Lyme Disease Ecology: Working to Understand Lyme Ecology in a Newly Emerging Hot Spot with Implications for Beyond

North Atlantic Fire Science Exchange & Consortium of Appalachian Fire Managers and Scientists Webinar

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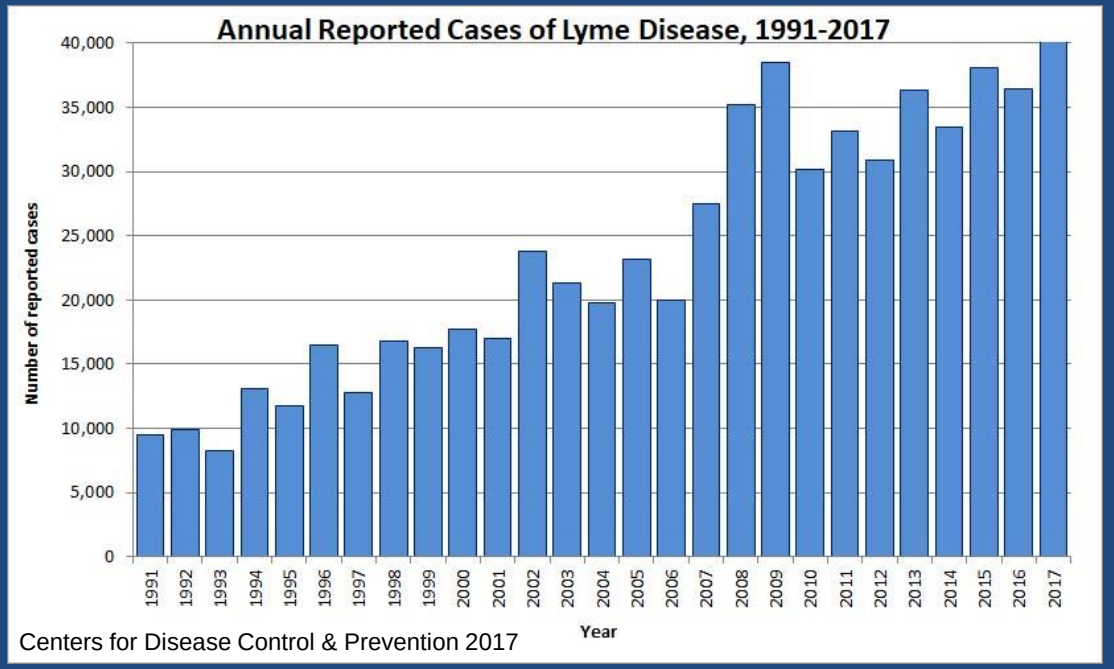
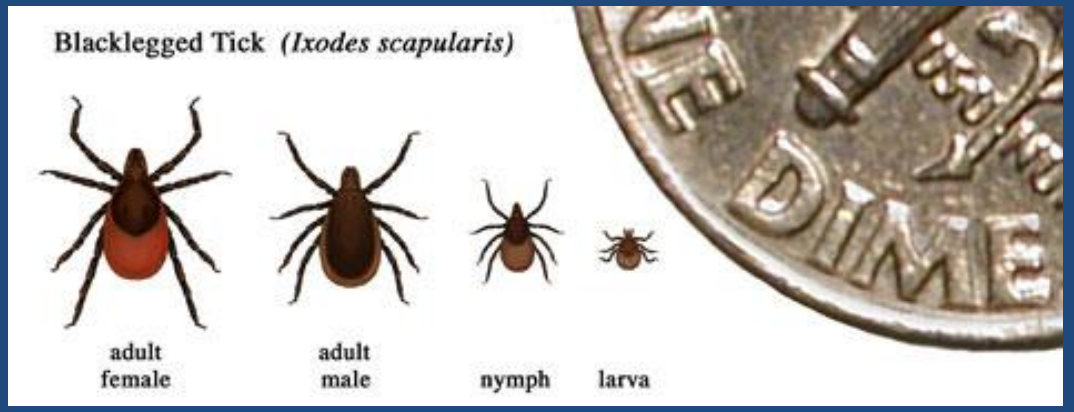
HOLLINS UNIVERSITY

