Northeast Regional Center for Excellence in Vector-Borne Diseases

Today's Presentation

Dr. James Burtis, Cornell University

- Where do ticks live in the environment?
- What animals do ticks feed on?
- How do these animals affect your risk for tick-borne diseases?

Dr. Maria del Pilar Fernandez, Columbia University

- Research on ticks in urban parks and residences
- How Staten Island, New York residents to avoid tick bites

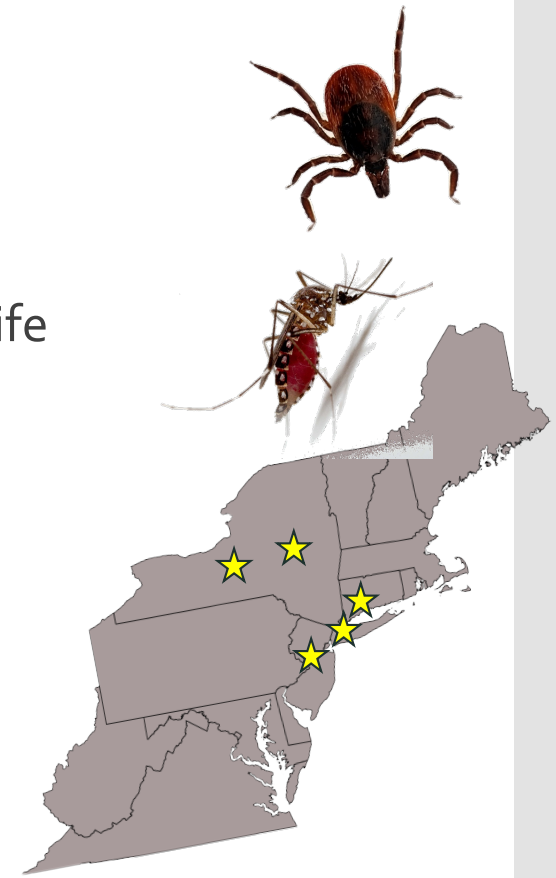
Dr. Dina Fonseca, Rutgers University

- Invasive ticks, how they can arrive and spread
- The Asian longhorned tick, present and future danger

NEVBD
NORTHEAST REGIONAL CENTER FOR EXCELLENCE IN VECTOR-BORNE DISEASES

NEVBD: Who We Are

- Funded by CDC in December 2016
- Lead Organizations ★
  - Cornell University, College of Agricultural & Life Sciences
  - New York State Department of Health
  - Columbia University
  - Connecticut Agricultural Experiment Station
  - Louis Calder Center, Fordham University
  - Rutgers University
- Represent 13 states and the District of Columbia



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Our 3 Overarching Goals

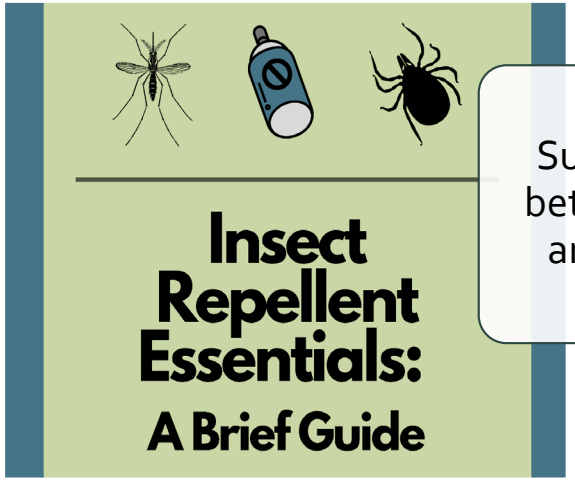
RESEARCH

Develop new tools to prevent & control vector-borne diseases

TRAINING

Train current and future public health entomologists

COMMUNITY



Support connections between public health and the community

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How to Connect

- NEVBD weekly e-newsletter
  http://bit.ly/NEVBD-Mailing-List
- Twitter @_NEVBD
- Website http://neregionalvectorcenter.com
- Program contact nevbd@cornell.edu

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Where do ticks live and how do the animals they feed on affect tick-borne diseases?

James Burtis
NEVBD Postdoctoral Associate

Important Ticks

Blacklegged Tick

Lone Star Tick

Dog Tick

Western Blacklegged Tick

Gulf Coast Tick

Pacific Coast Tick

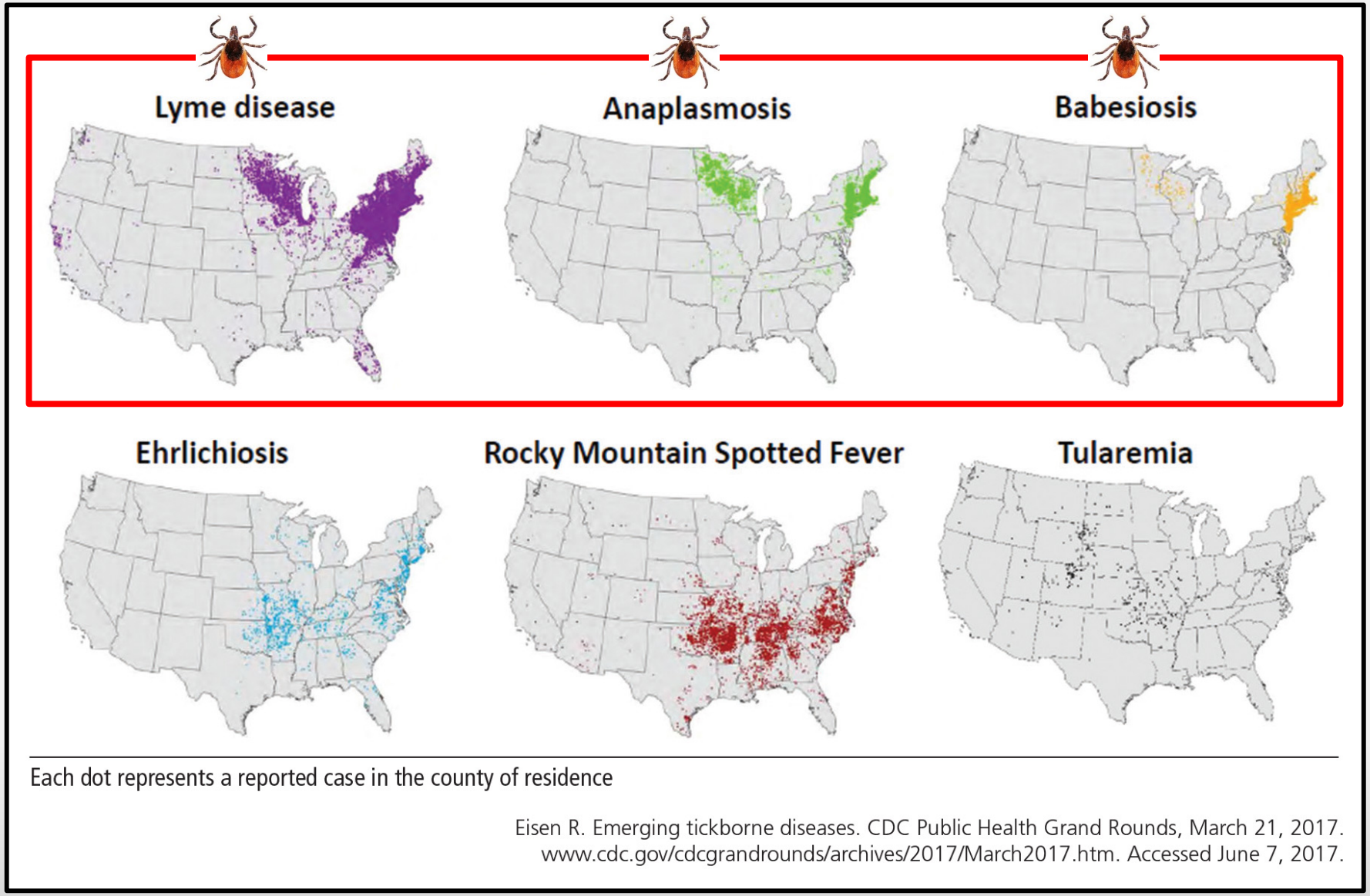
Asian Longhorned Tick

Cayenne Tick

Rocky Mountain Wood Tick

Photos courtesy of tick encounter resource center
https://tickencounter.org/

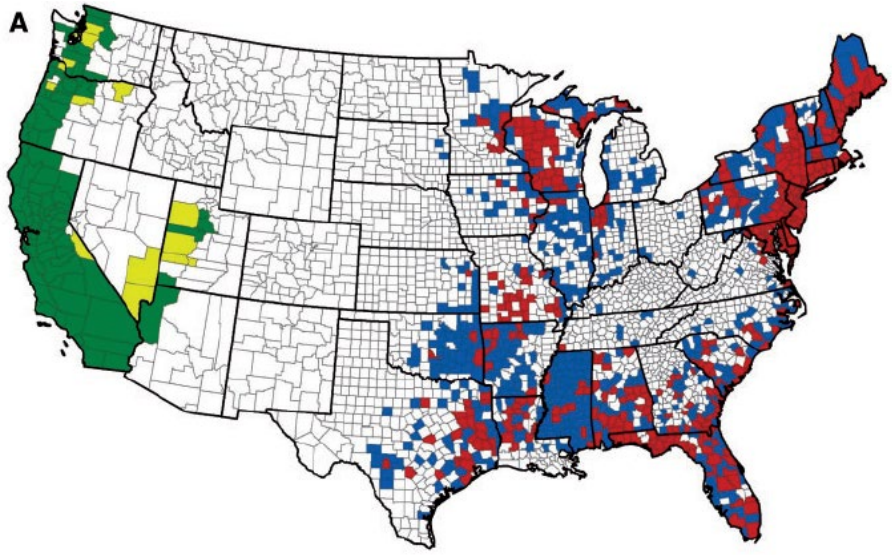
Where are People Getting Sick?



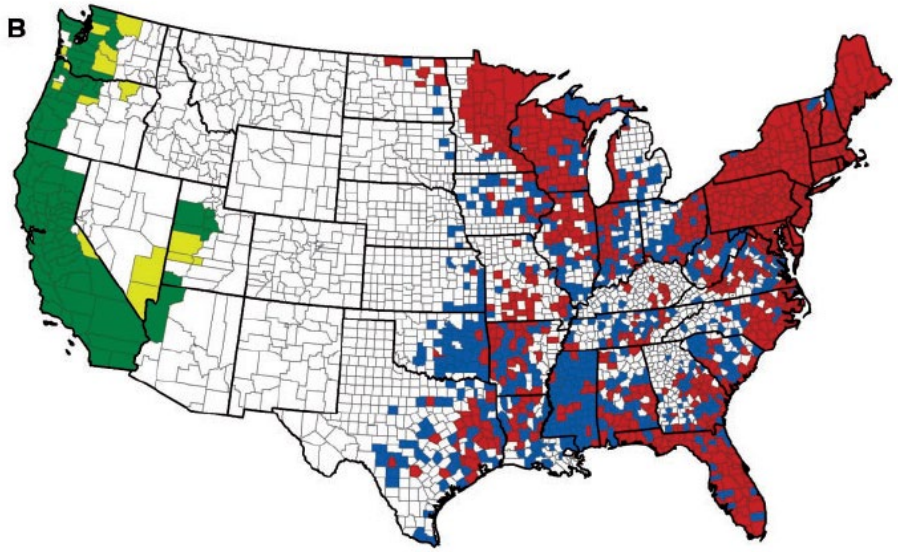
Eisen R. Emerging tickborne diseases. CDC Public Health Grand Rounds, March 21, 2017. www.cdc.gov/cdcgrandrounds/archives/2017/March2017.htm. Accessed June 7, 2017.

Are Blacklegged Ticks in New Places?

Blacklegged tick reports
1907 - 1996



Blacklegged tick reports
1907 - 2015

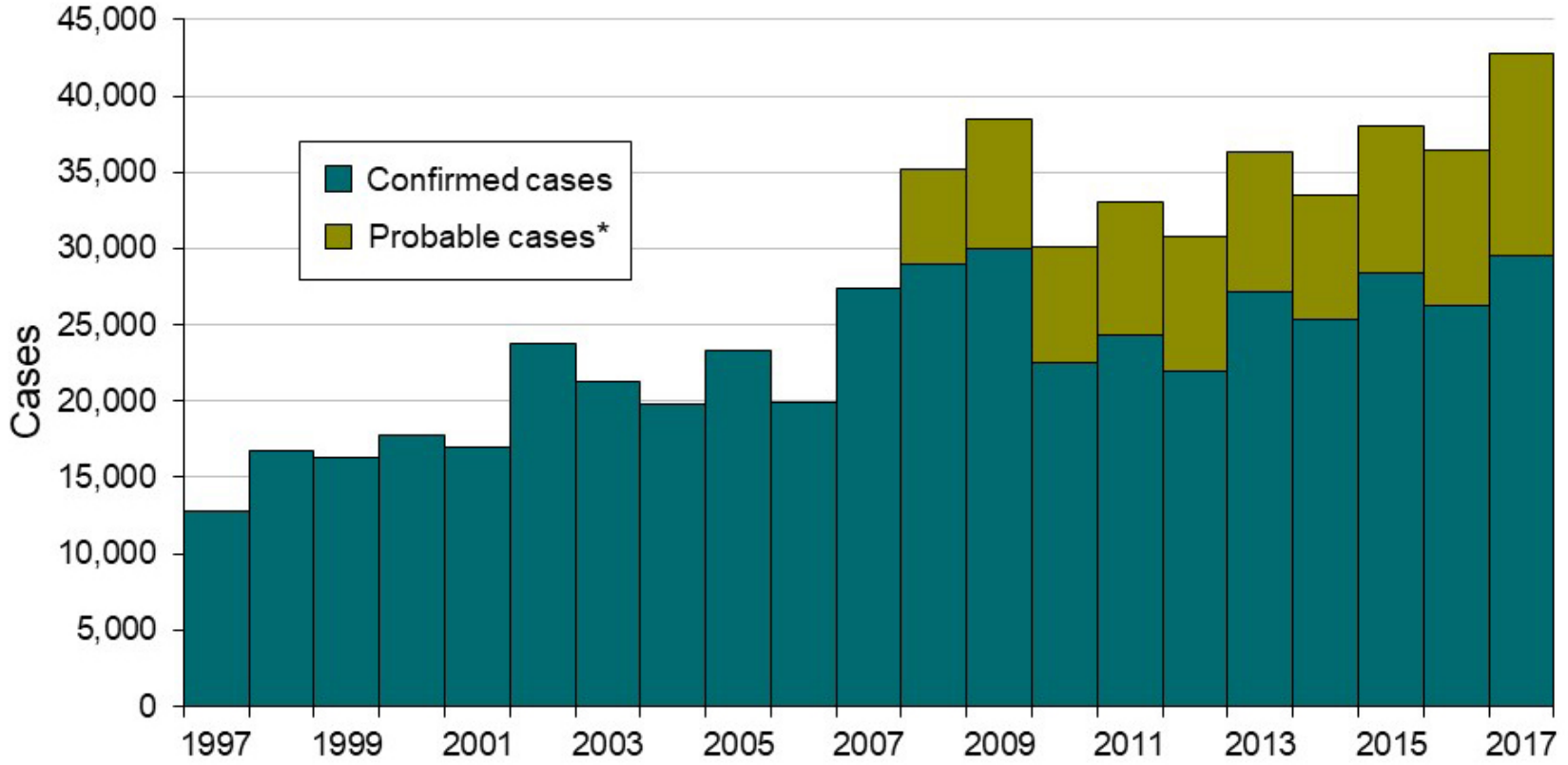


- Blacklegged tick established
- Blacklegged tick reported
- Western blacklegged tick established
- Western blacklegged tick reported

Eisen et al. 2016. *J Med Entomol*

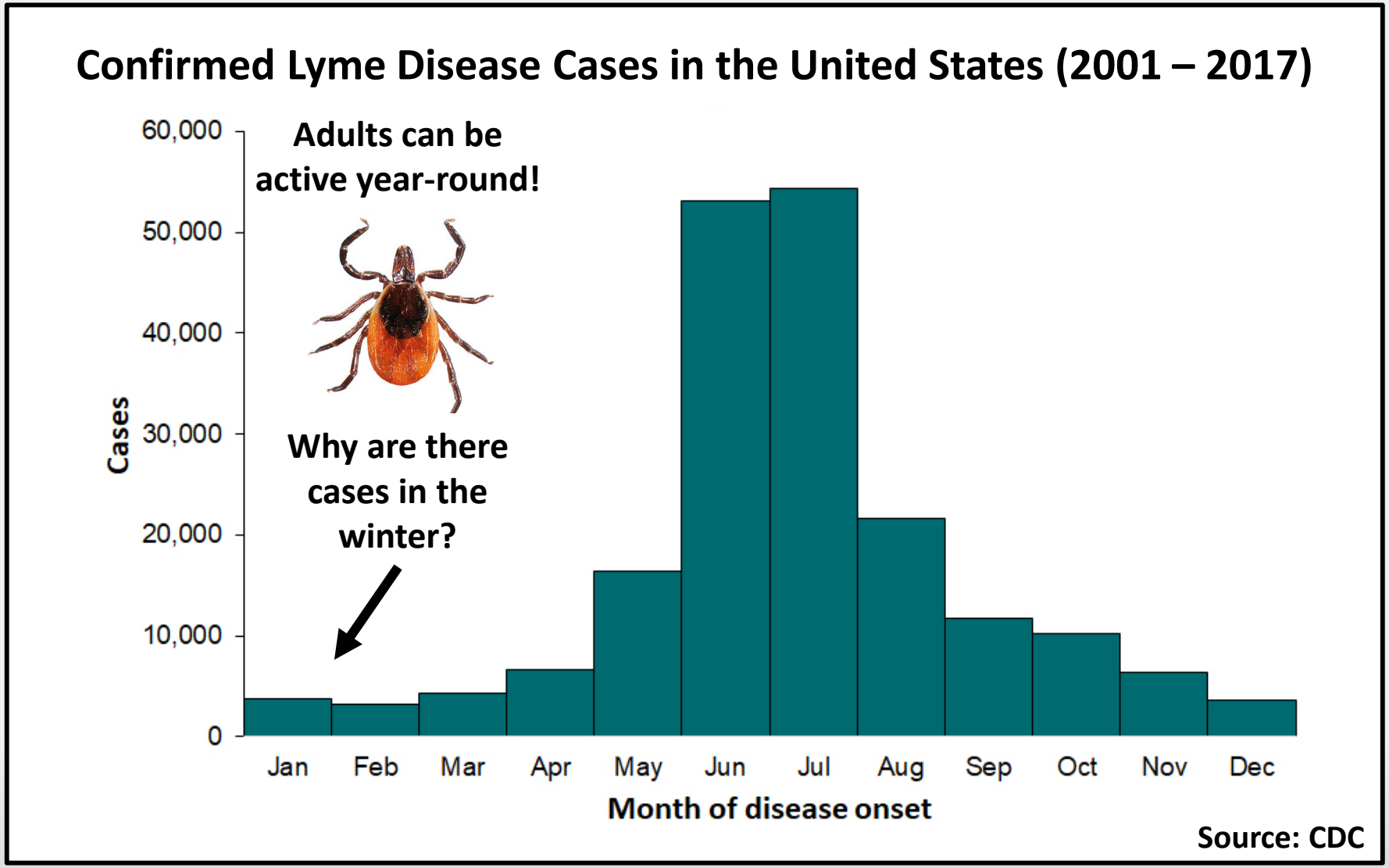
Incidence of Lyme Disease

Number of Lyme Disease Cases in the United States (1997 – 2017)



Source: CDC

When Do People Get Sick?



