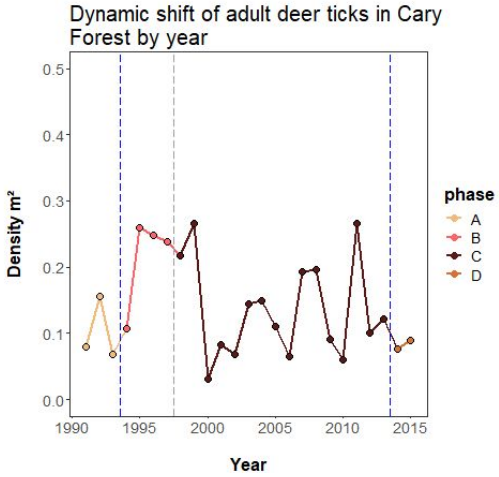
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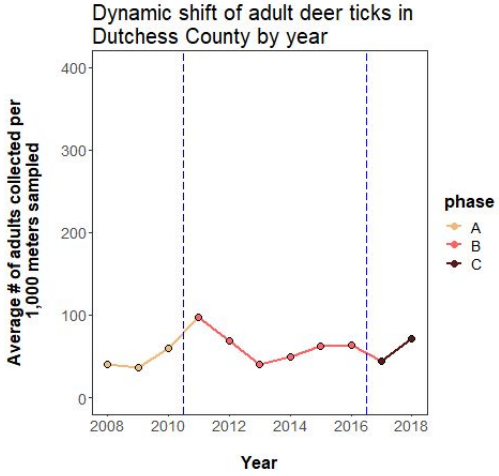
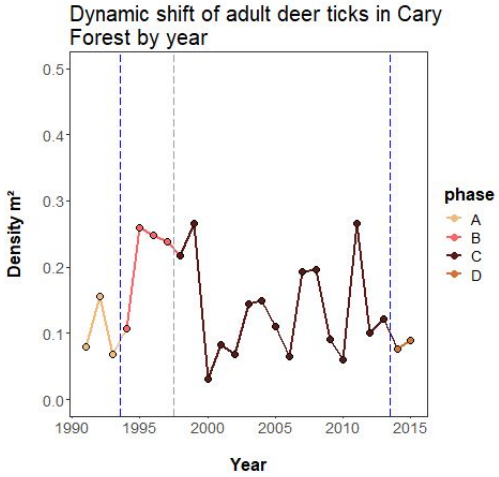

Dynamic shift of adult deer ticks in Dutchess County by year
Average # of adults collected per 1,000 meters sampled
400
300
200
100
0
2008
2010
2012
2014
2016
2018
Year
phase
A
B
C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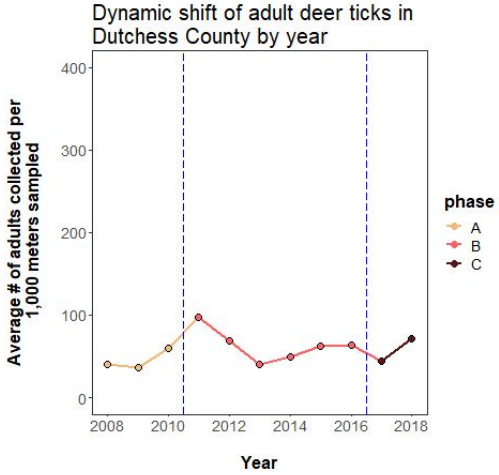
2015
Year
phase
A
B
C
D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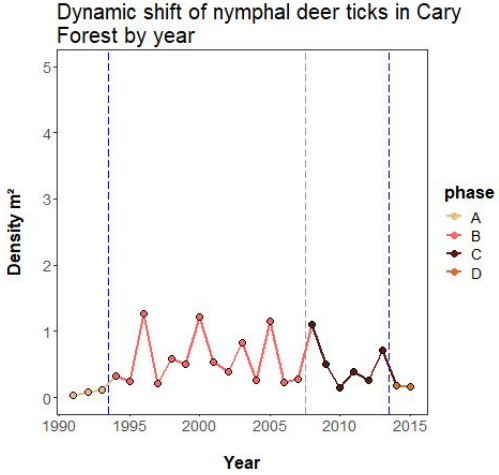
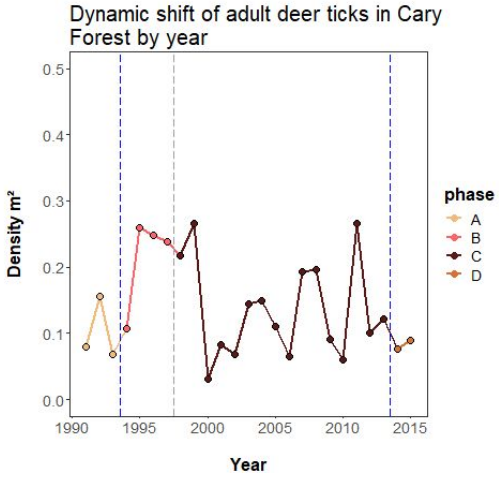
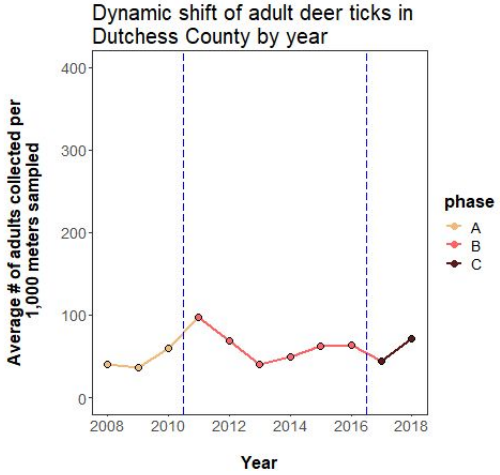
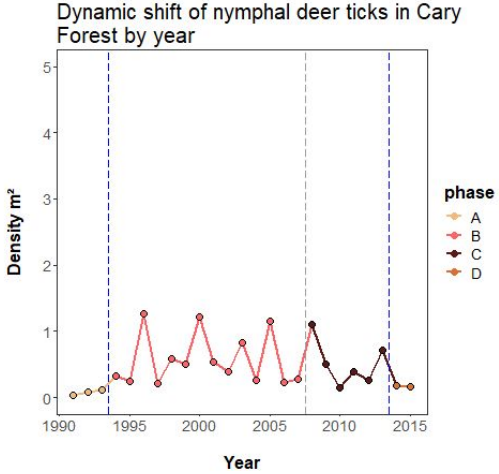
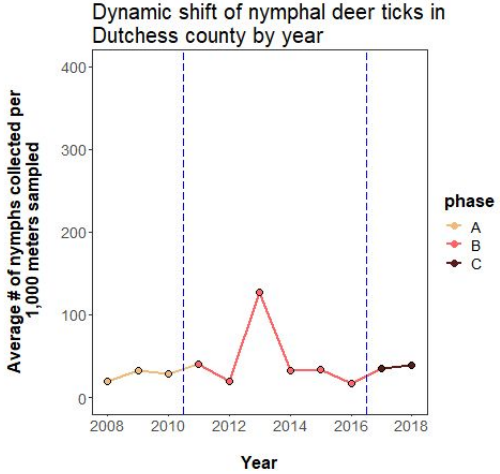
Average # of adults collected per 1,000 meters sampled
400
300
200
100
0
2008
2010
2012
2014
2016
2018
Year
phase
A
B
C