Basics of Lyme Disease

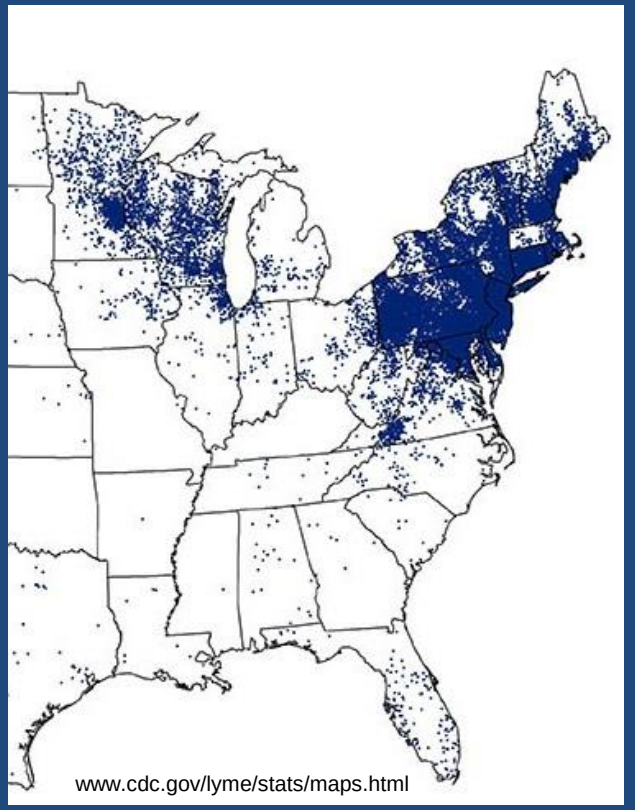
- 30,000 cases annually
  - Actually more like 300,000
- Pathogen: *Borrelia burgdorferi*
- Vector: *Ixodes* spp.
  - *Ixodes scapularis*, black-legged tick