How do People Pick Up Ticks?

- Ticks search for hosts by waiving their legs around (questing)
- They tend to wait on top of leaf litter and low-lying vegetation
- Blacklegged ticks generally do not move far horizontally on their own
- This species mostly waits for a host to pass by so it can attach

Where do Ticks Live?

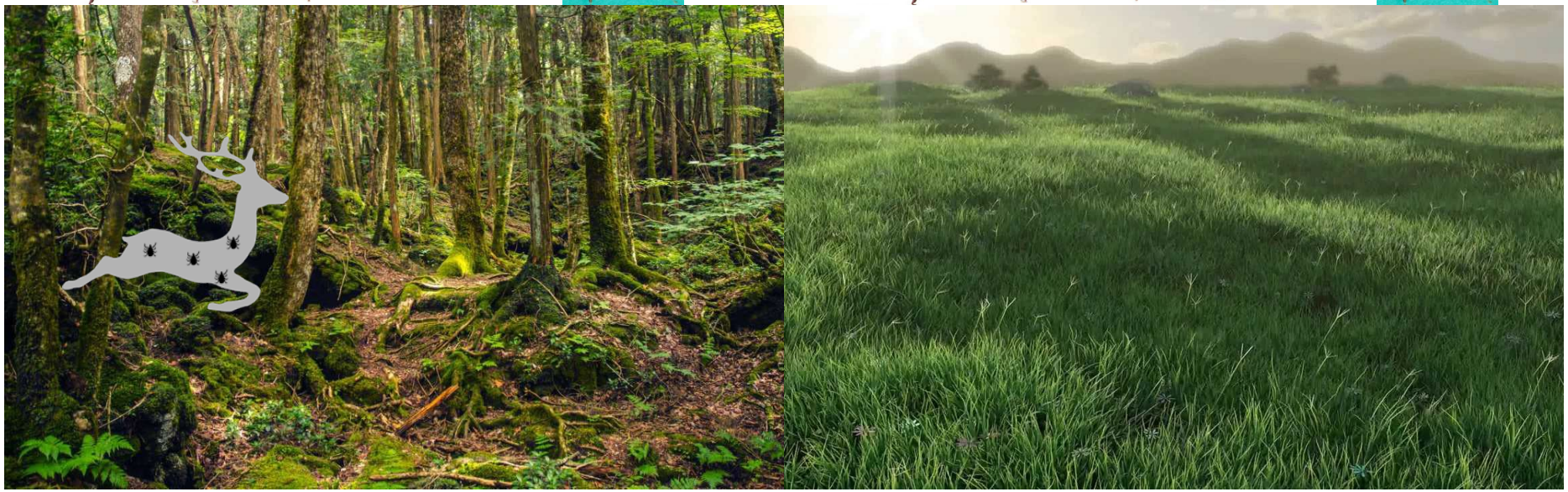
Vegetation provides humid habitat

Temperature fluctuation is reduced

Direct sunlight can dry out ticks

Temperatures fluctuate rapidly

Where do Ticks Live?

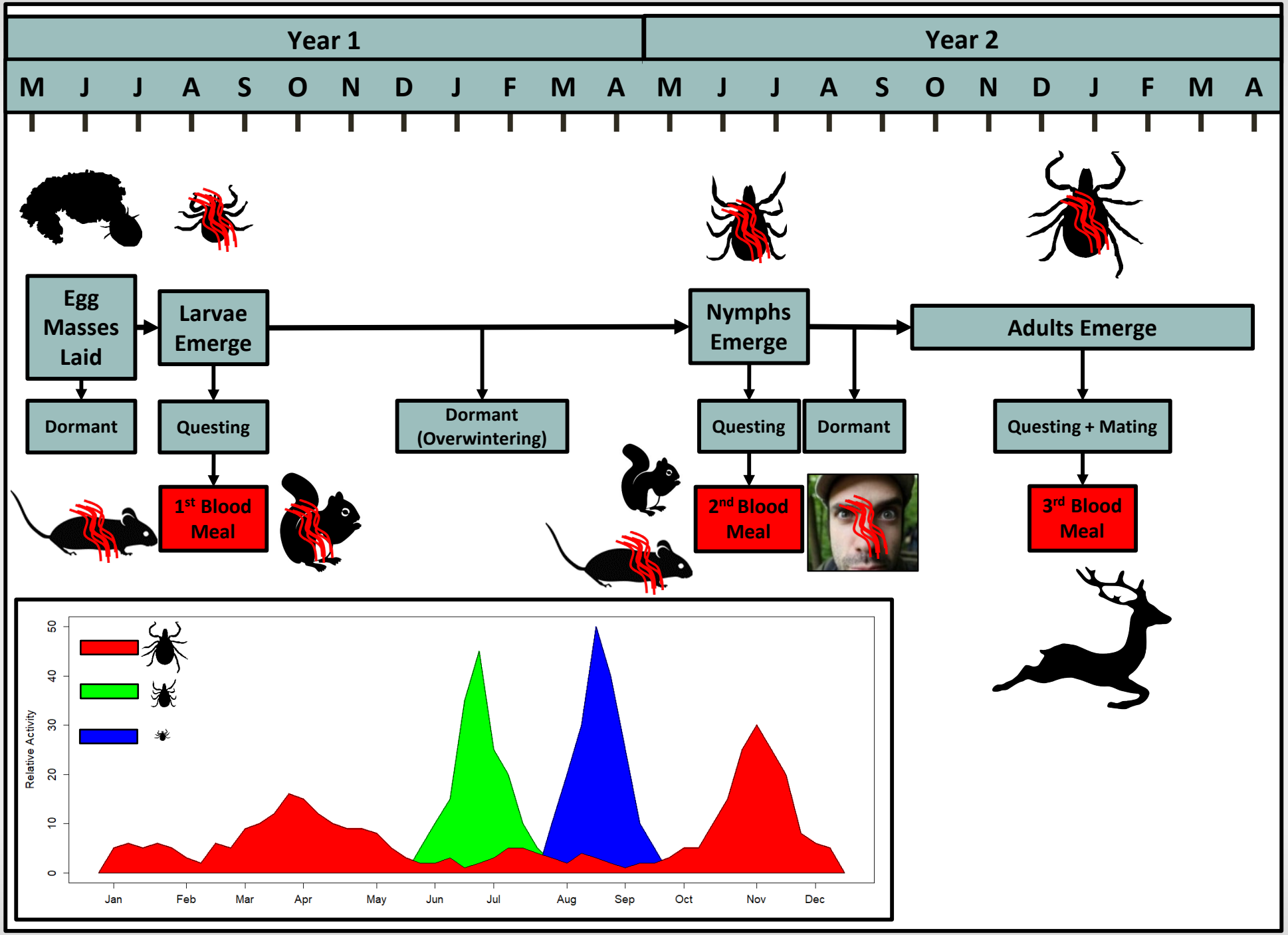


Does this mean you will never be bitten by a tick in a grassy field?

NO!

Some other tick species, like the lone star tick, do well in fields

Animals can also move ticks into unsuitable habitats


Year 1
Year 2
M J J A S O N D J F M A M J J A S O N D J F M A
Egg Masses Laid
Larvae Emerge
Nymphs Emerge
Adults Emerge
Dormant
Questing
Dormant (Overwintering)
Questing
Dormant
Questing + Mating
1st Blood Meal
2nd Blood Meal
3rd Blood Meal
Relative Activity
0
10
20
30
40
50
Jan
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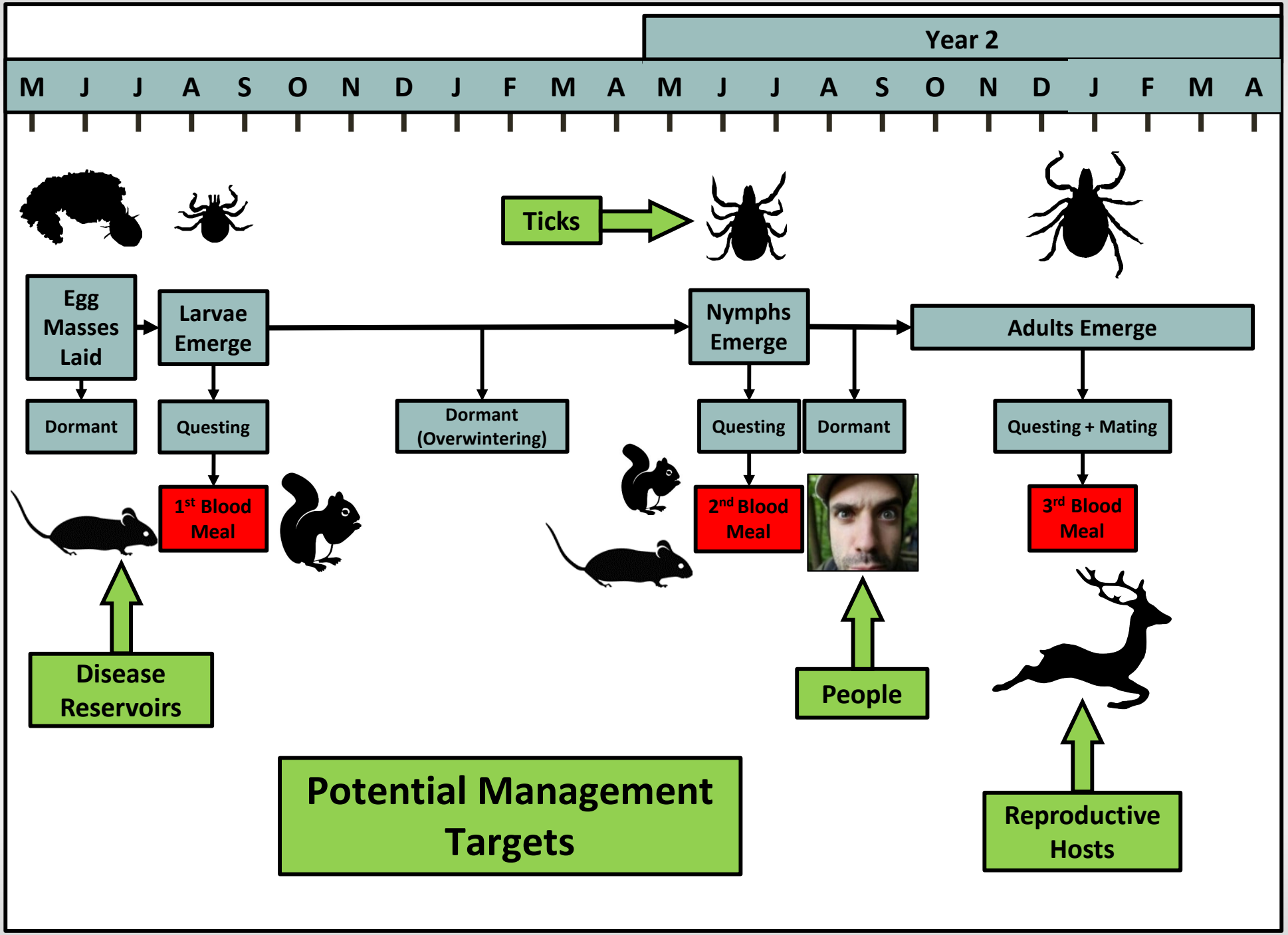
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec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Questing + Mating
1st Blood Meal
2nd Blood Meal
3rd Blood Meal
Disease Reservoirs
People
Reproductive Hosts
Potential Management Targets

Bait Boxes

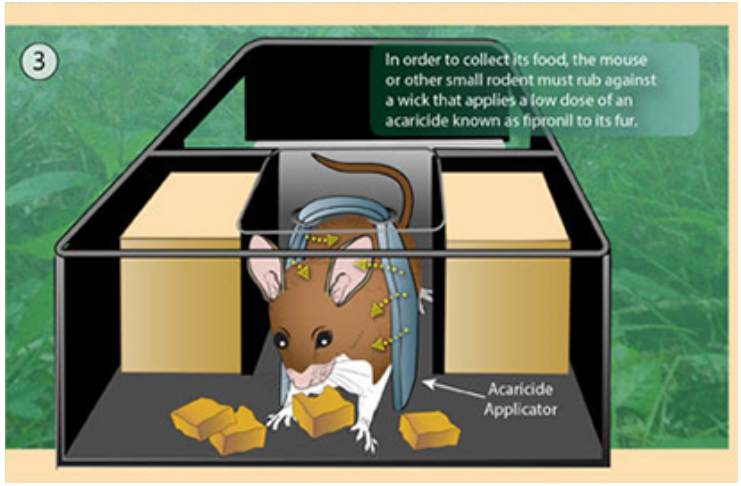
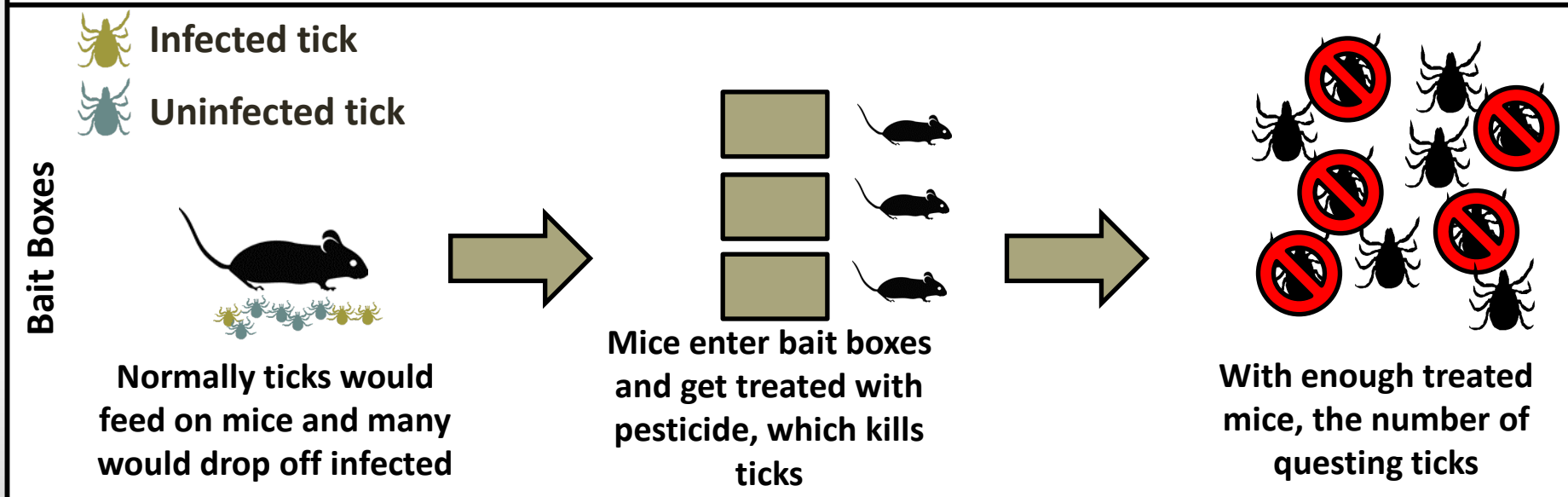


Diagram courtesy of Yale School of Public Health

On small scales bait boxes can reduce the number of questing nymphs by 50% (Dolan et al. 2004).

This method needs to be tested on a larger scale for area wide tick control.

Need a pesticide applicator license to use.



Bait Vaccines

Small mammal live trap baited with vaccine

On small scales this can reduce the number of nymphs infected with Lyme disease bacteria (Richer et al. 2014).

The effect gets stronger multiple years.

Only targets one pathogen and does not reduce the number of ticks overall.