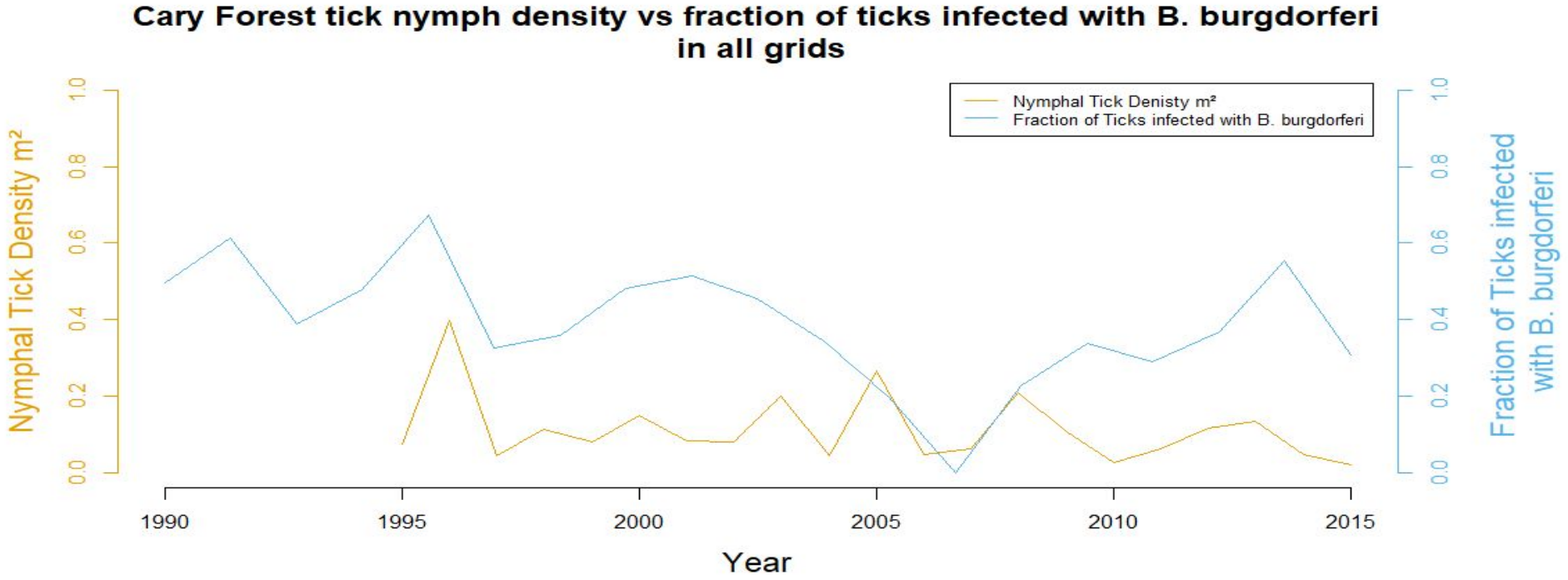

Dynamic shift of nymphal deer ticks in Cary Forest by year
Density m²
5
4
3
2
1
0
1990
1995
2000
2005
2010
2015
Year
phase
A
B
C
D