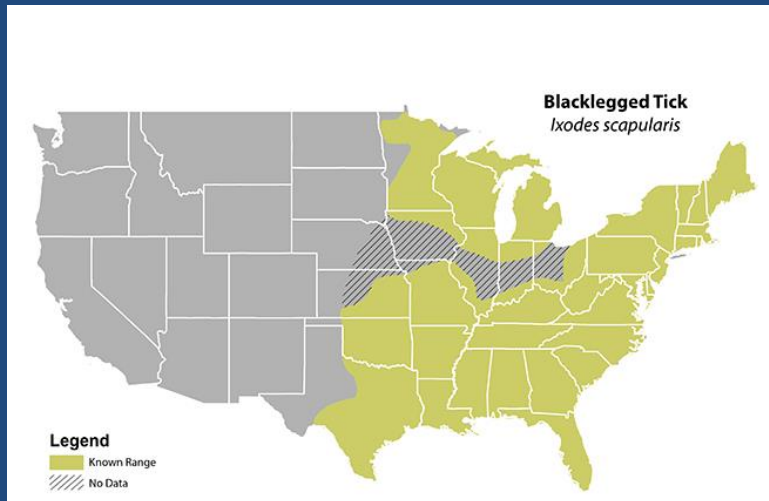


Basics of Lyme Disease

- Cases concentrated in NE and upper midwest

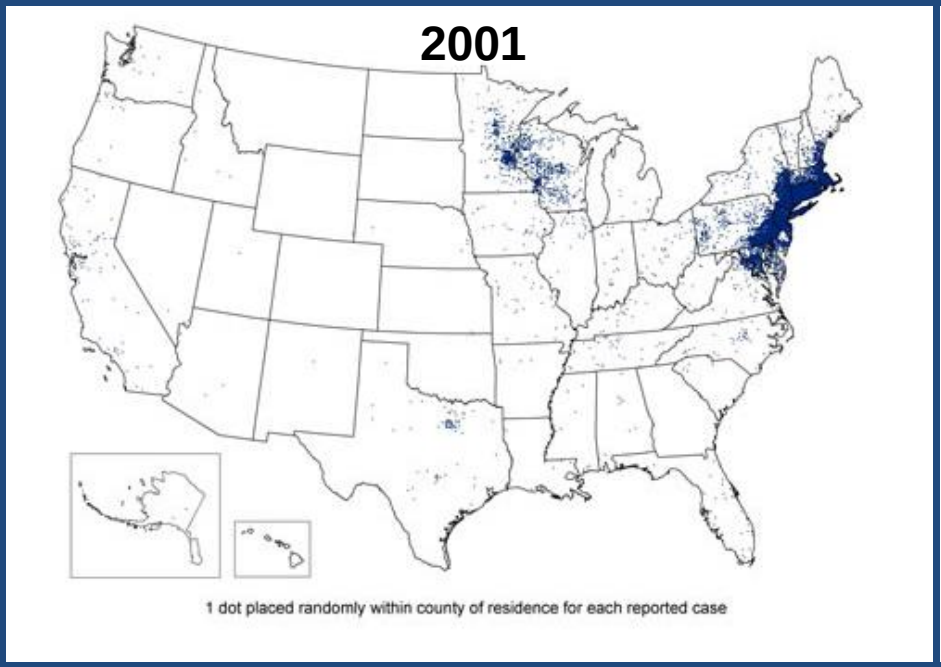


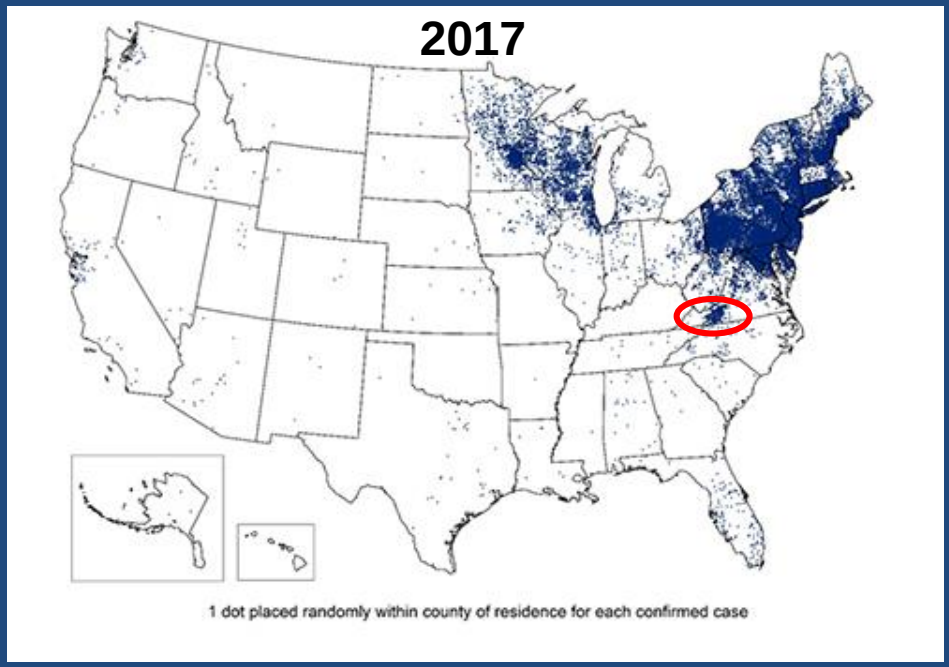
- Distinct differences between northern and southern populations of black-legged ticks