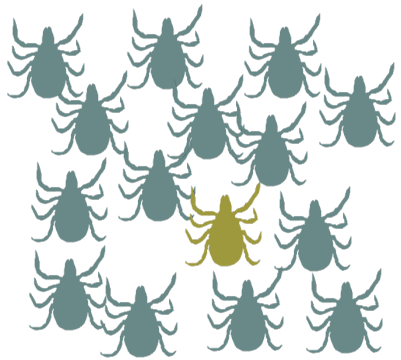
Infected Nymph

Uninfected Nymph

Bait Boxes

Normally approximately 30% of nymphs in the field are infected with Lyme disease bacteria

Mice eat the vaccine bait which slows the transmission of the bacteria to ticks



With enough treated mice, the percentage of infected ticks is reduced

Deer Management

4-Posters

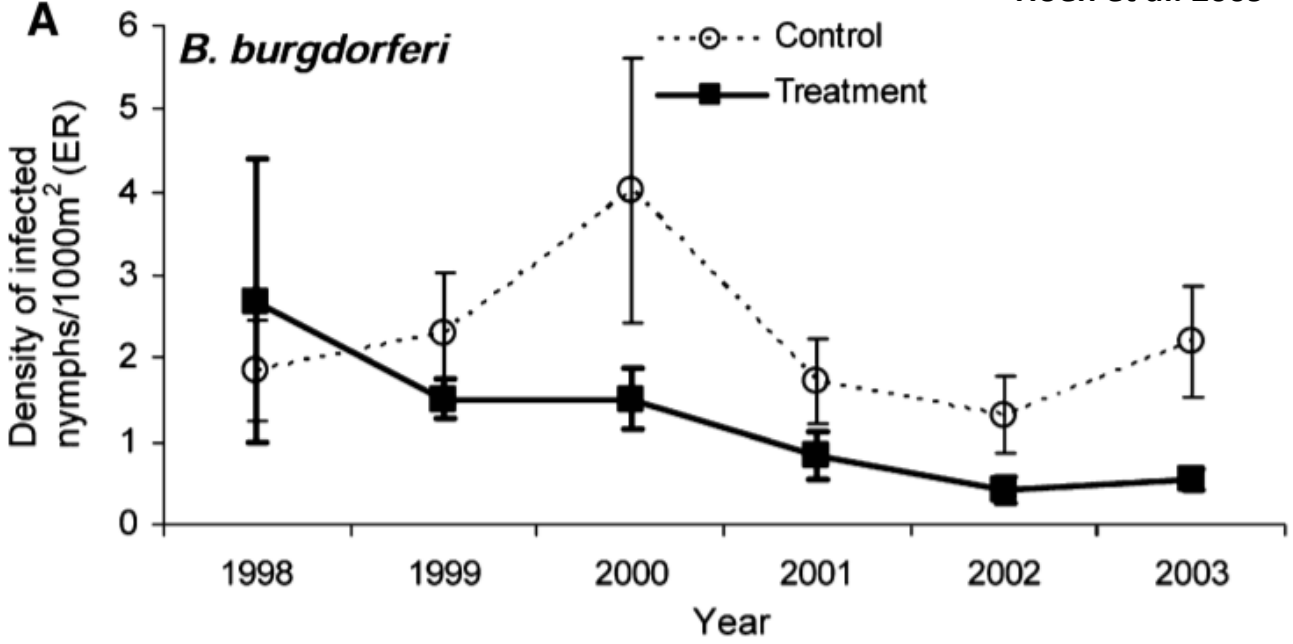
- **Permethrin-treated rollers are attached to feed stations**
- **When deer eat the feed they are inoculated**
- **Has been shown to be effective in some cases**
- **Requires a high density of stations to be effective, which can be expensive**
- **Must be maintained by technician through the season**

Photo Credits: Shelter Island Reporter

Deer Management

4-Posters

Hoen et al. 2009



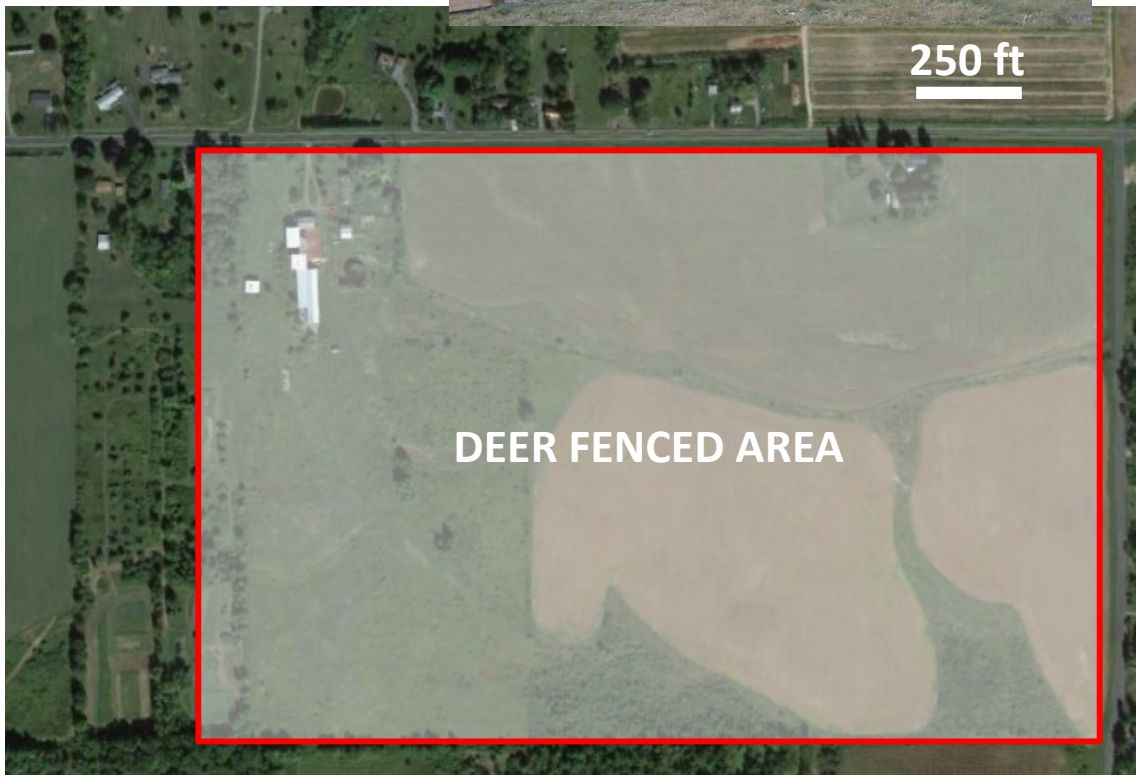
- **Treatment has been shown to be effective in the field**
- **The effect increases over time**

Deer Management

4-Posters

Fencing

Fencing can be an effective way to avoid ticks, but…



Deer Management

4-Posters

Fencing

Fencing can be an effective way to avoid ticks, but…

… it doesn't keep other animals out.

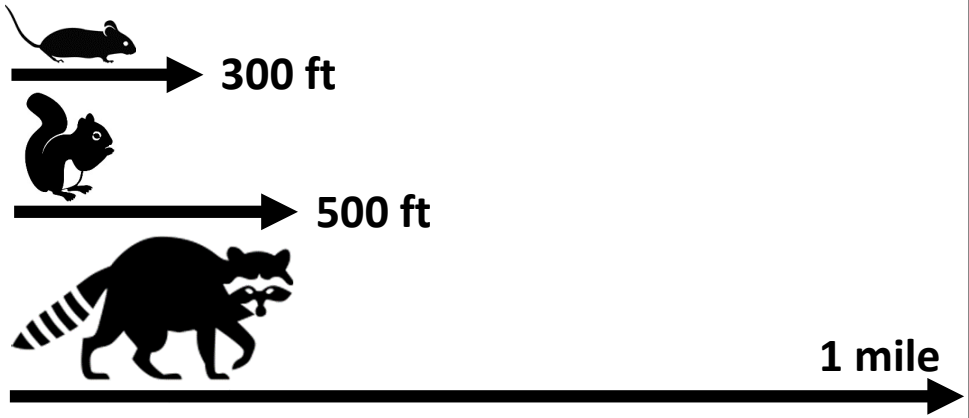
Deer Management

4-Posters

Fencing

- Doesn't keep other animals out, so must cover a large area

- **Effectiveness depends on habitat and others hosts**



Deer Management

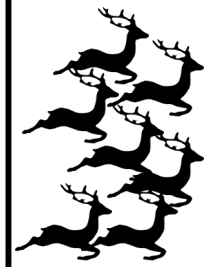
4-Posters

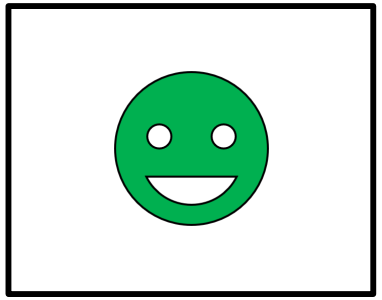
Fencing

- Doesn't keep other animals out, so must cover a large area

- Effectiveness depends on habitat and others hosts

- **Fence must be maintained**





Deer Management

4-Posters

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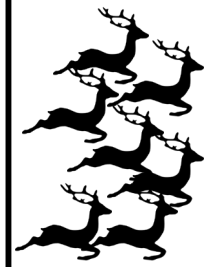
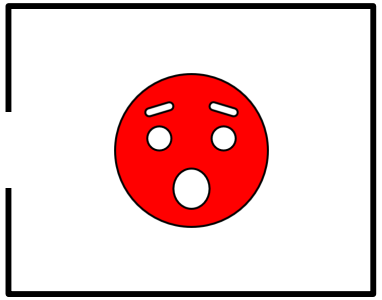




Deer Management

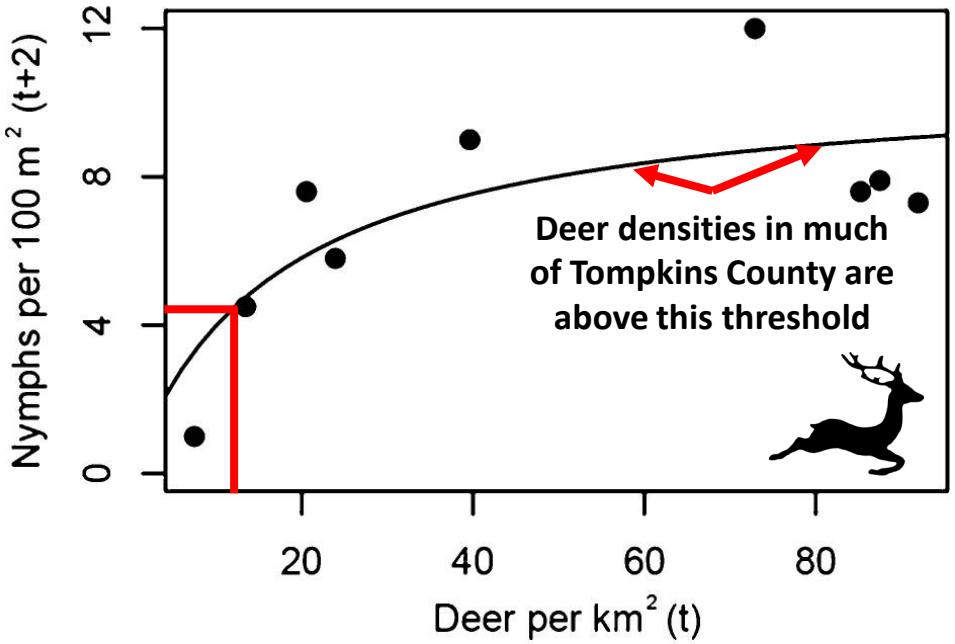
4-Posters

Fencing

Population Management

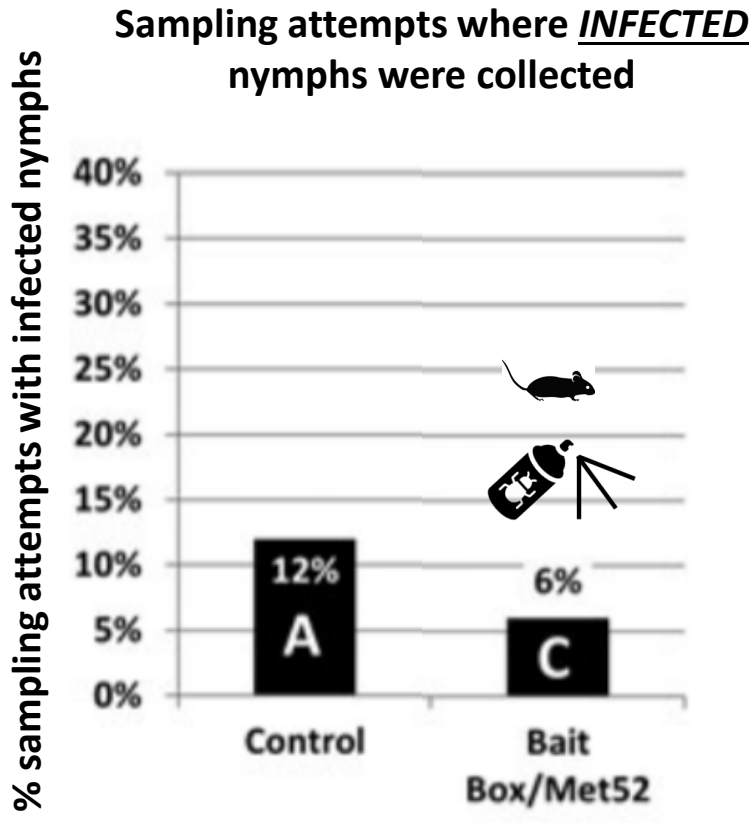
- Deer management can be effective.
- Must hit a target of < 10 deer / km² to affect ticks
- This can be difficult in areas where deer densities approach 60 – 80 deer / km²

Stafford et al. 2003



Combining Methods

- Integrated tick control programs can use multiple methods at the same time
- In Connecticut, a combination of bait boxes and a biopesticide (met52) was found to reduce tick risk in the environment
- This study was conducted on a small scale and parts are being replicated in Connecticut
- Another study in NY is also investigating efficacy on a county scale



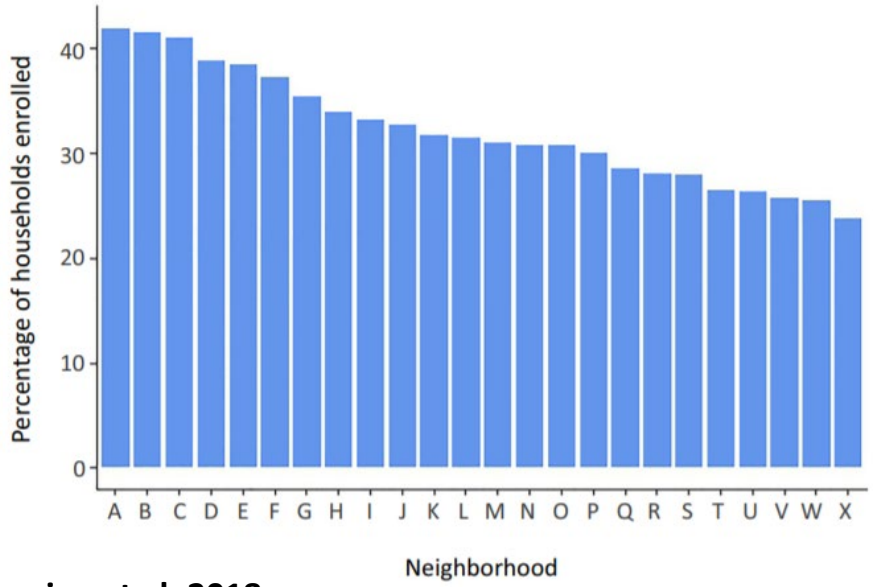
Williams et al. 2018

The Tick Project

(A)

	Met52 fungal spray	Placebo fungal spray
Select TCS bait boxes	6 neighborhoods	6 neighborhoods
Placebo bait boxes	6 neighborhoods	6 neighborhoods

(B)



Keesing et al. 2018

(A)

(B)

- **Tick Project is an ongoing evaluation of area-wide control using bait boxes and Met52**
- **Covers large areas in Dutchess county NY**
- **Experiment will conclude in 2021**

Citizen science, research, education and prevention.

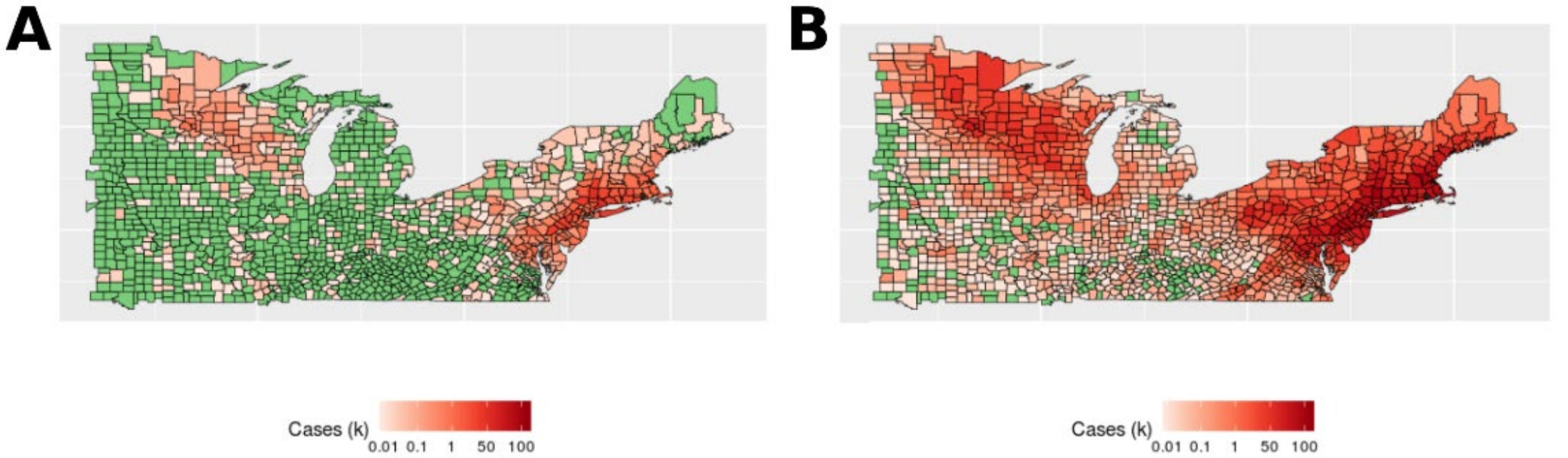
Close encounters of the tick kind

Maria del Pilar Fernandez, PhD

Eco-epidemiology lab, Columbia University

Geographic expansion of Lyme disease cases between 2000 and 2017

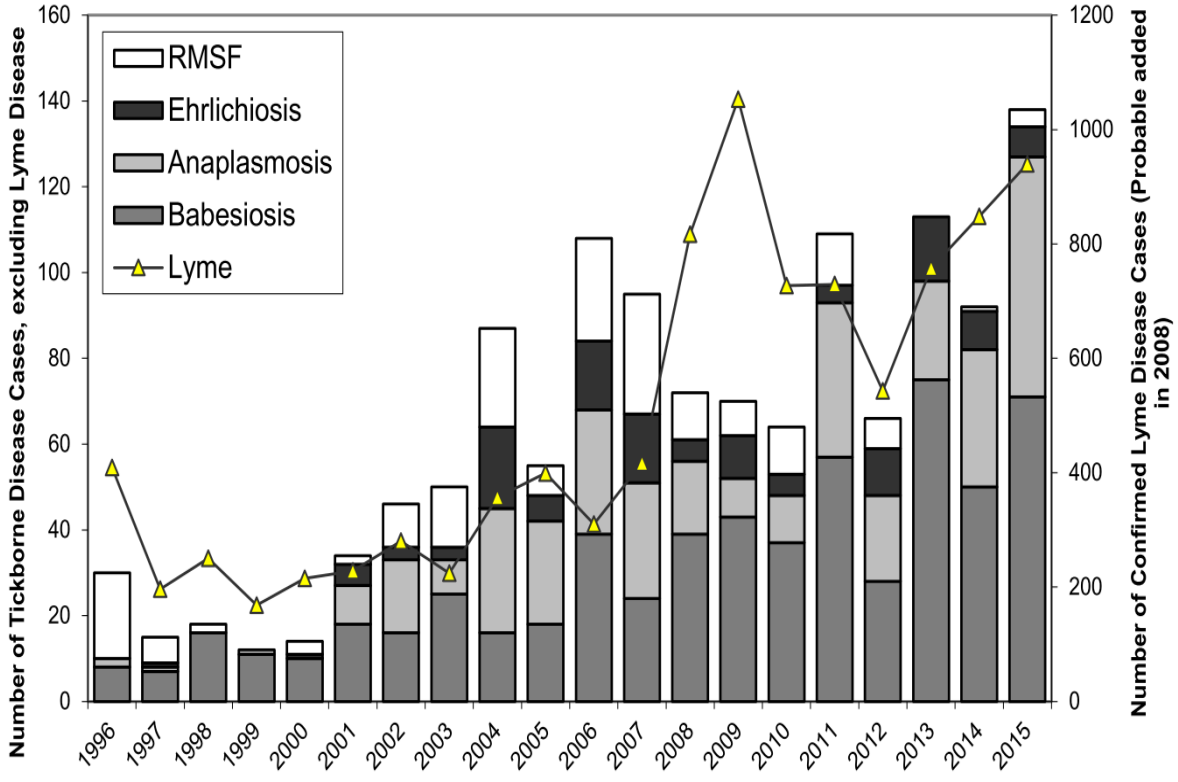
Bisanzio et al. *JAMA Network Open, 2019*