Dynamic shift of adult deer ticks in Cary Forest by year
Density m²
0.5
0.4
0.3
0.2
0.1
0.0
1990
1995
2000
2005
2010
2015
Year
phase
A
B
C
D

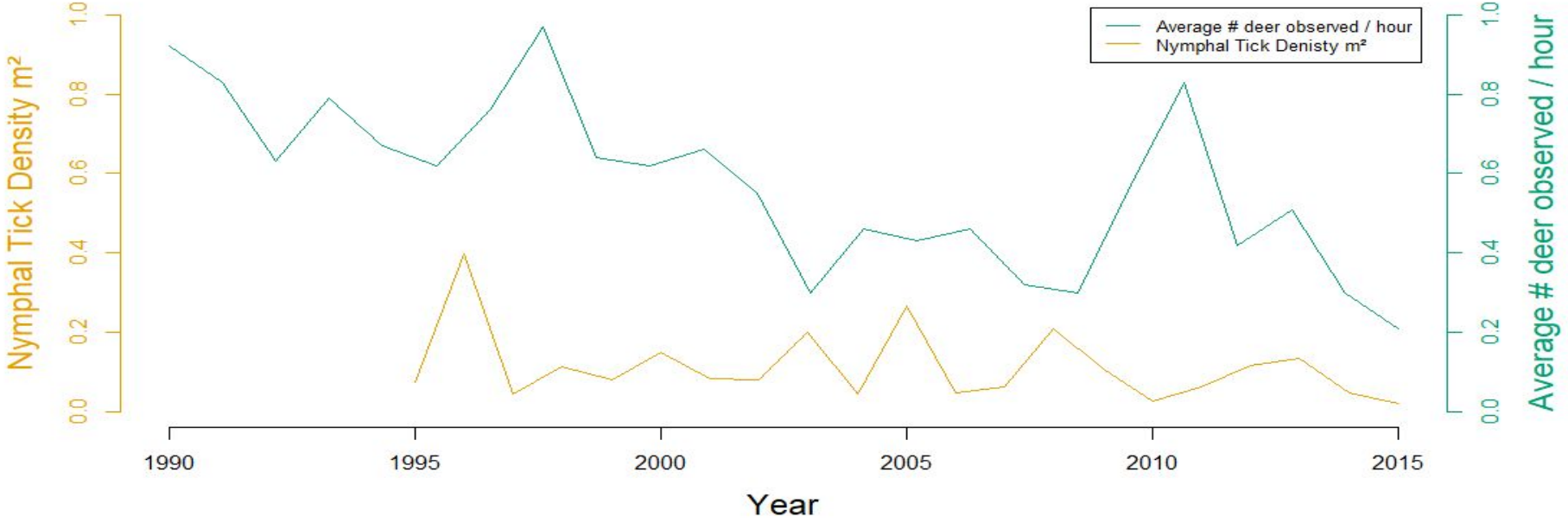

Dynamic shift of adult deer ticks in Dutchess County by year
Average # of adults collected per 1,000 meters sampled
400
300
200
100
0
2008
2010
2012
2014
2016
2018
Year
phase
A
B
C


Dynamic shift of nymphal deer ticks in Cary Forest by year
Density m²
5
4
3
2
1
0
1990
1995
2000
2005
2010
2015
Year
phase
A
B
C
D


Dynamic shift of nymphal deer ticks in Dutchess county by year
Average # of nymphs collected per 1,000 meters sampled
400
300
200
100
0
2008
2010
2012
2014
2016
2018
Year
phase
A
B
C


Cary Forest tick nymph density vs fraction of ticks infected with B. burgdorferi in all grids
Nymphal Tick Denisty m²
Fraction of Ticks infected with B. burgdorferi
Nymphal Tick Density m²
Fraction of Ticks infected with B. burgdorferi
0.0
0.2
0.4
0.6
0.8
1.0
1990
1995
2000
2005
2010
2015
Year

Cary Forest tick nymph density vs average # of deer observed per hour in all grids



Discussion

- Tick density and lyme disease occurrence may be changing over time due to deer and parasitoid density
    - This could impact the dynamic regime shifts
- Adult/nymphal deer tick density in Cary Forest appeared to converge on significance when the number of years in the window was highest
    - This may support the prediction that longer term trends are more likely to reach stability
- Deer tick density in the NY Department of Health study rarely reached significance
    - This does not seem to support the prediction that longer term trends are more likely to reach stability
- The trends in the timeseries do not support the idea that deer tick population is increasing significantly over the past few years

Acknowledgements

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The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or the National Science Foundation.

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- 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