https://tickapp.tamu.edu/ticks/blacklegtick.html

Lyme Disease Spatial Trends Over Time

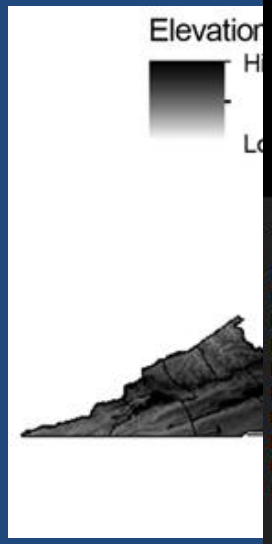




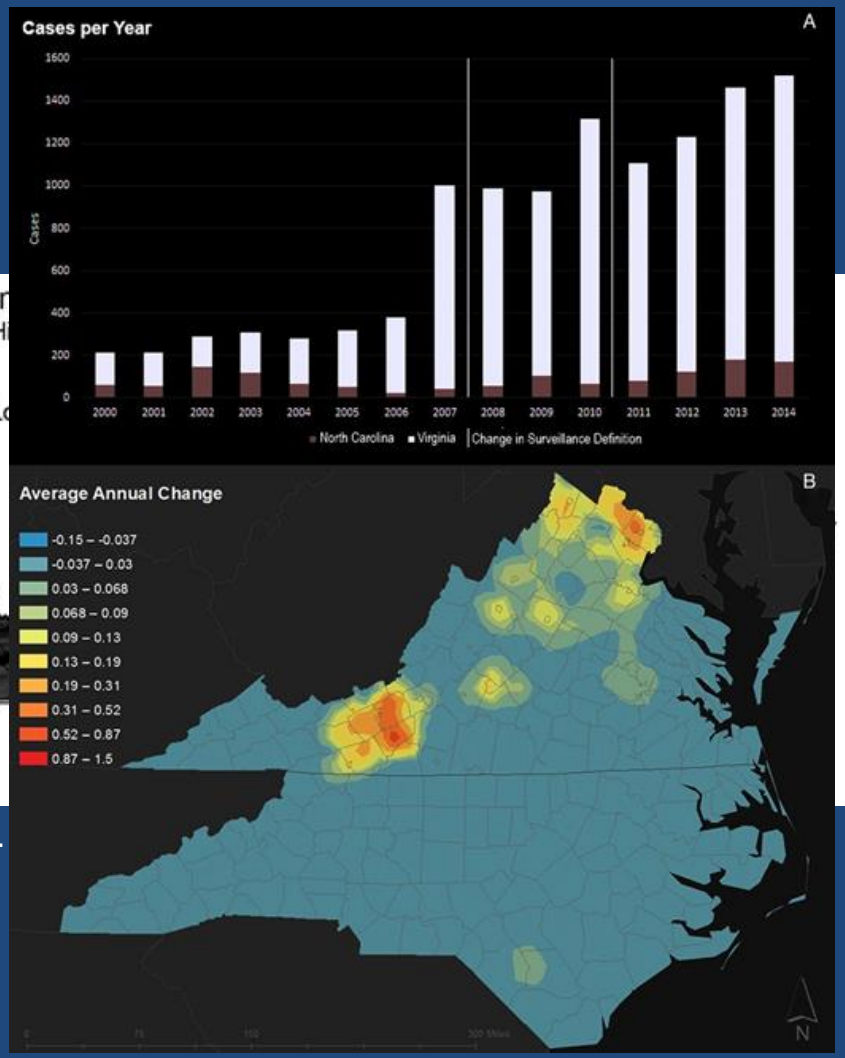
https://www.cdc.gov/lyme/stats/maps.html

Virginia: The Frontline of Lyme Disease

- Marked increase in cases, especially since 2007 (Brinkerhoff et al. 2014)
  - Primarily western portion of state
  - → Cases increasing most at high elevations
- Found highest densities of *I. scapularis* at high elevation site
- Need more data from western portion of state



Brinkerhoff et al.



Lantos et al. 2015

Why the High Cases in the Roanoke Valley?

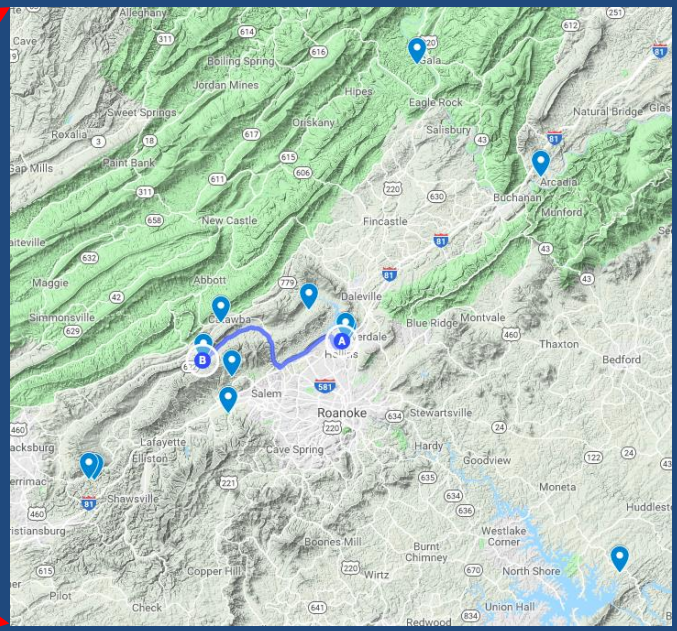
- **<u>Potential Reasons</u>**
  - Over reporting
  - Greater abundance of *I. scapularis*
  - Populations of *I. scapularis* that quest more aggressively
  - Greater prevalence of *B. burgdorferi*
  - Higher contact rates with humans
  - Some combination

Research Objectives:

1. To determine species abundance and phenology of native tick species within Roanoke Valley

2. To determine any associations between species composition and phenology with elevation

Collection Sites



Virginia State Map. (n.d.). Retrieved August 1, 2019, from https://www.nationsonline.org/oneworld/map/USA/virginia_map.htm

Methods

- Flagging sessions performed monthly
  - Elevation taken at each site
- Morphological ID of genus and/or species
  - PCR & sequencing of 16S gene when needed

Results: Feb. 2018 – Jan. 2019

Species	Lifestage	Months Collected	Total
Ixodes scapularis	adult	October - December, January - March	134
Ixodes scapularis	nymph	April - October	306
Ixodes spp.	larvae	June - October, January	1510
Amblyomma americanum	adult	February - July	87
Amblyomma americanum	nymph	April - October	1419
Ambylomma spp.	larvae	May - November	15872
Dermacentor variabilis	adult	April - August	50
Dermacentor albipictus	larvae	October - November	48
Haemaphysalis leporispalustris	nymph	June	1
Haemaphysalis leporispalustris	larvae	September - November	6
Haemaphysalis longicornis	larvae	October	1
Grand Total			**19434**