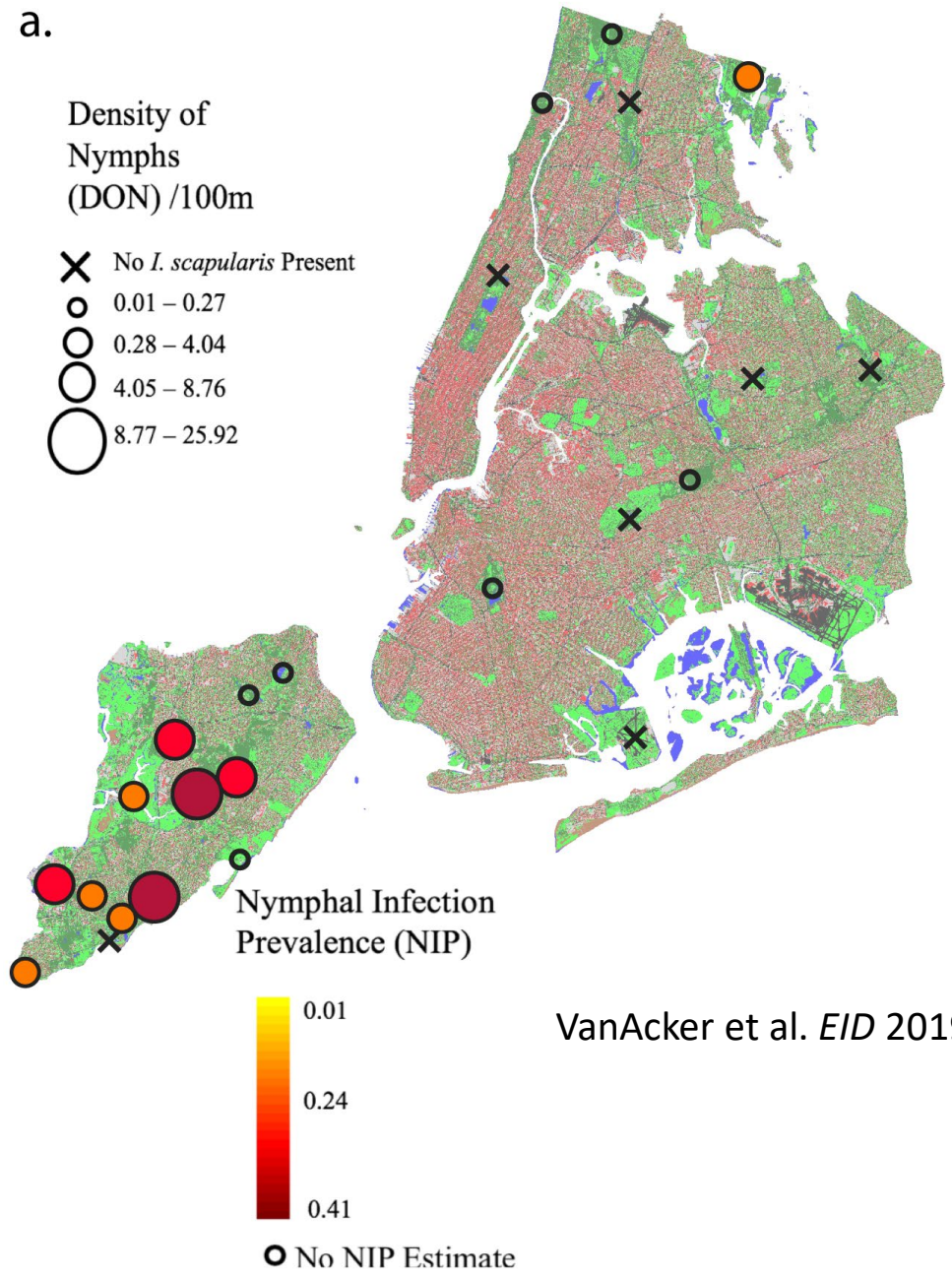
Reported cases in 2000

Reported cases in 2017

And also into urban areas of long-endemic areas…

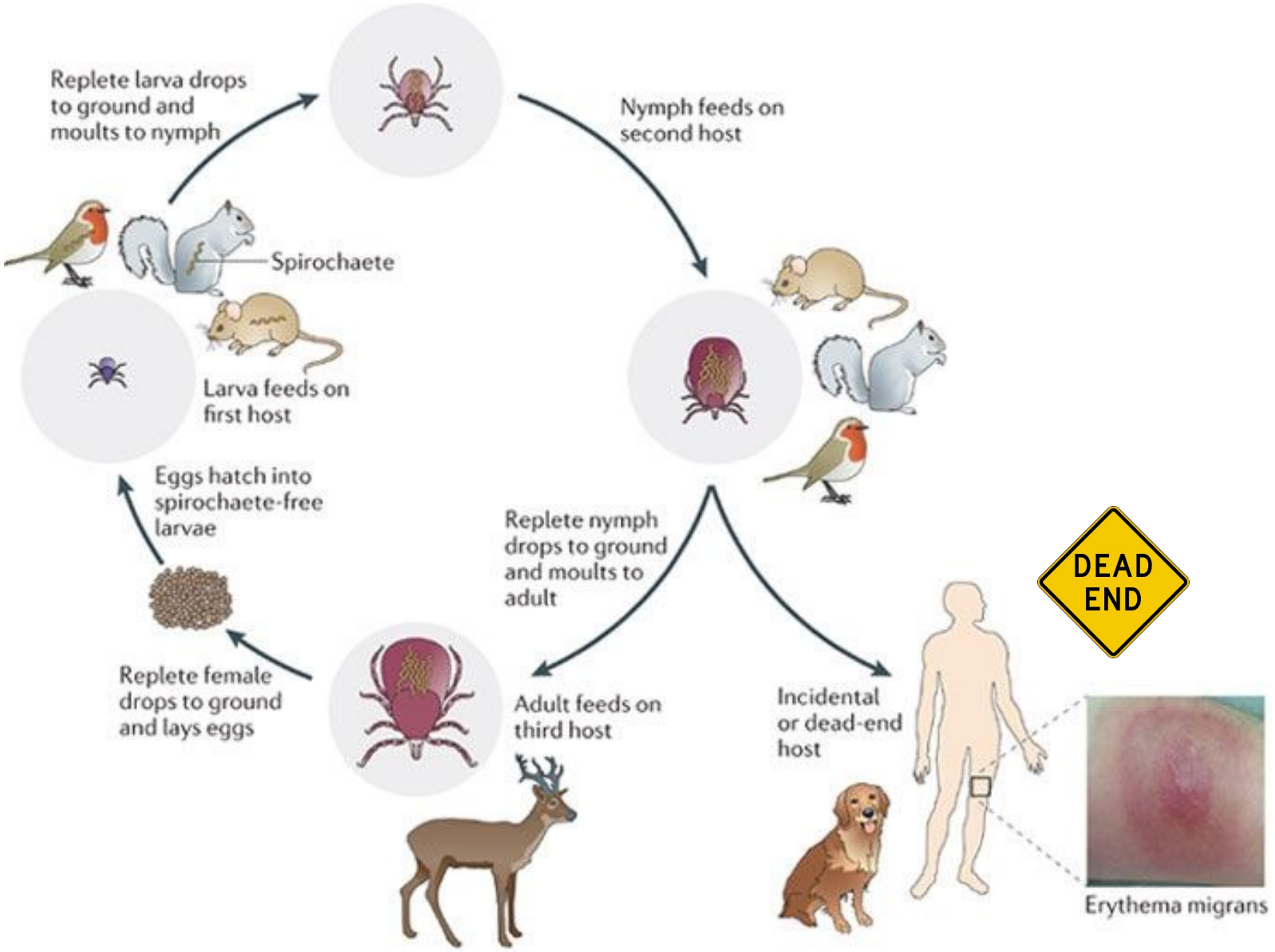


NYC Department of Health



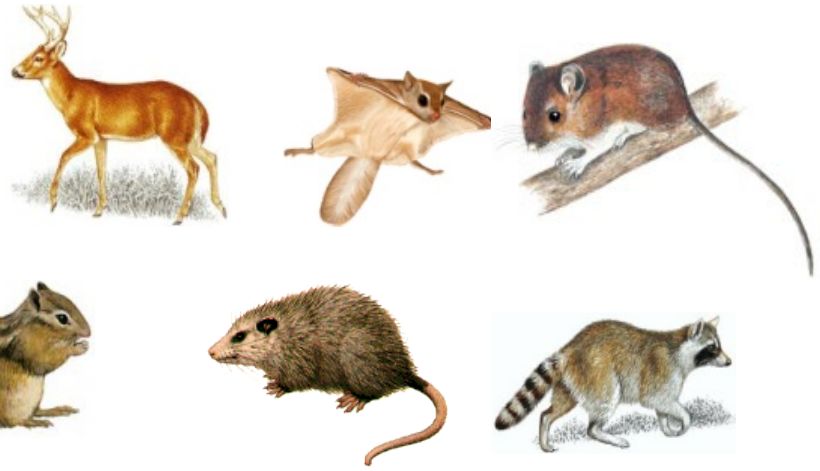
VanAcker et al. *EID* 2019

Lyme disease: how is it transmitted?

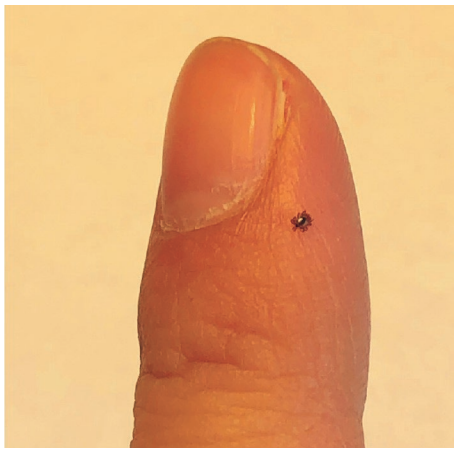


More ticks, more cases?

Host availability



Number of infected nymphs



Environmental factors

More ticks, more cases?

Host availability

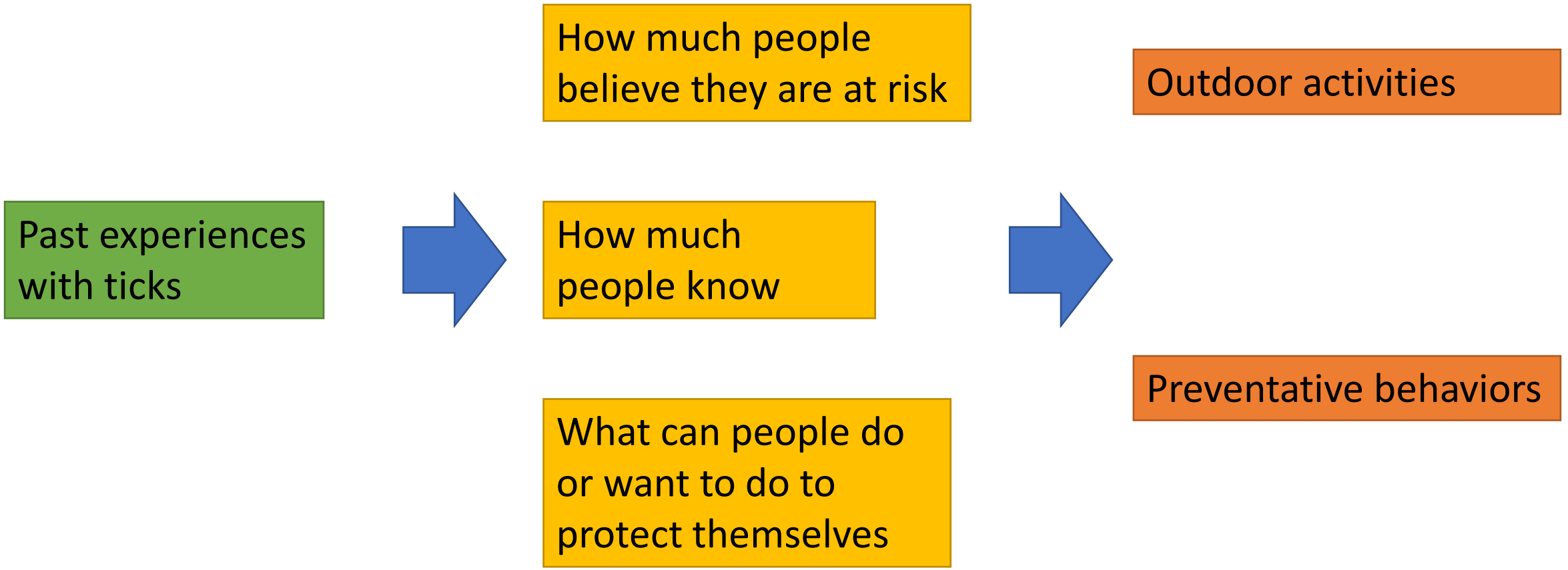
Environmental factors

Number of infected nymphs

People's exposure to ticks

Lyme disease

Understanding human exposure to ticks



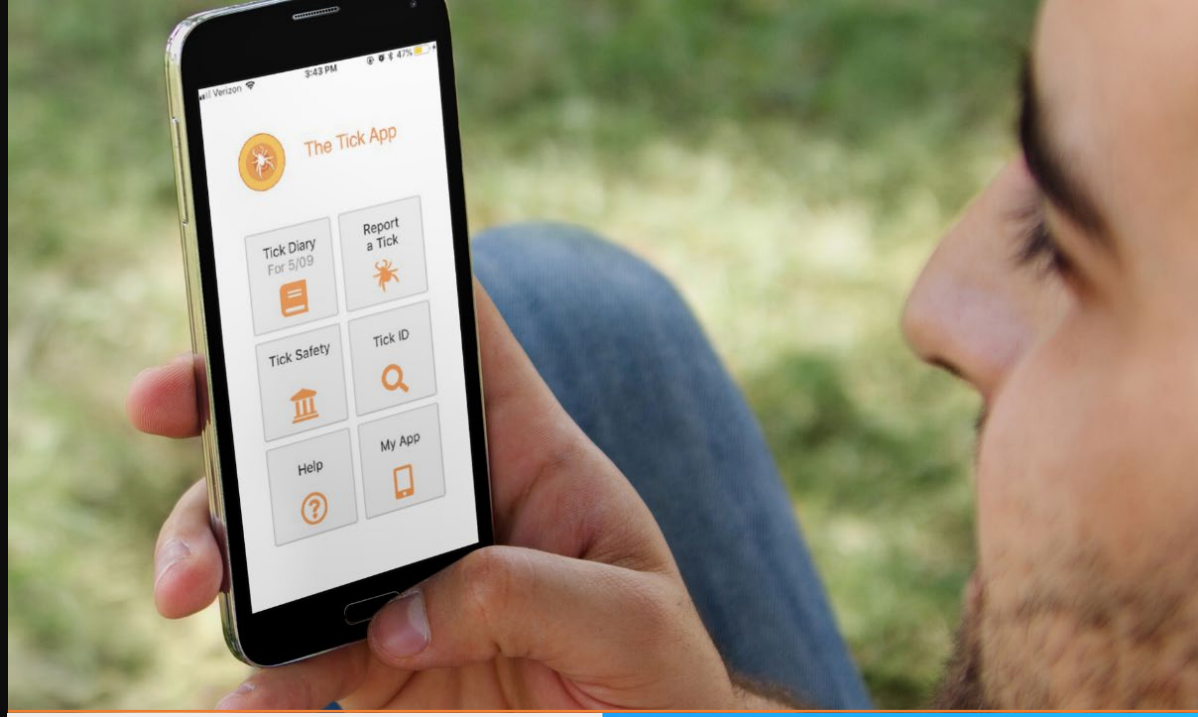
How are we studying it?

How?	A smarthphone application
Where?	Midwest and Northeast U.S.

How?	K.A.P. surveys
Where?	Staten Island, NYC

What is The Tick App?

ALL-IN-ONE free smartphone app to combine research, citizen science, education and prevention!



Google Play

App Store

NEVBD
NORTHEAST REGIONAL CENTER FOR EXCELLENCE IN VECTOR-BORNE DISEASES

Columbia University

NE COE: Maria del Pilar Fernandez, Maria Diuk-Wasser

Midwest Center of Excellence
VECTOR-BORNE DISEASE

University of Wisconsin-Madison

Michigan State University

MW COE: Gebbiena Bron, Susan Paskewitz, Lyric Bartholomey, Jean Tsao

CENTER FOR HEALTH ENHANCEMENT SYSTEMS STUDIES (CHESS)

App developer

One time

Download and install

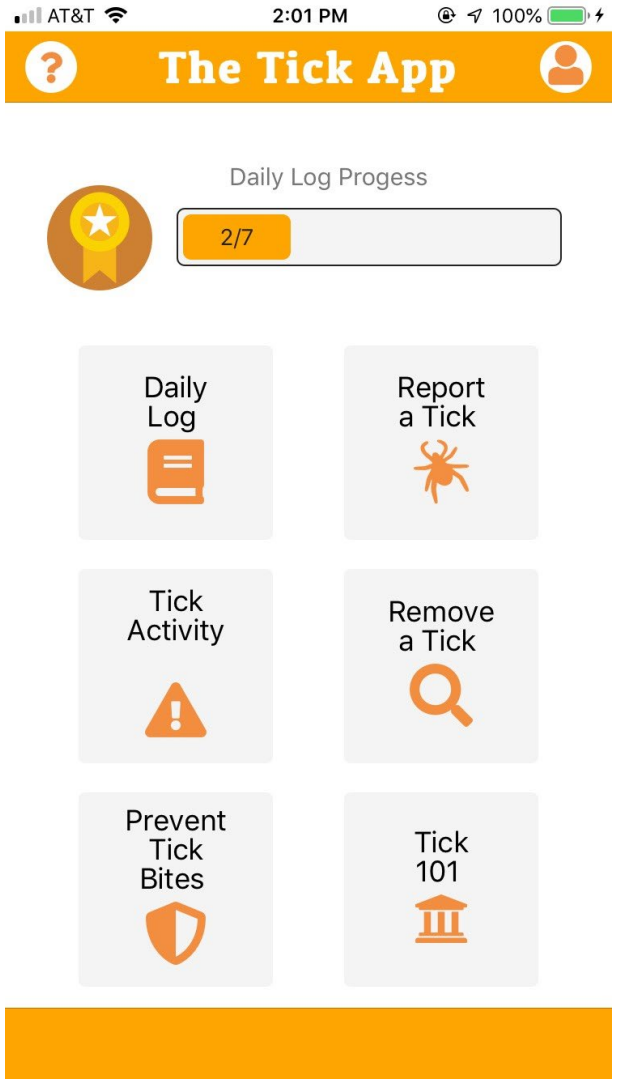
Consent form

Create user

Complete Baseline survey

Location
Occupational risk factors
Outdoor activities
Preventive measures
House characteristics
Pets

Daily survey (at least 15)
Tick count
Activities associated with the risk of tick exposure



Access homepage

Any time
Details about the tick
Tick ID

Download and install

Consent form

Create user

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Location
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One time

Daily survey (at least 15)
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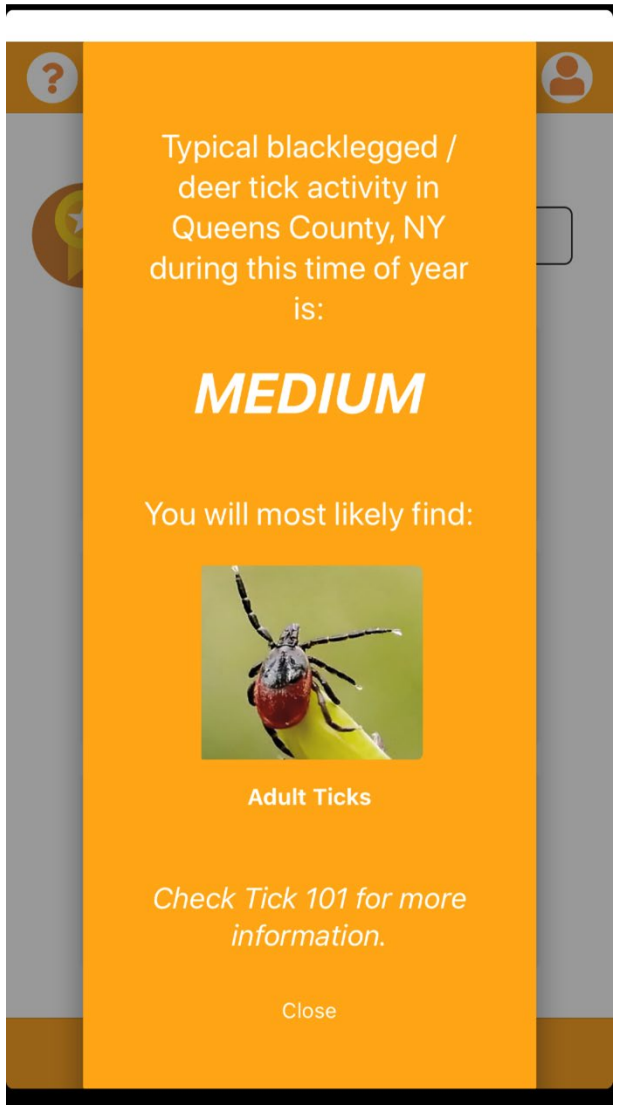

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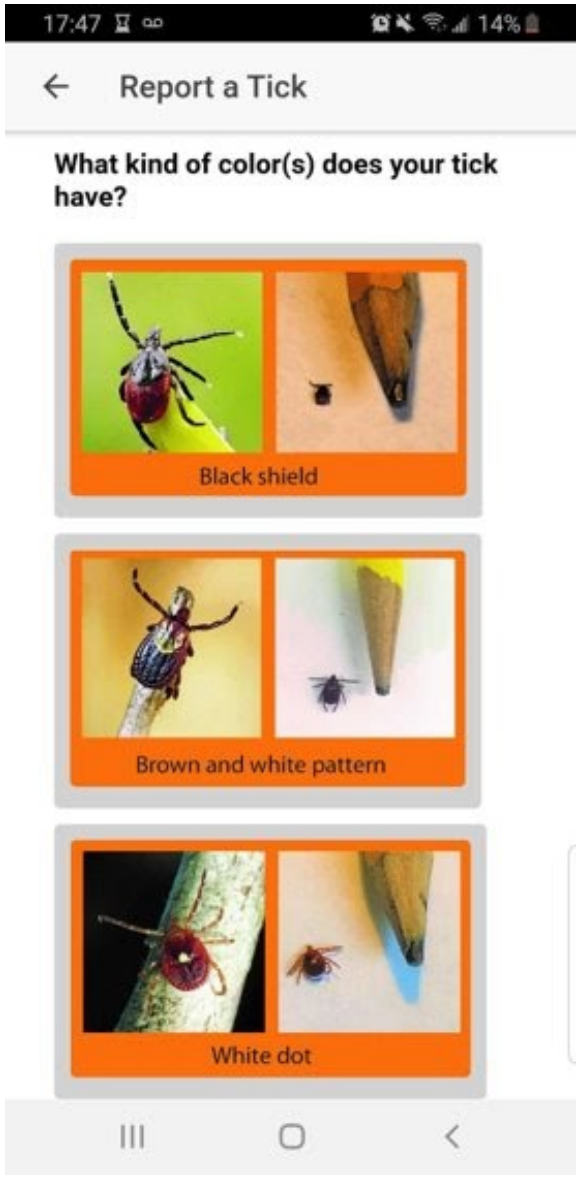
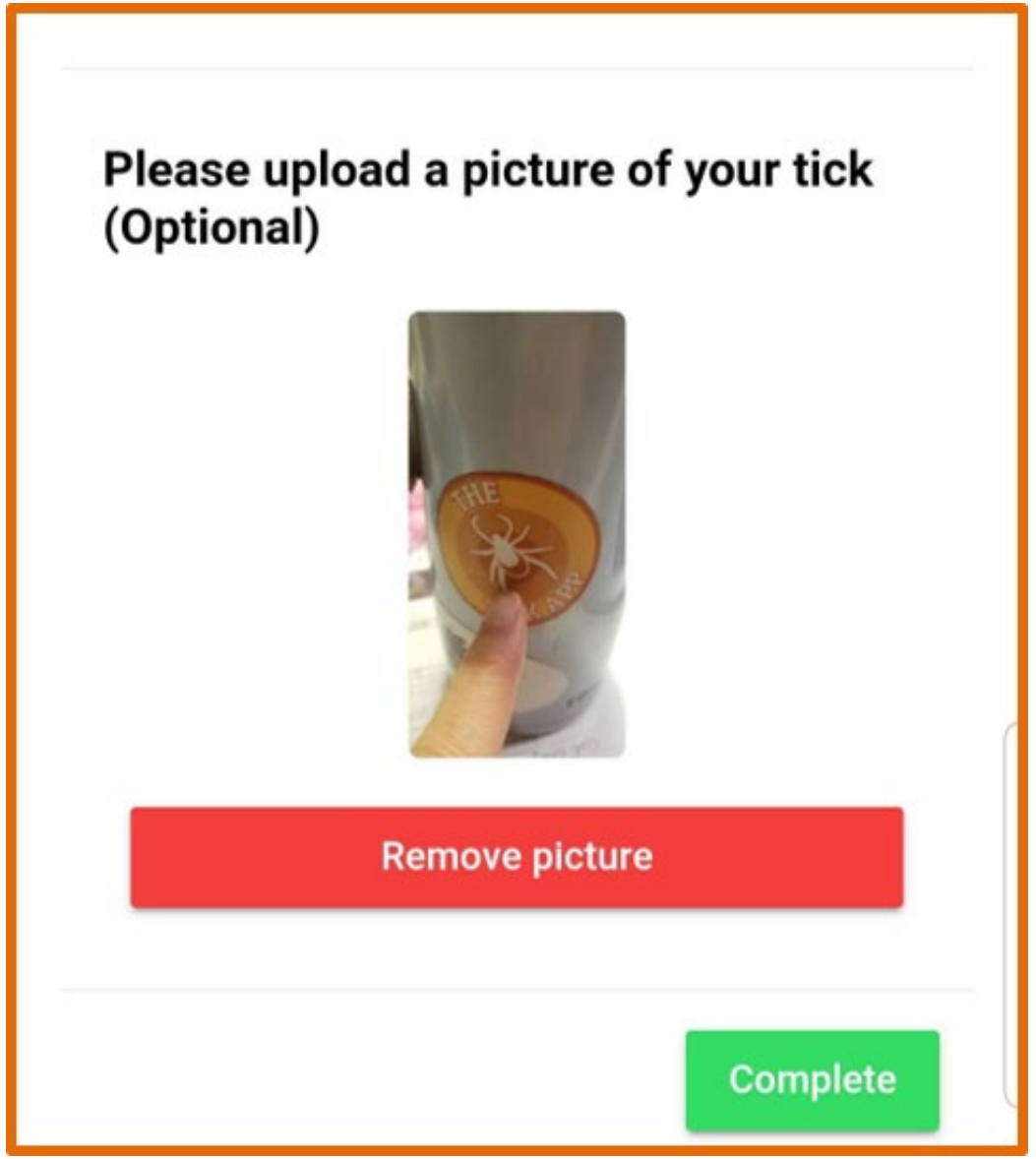

17:47
14%
Report a Tick
What kind of color(s) does your tick have?
Black shield
Brown and white pattern
White dot


Please upload a picture of your tick (Optional)
Remove picture
Complete

Original Paper

Usability and Feasibility of a Smartphone App to Assess Human Behavioral Factors Associated with Tick Exposure (The Tick App): Quantitative and Qualitative Study

Maria P Fernandez[1,2*], PhD; Gebbiena M. Bron[3*], DVM, PhD; Pallavi A Kache[2], MPH; Scott R Larson[3], PhD; Adam Maus[4], MSc; David Gustafson Jr[4], MSc; Jean I Tsao[5], PhD; Lyric C Bartholomay[6], PhD; Susan M Paskewitz[3], PhD; Maria A Diuk-Wasser[2], PhD

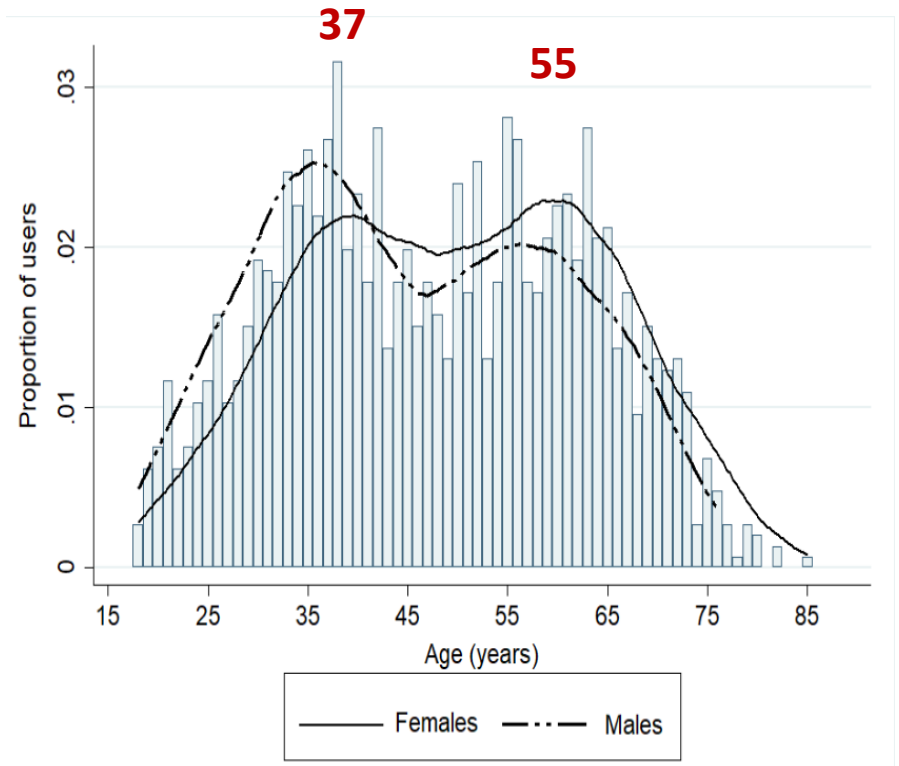
[1]Earth Institute, Columbia University, New York City, NY, United States

Who is using the app?

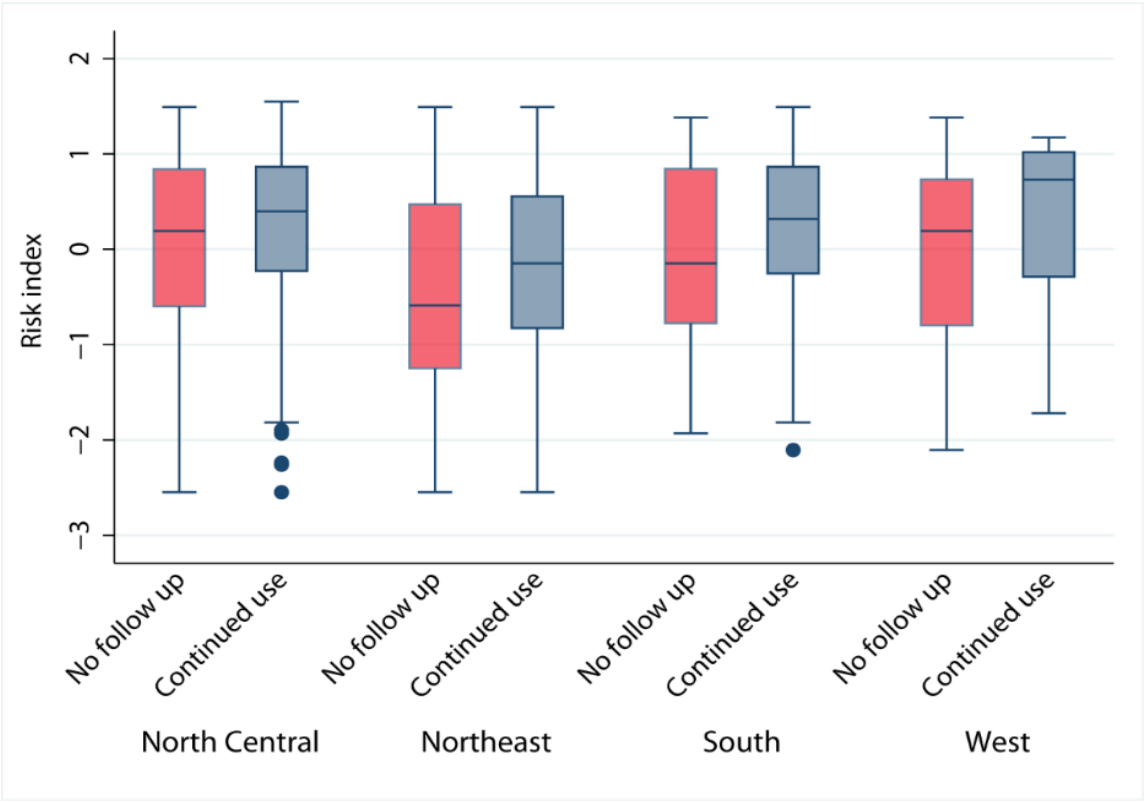
Demography

49%

49.5%



Risk behavior



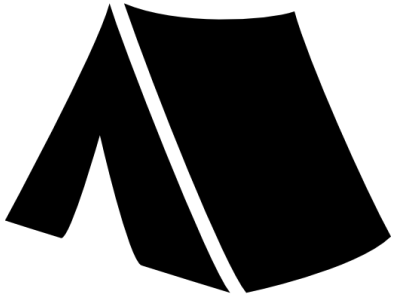
Users that did outdoor activities more frequently used the app