SW VA:

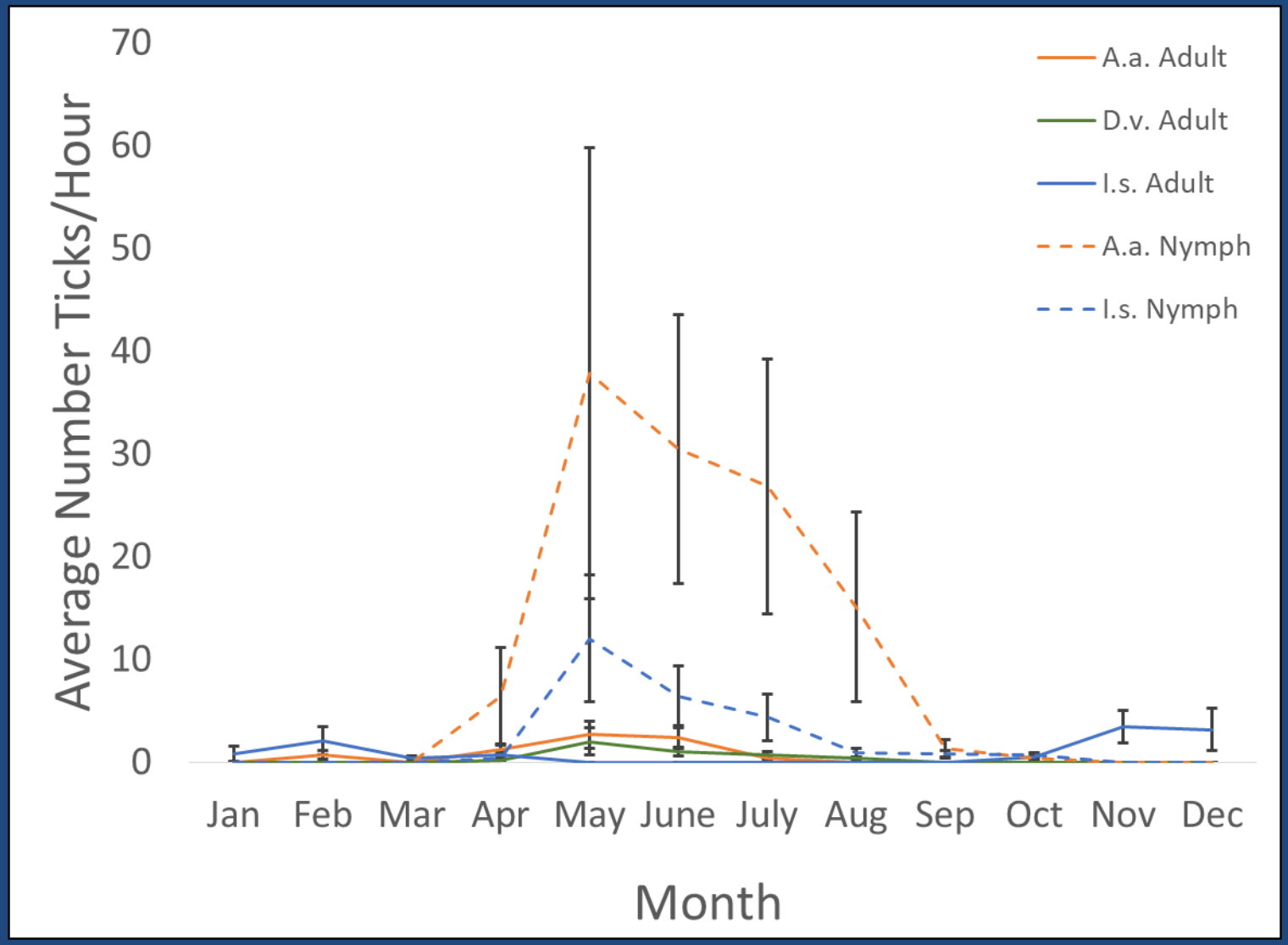
Nymphs: 12 ± 6.2 ticks/hour

Adults: 3.4 ± 1.6 ticks/hour

SW GA

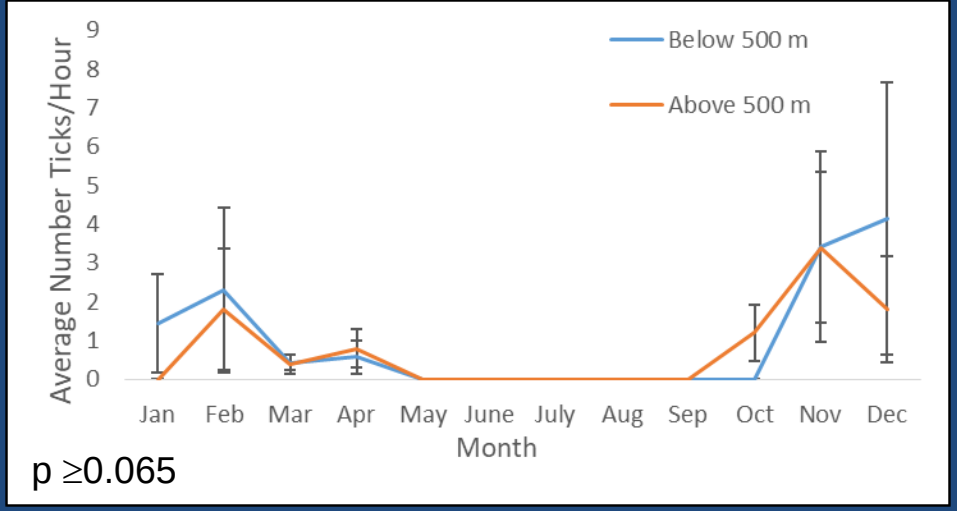
Nymphs: 0 collected

Adults: 2.3 ± 1.5 ticks/hour



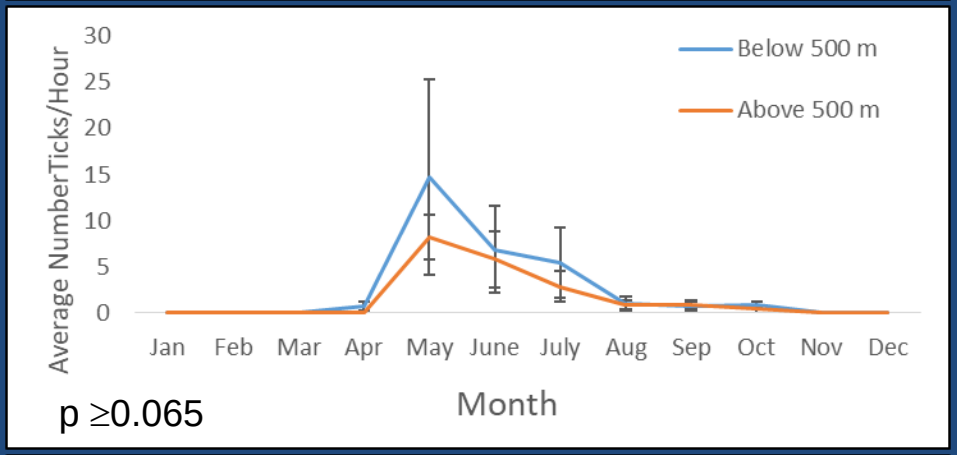
I. scapularis

A.) adults



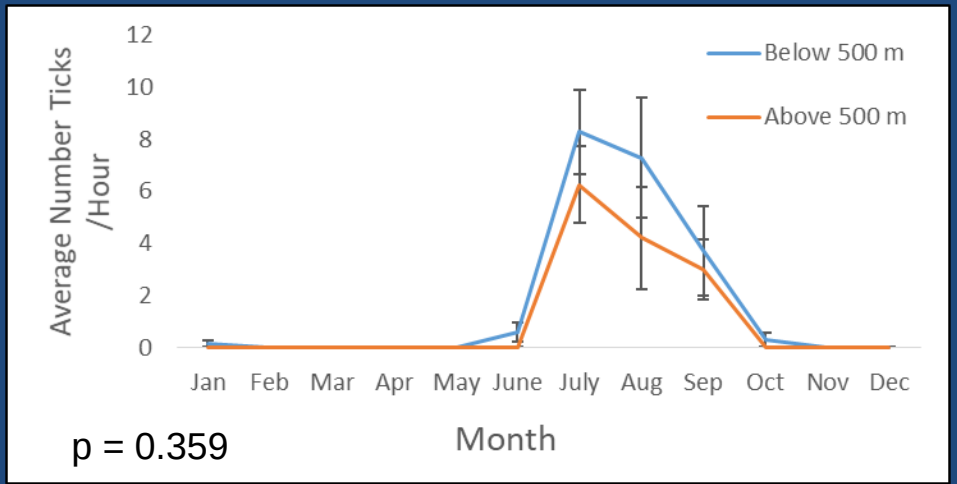
p ≥0.065

B.) nymphs



p ≥0.065

C.) larvae



p = 0.359

Discussion

- No correlation between *I. scapularis* abundance and elevation
  - Do occur above 510 m
  - Limited elevation range in current study