Midwesteners reported more frequent participation in outdoor activities

Pearson Chi-squared $p<0.001$

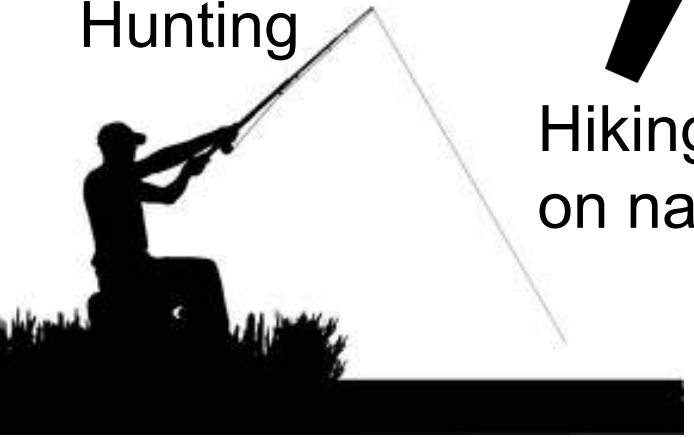
Hunting

Hiking / walking on nature trails

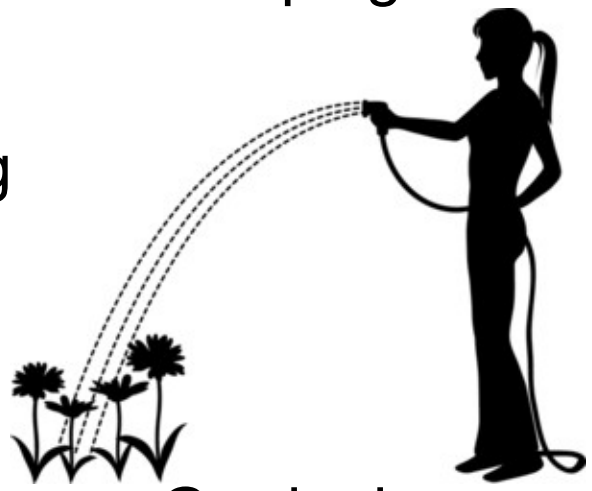


Camping

Birding



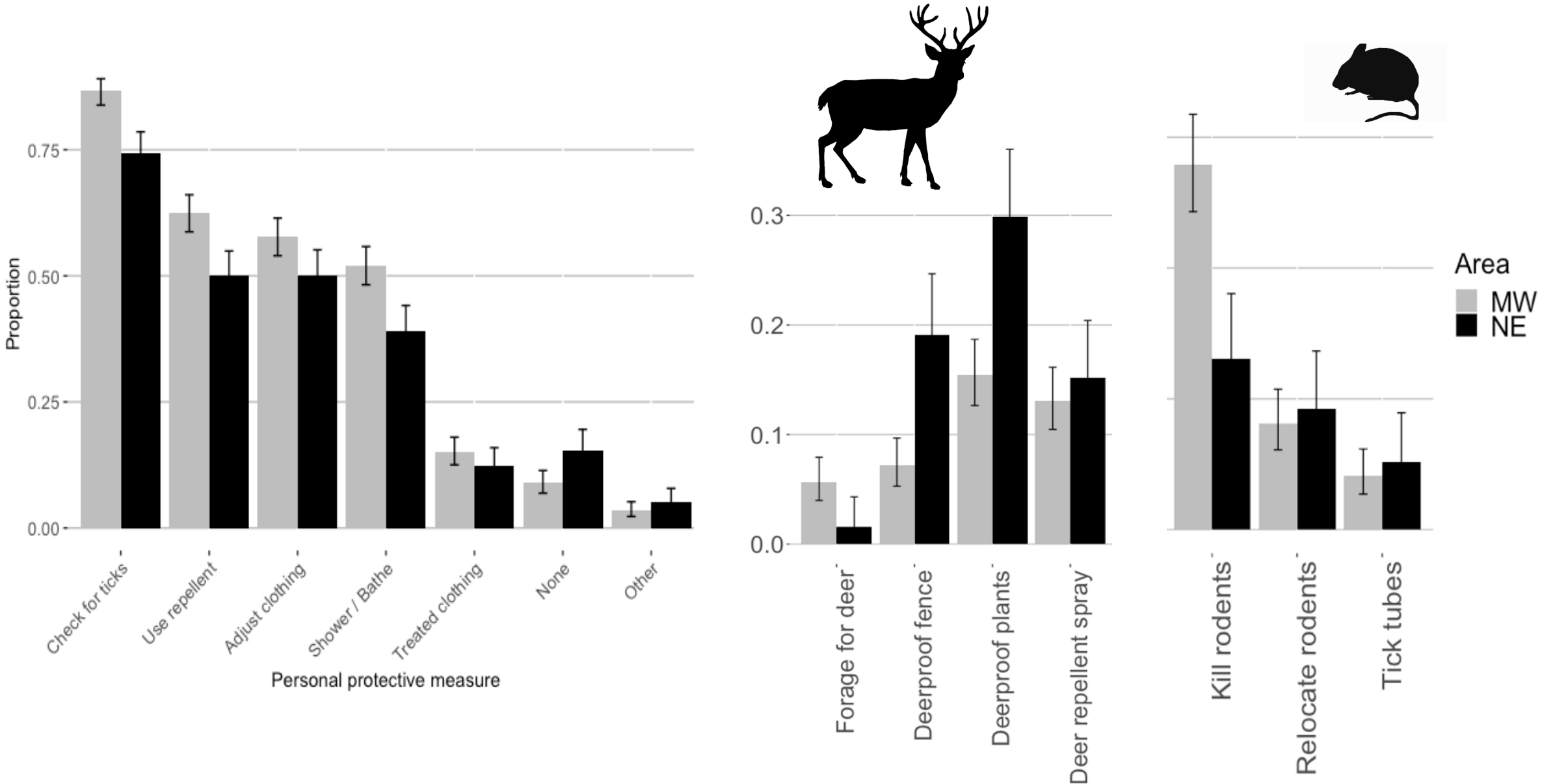
Fishing



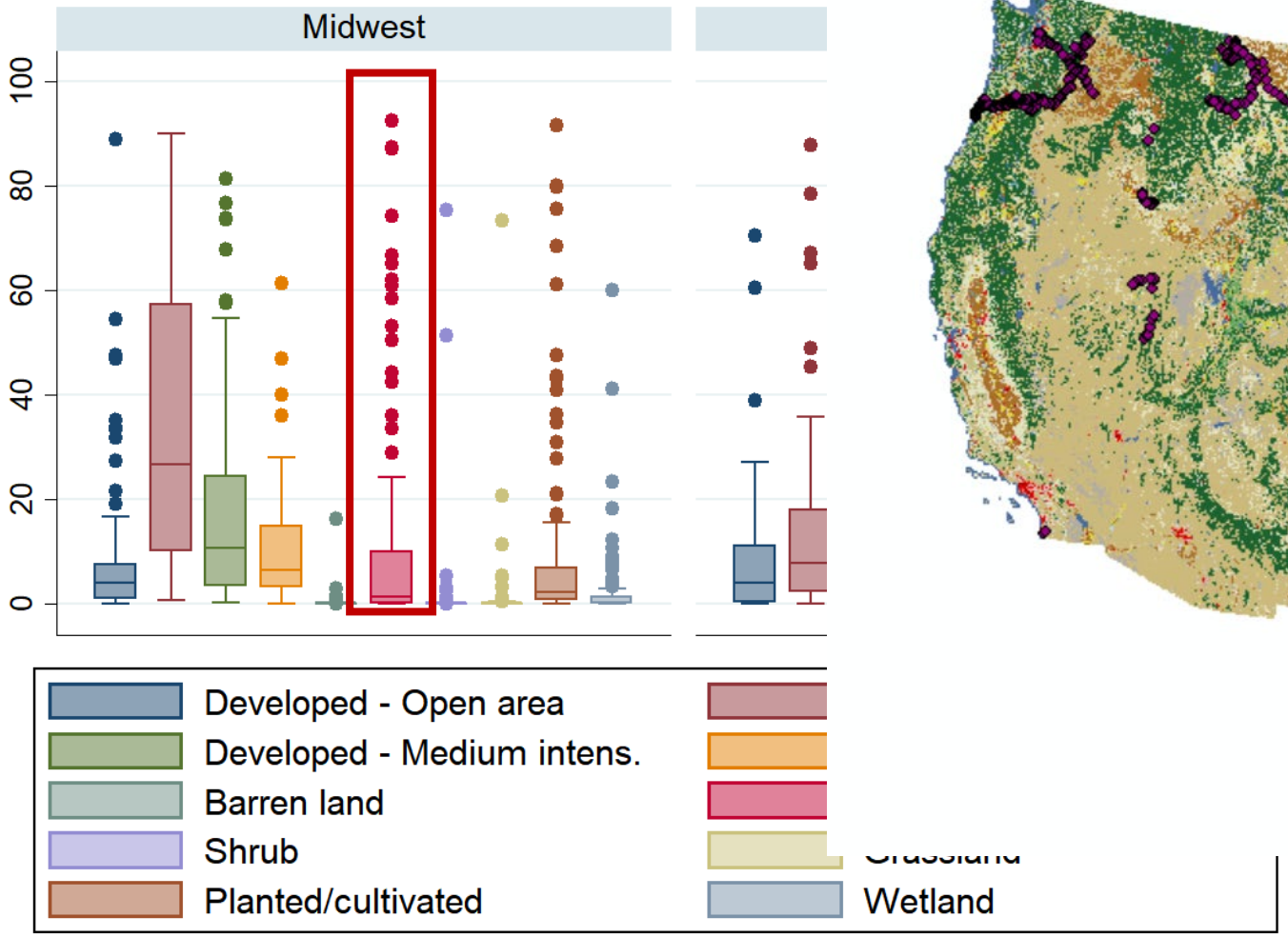
Gardening

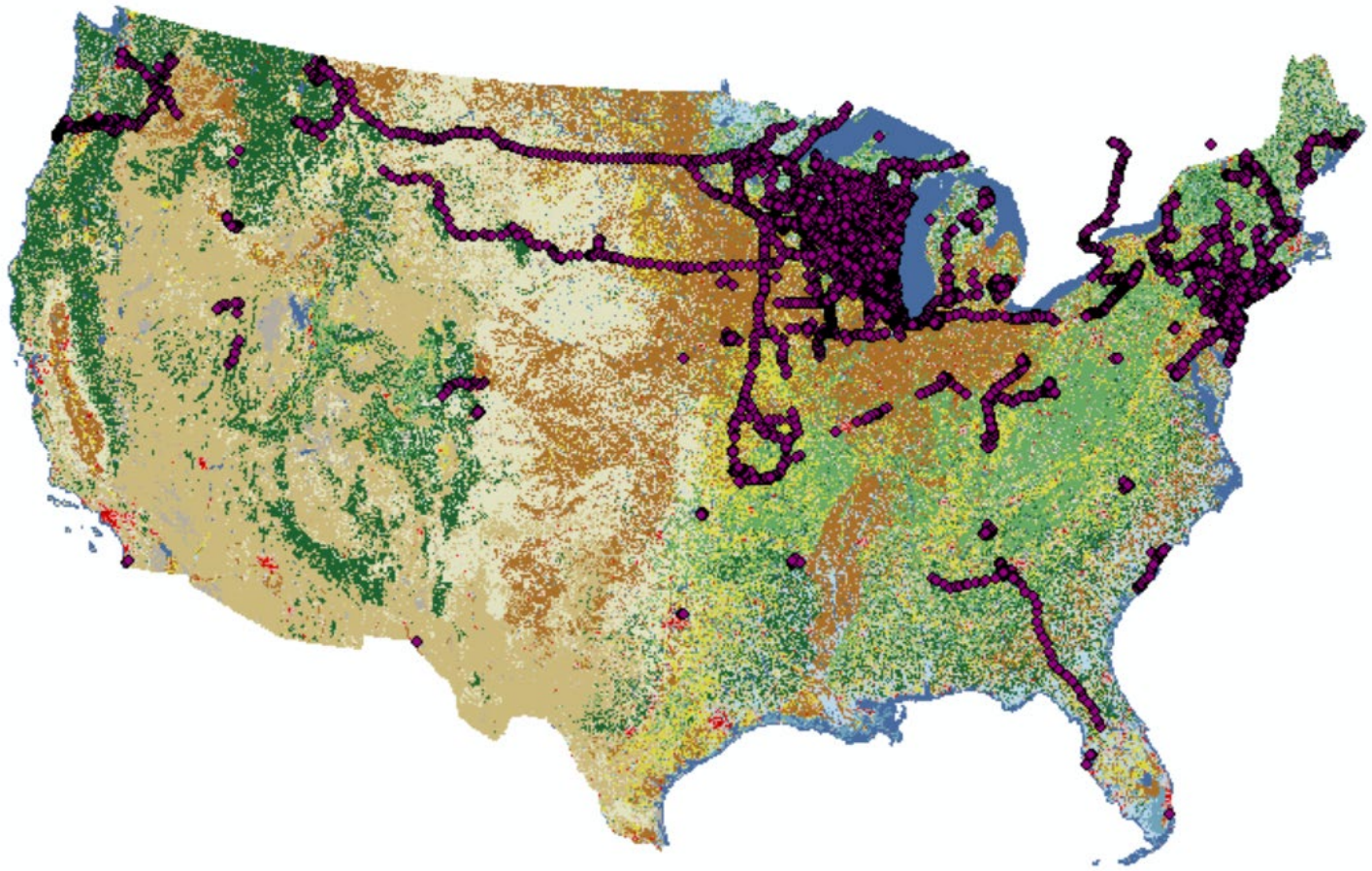
Mowing the lawn

Differences between users in the Midwest and Northeast in their preventative behaviors

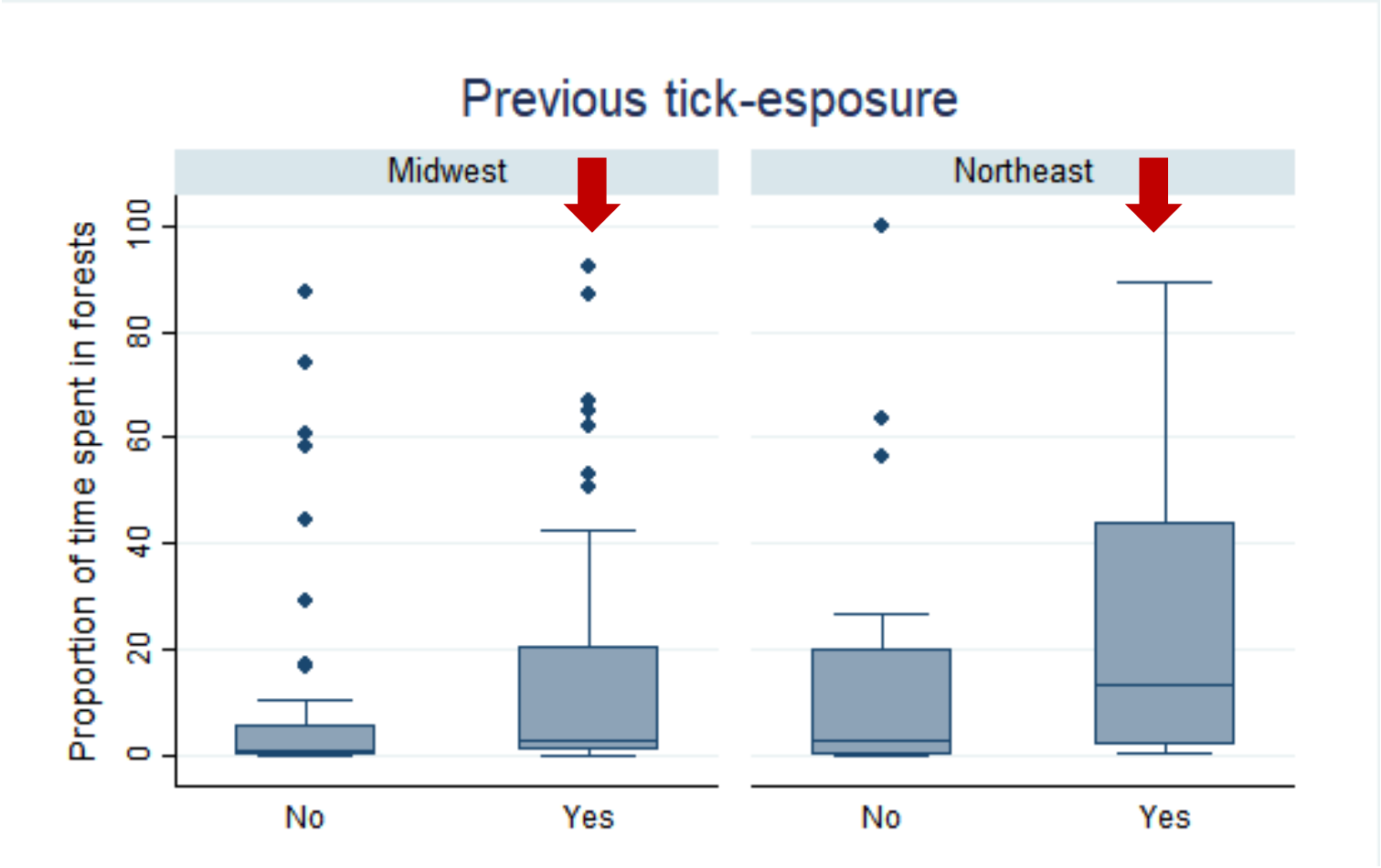


GPS data help us understand time spent in risky habitats for Lyme disease





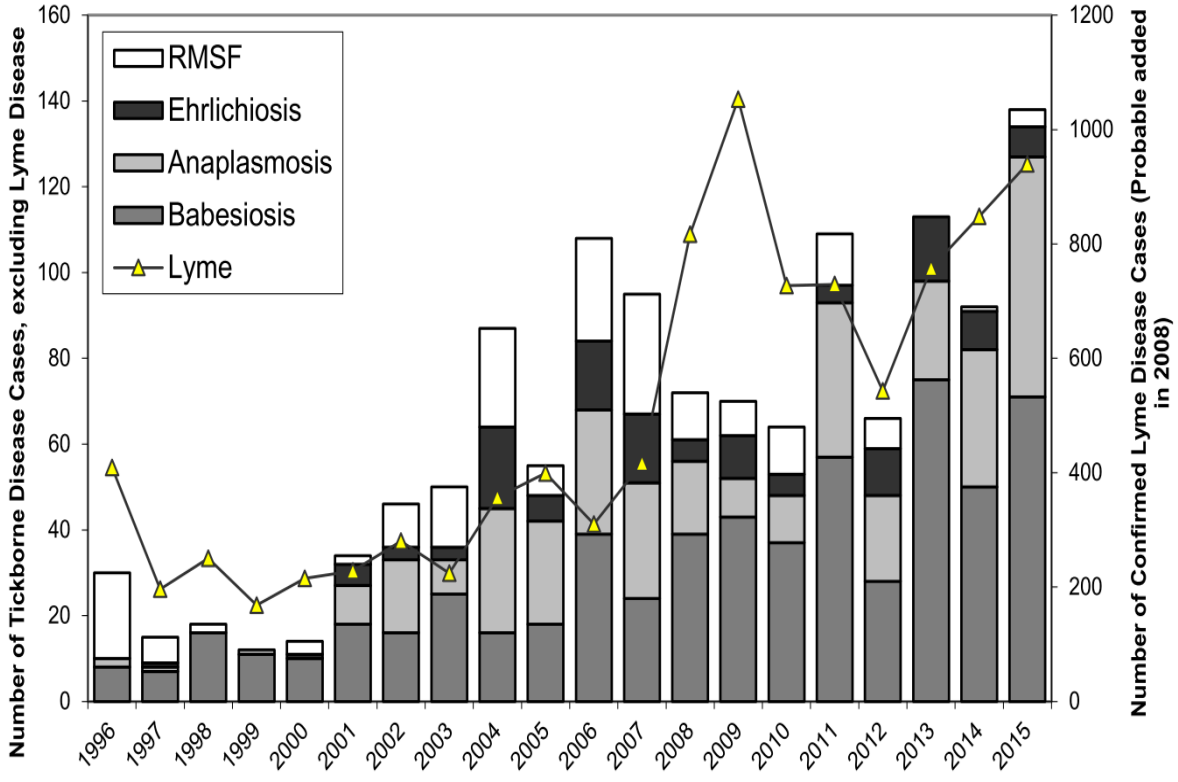
Time spent in forests was associated with tick exposure in both regions