- *I. scapularis* nymphal activity similar to ticks from northeastern U.S.
  - Does not correlate with behavior in other regions of Virginia

- Roanoke Valley
  - Large population
  - Outdoor recreation-centered lifestyle

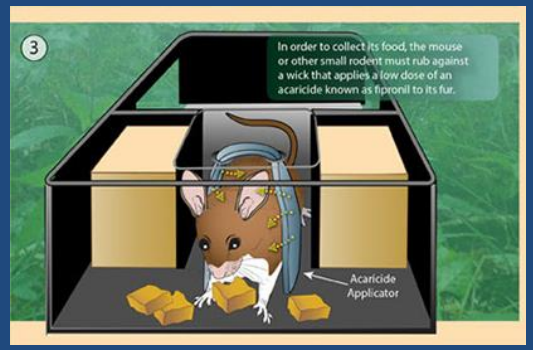
→ More aggressive *I. scapularis* nymphs + large human population + outdoor enthusiasts = Higher Lyme incidence

On-Going Work

- Finalize molecular ID's & stats
- Pathogen testing
- Genetic analysis of *I. scapularis*
- Behavioral studies

What Role Can Land Managers Play to Reduce Lyme Disease Risk?

- Numerous studies on tick control
  - Burning
  - Herbicide
  - Acaricide
  - Mechanical clearing
  - Acaricide on deer & small mammals
  - Deer removal



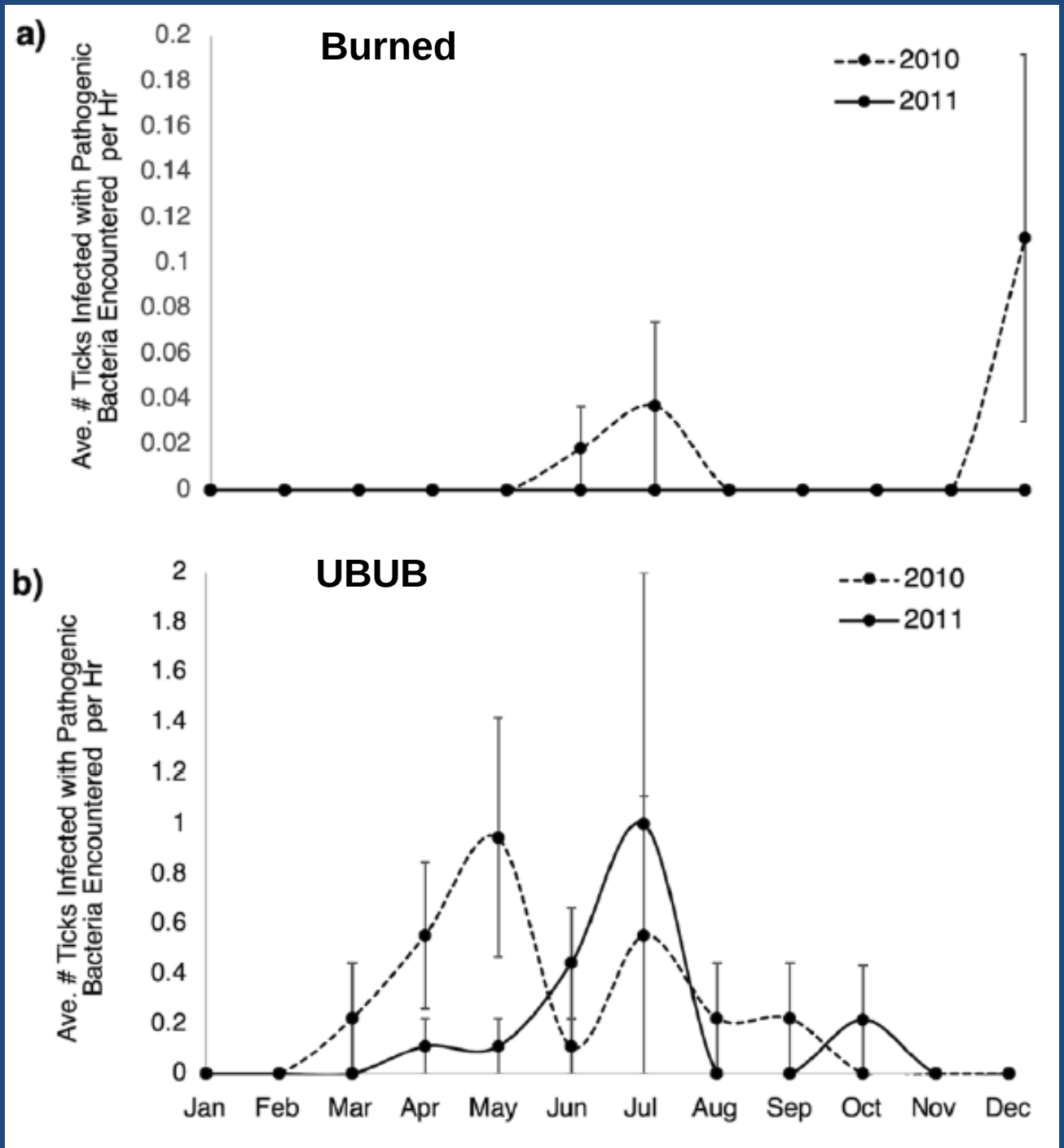
Methods Efficacy with Black-legged ticks