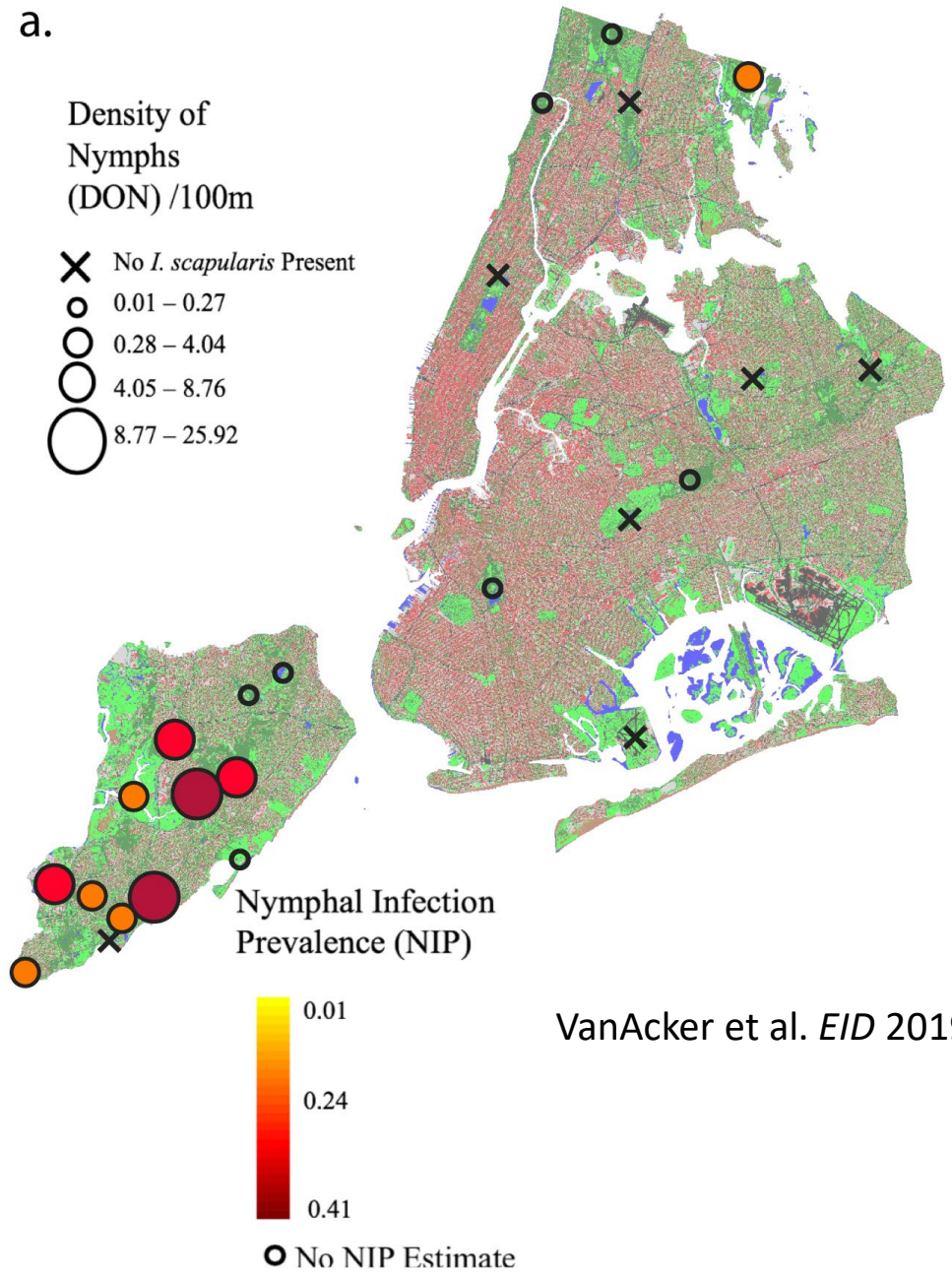
Human behavior and tick encounters on Staten Island, NYC

A more detailed analysis: where and how are people getting exposed?

And also into urban areas of long-endemic areas…



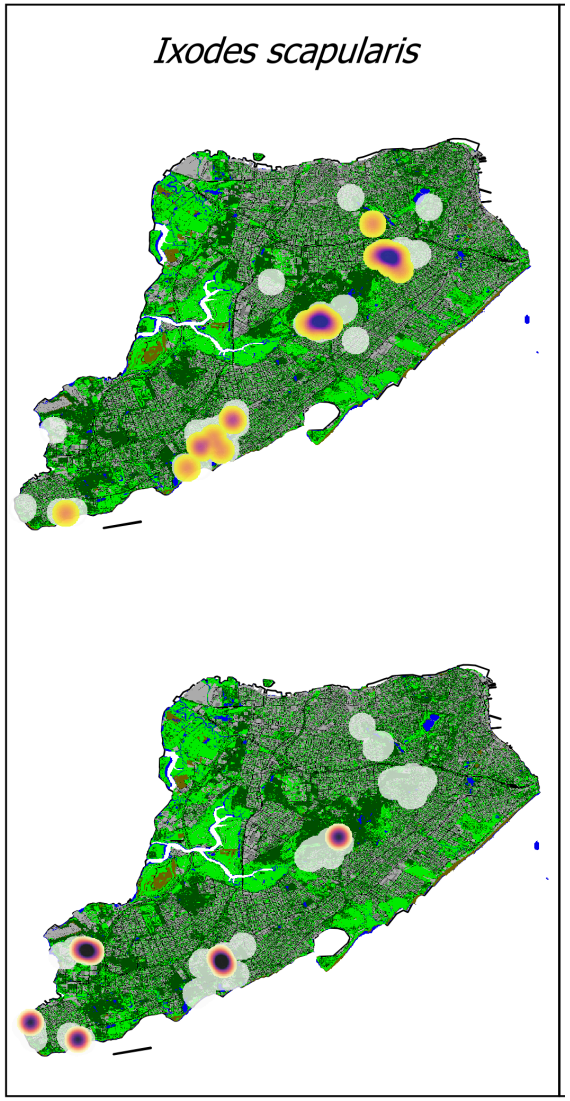
NYC Department of Health

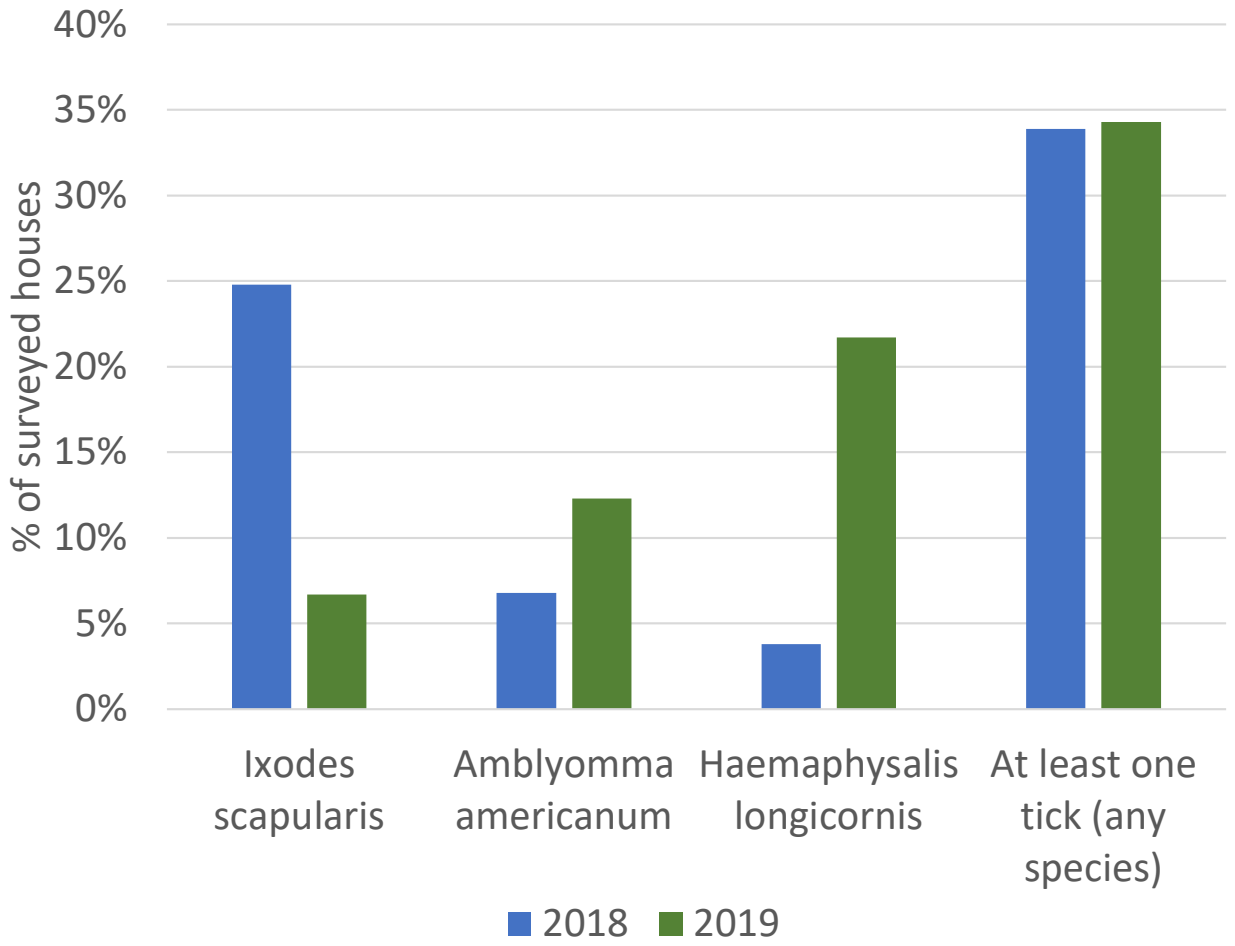


VanAcker et al. *EID* 2019

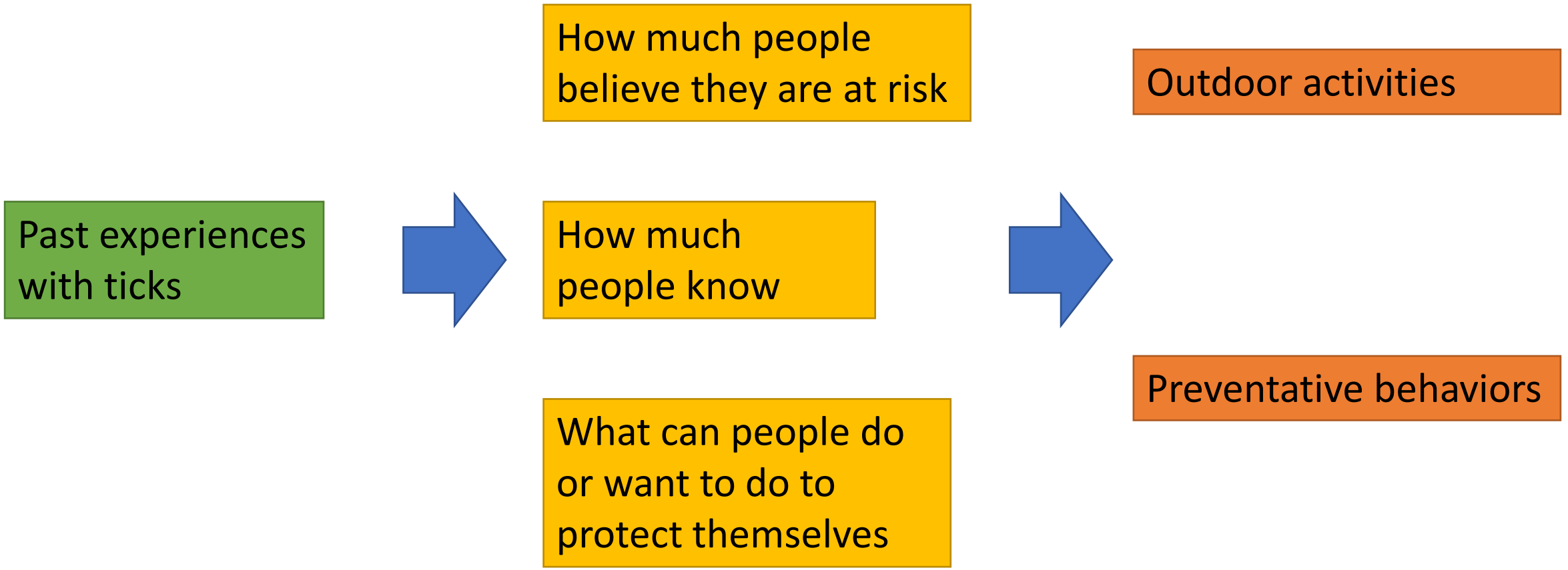
A third of the yards surveyed on Staten Island had at least one tick (n=133)