Method	# studies >50% reduction >1 yr later / total # studies	% studies >50% reduction >1 yr later
Habitat Modification	0/1	0
Prescribed Burn	1/4	25
Synthetic Acaricide	0/15	0
Natural Acaricide	0/8	0
Fungal Acaricide	0/3	0
TickBot	0/1	0
Bait Box	4/4	100
Tick Tubes	4/6	66.7
Deer Removal	2/5	40
Deer Fence	3/4	75
4-Poster	10/12	83.3

White & Gaff 2018: https://academic.oup.com/jipm/article/9/1/12/4967809

Ticks & Fire

- Tick populations reduced *immediately* after fire.
- Tick populations steadily recover over-time
- Dispute over *long-term* effects of fire on tick abundance
  - Increase or decrease in tick population??
- Previous studies fail to account for variables affecting tick populations and/or do not simulate “real-world” management practices



Negative binomial regression: $p = 0.037$

→ Interaction between burning and season

Gleim et al. 2019
https://rdcu.be/b1kc1

Findings of Ticks & Fire Study

- Long-term prescribed fire reduces tick populations
  - Regardless of burn interval, host abundance, & vegetation structure

  →98% reduction in encounter rate with ticks infected with pathogenic bacteria!!

- Major reduction in disease risk for humans:
  - 0.11 infected ticks/ hour in all burn treatments
  - 1.0 infected tick/hr in UBUB

- WHY?
  - Change in vegetation structure → hotter, drier environment
  - Emphasizes need for long-term burning, not singular burns

- Potential tool for reducing tick-borne disease risk in other regions and ecosystems??
  - Lyme-endemic areas

How to Reduce Your Risk of Tick-borne Diseases

- Keep ticks off of you
  - Use Repellent (deet, etc)
  - Treat clothes with permethrin
  - Wear pants, close-toed shoes, & long sleeves
    - Light colors
  - Check your clothes while outside
- Promptly change clothes & shower
- Prompt full-body tick check
  - Remove tick as soon as found
  - Check your children!

How to Remove Ticks & What to Do Afterwards

- Clean the tick bite
  - Soap & water, hydrogen peroxide or rubbing alcohol + antibiotic ointment
- Inspect level of engorgement
- Keep the tick for a month

Acknowledgements for Virginia Work

Funding:

- Virginia Foundation of Independent Colleges (VFIC)
- Hollins University

Collaborators:

- Hollins: Ciera Morris & Morgan Wilson

For permission to use land:

- Virginia Dept. of Game & Inland Fisheries, City of Roanoke, Roanoke County, Virginia Dept. of Forestry, Nature Conservancy, & private landowners

For field assistance:

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Acknowledgements for Georgia Work

Funding:

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- University of Georgia (UGA)
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Collaborators:

- UGA: Michael Yabsley & Roy Berghaus
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- CDC: Michael Levin & Galina Zemstova

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- Research associates & technicians of Jones Center Wildlife Lab

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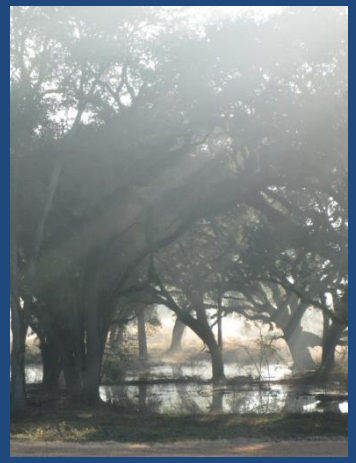
- Yabsley lab members





Questions?

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