2018-2019

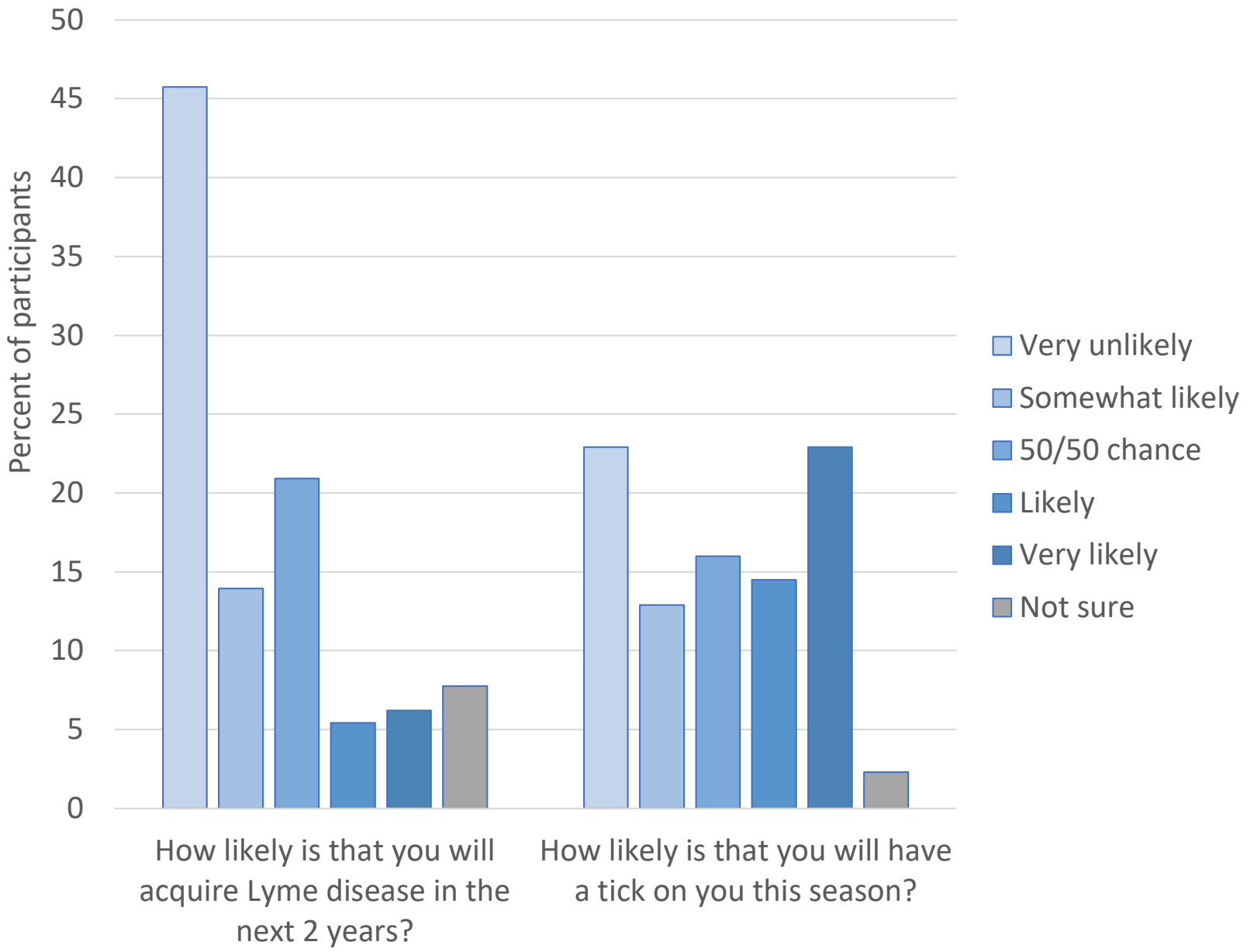




Understanding human exposure to ticks

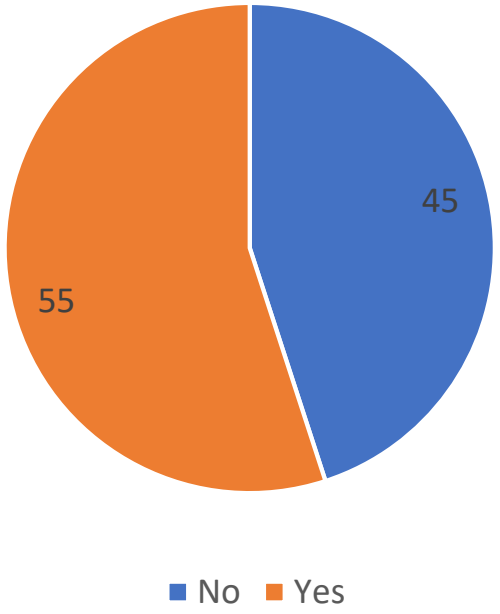


How much people believe they are at risk

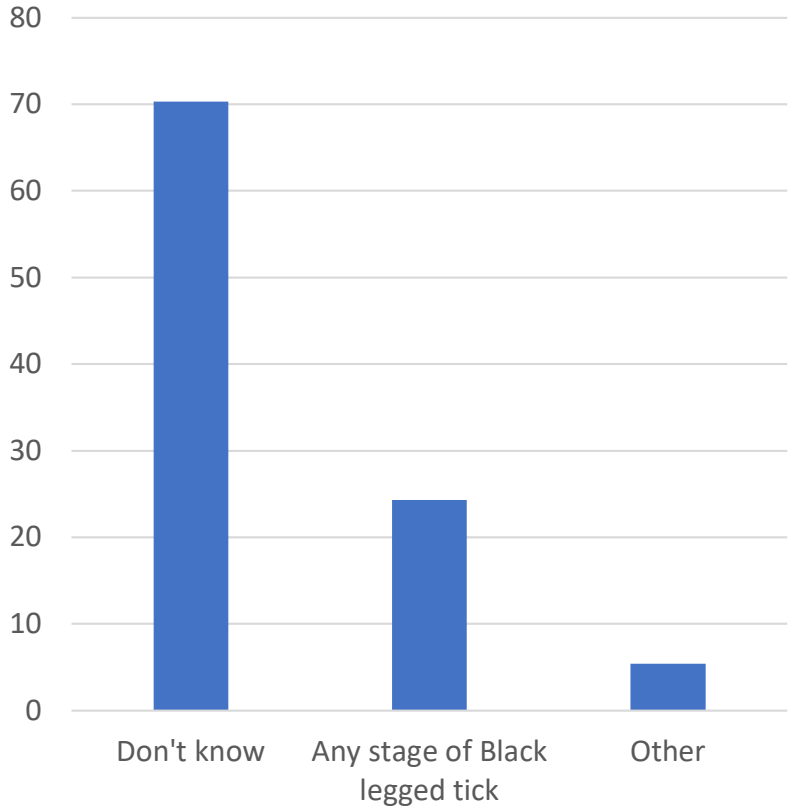


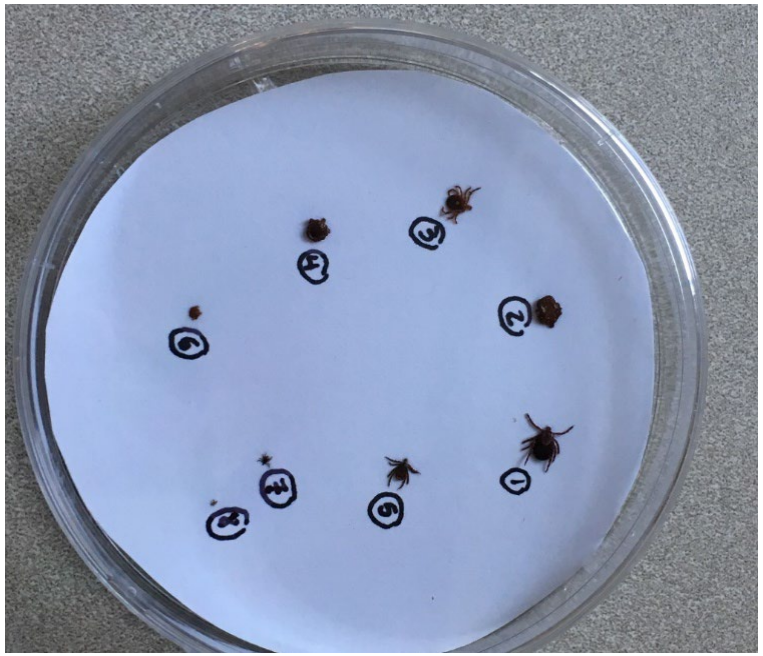
How much people know

Have you ever found a tick on you/your pet/member of your household?



Which one is the tick that transmits Lyme disease





What can people do or want to do to protect themselves

Adaptive behaviors

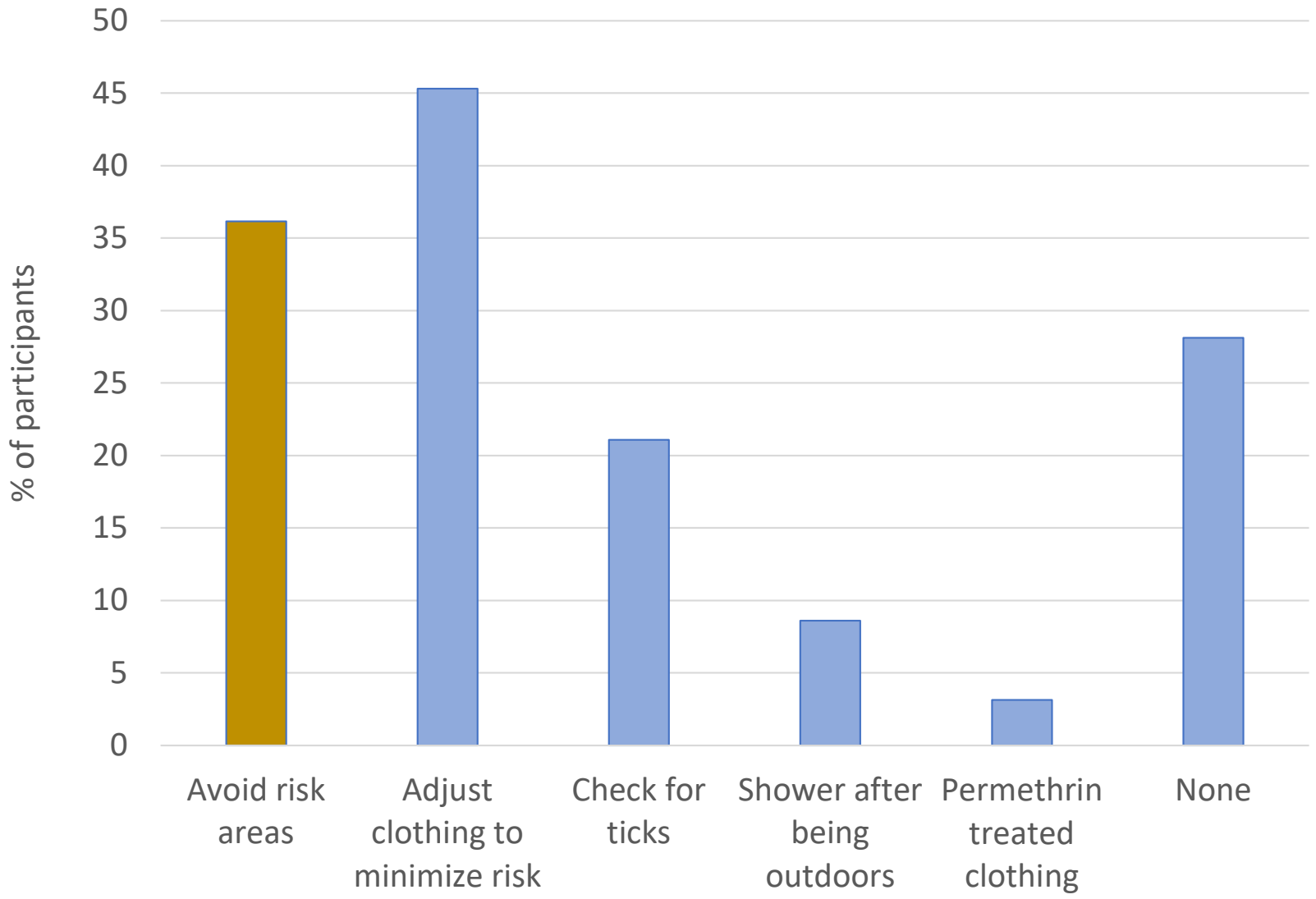
Avoidance

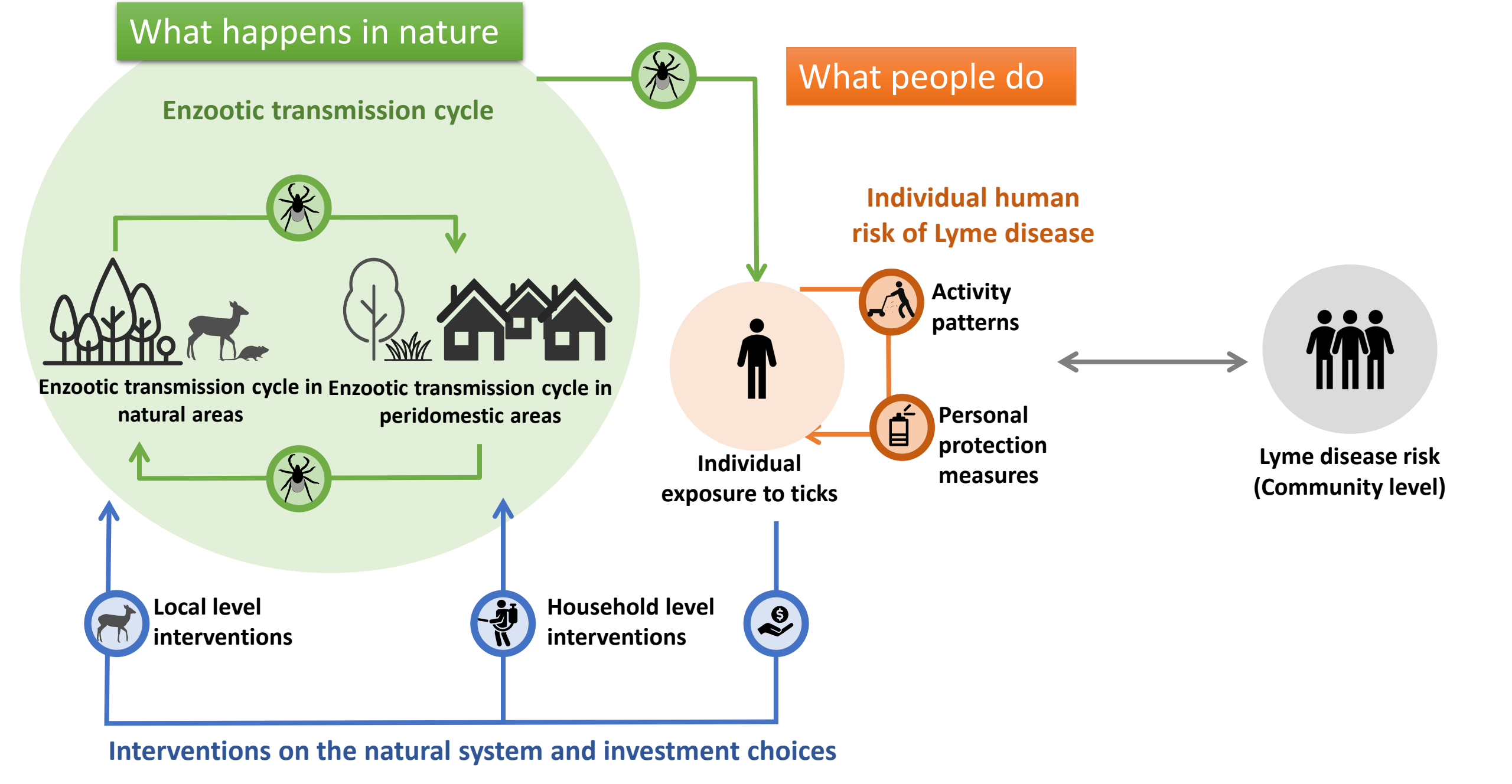
Personal protective measures to reduce risk

Risk mitigation

Interventions to reduce tick densities:

- Spraying in the yard
- Deer control




What happens in nature
Enzootic transmission cycle
Enzootic transmission cycle in natural areas
Enzootic transmission cycle in peridomestic areas
What people do
Individual human risk of Lyme disease
Activity patterns
Personal protection measures
Individual exposure to ticks
Lyme disease risk (Community level)
Local level interventions
Household level interventions
Interventions on the natural system and investment choices

Thank you

PROJECT WEBSITES

| http://nycticks.e3b.columbia.edu

| www.thetickapp.org

|https://ecoepidemiologylab.e3b.columbia.edu/

Center for
VECTOR BIOLOGY
RUTGERS

Asian longhorned ticks

Dina M. Fonseca, PhD

Director, Center for Vector Biology

Rutgers, the state university of NJ

RUTGERS
New Jersey Agricultural
Experiment Station

A swarming, exotic tick species is now living year round in N.J.

Updated Apr 24; Posted Apr 21

NEWS ANIMALS

This invasive tick can clone itself and suck livestock dry

In its native East Asian range, the longhorn tick spreads potentially fatal human diseases

BY LEAH ROSENBAUM 7:00AM, JUNE 29, 2018

Exotic tick species invades New Jersey and appears to be spreading

Scott Fallon, Staff Writer, @NewsFallon Published 5:33 a.m. ET May 3, 2018 | Updated 2:59 p.m. ET May 3, 2018

ENVIRONMENT

This Self-Cloning Tick is Terrorizing More States

BY JAKE ROSSEN JULY 12, 2018

Asian longhorned tick, *Haemaphysalis longicornis*

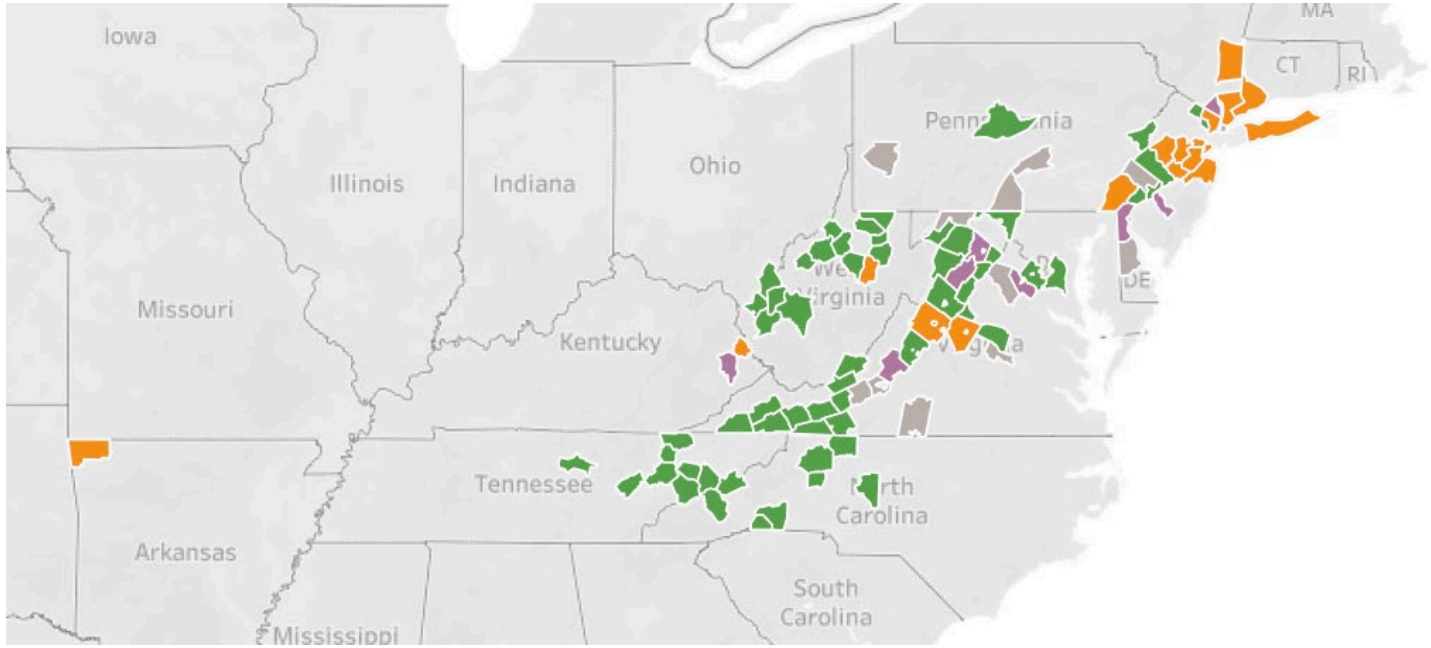
Photo by Vecchio

- Native to east Asia (China, Korea Peninsula, Japan)
- 1900's – established in Australia and the south Pacific
- 2017 - field populations first detected in NJ
- 3 host tick
- Parthenogenetic populations – no males have been found in the US
- Very large infestations can develop from single individuals
- Broad host range (pets, livestock, wildlife, people)
- In its native range can transmit dangerous pathogens to humans

Useful links: http://vectorbio.rutgers.edu/outreach/ticknews.php
(biology, identification, fact sheets, press releases from all states 1st detections)

US Distribution

- 12 states: AR, CT, DE, KY, MD, NJ, NY, NC, PA, TN, VA, WV
- Hosts: dog, cat, coyote, grey fox, red fox, opossum, raccoon, groundhog, cow, goat, sheep, white-tailed deer, elk, horse, red-tailed hawk, Canada goose, human



specimens collected in 2010 and 2013 found in archived samples

USDA Natl Situation Report (Apr 2020)

The good news

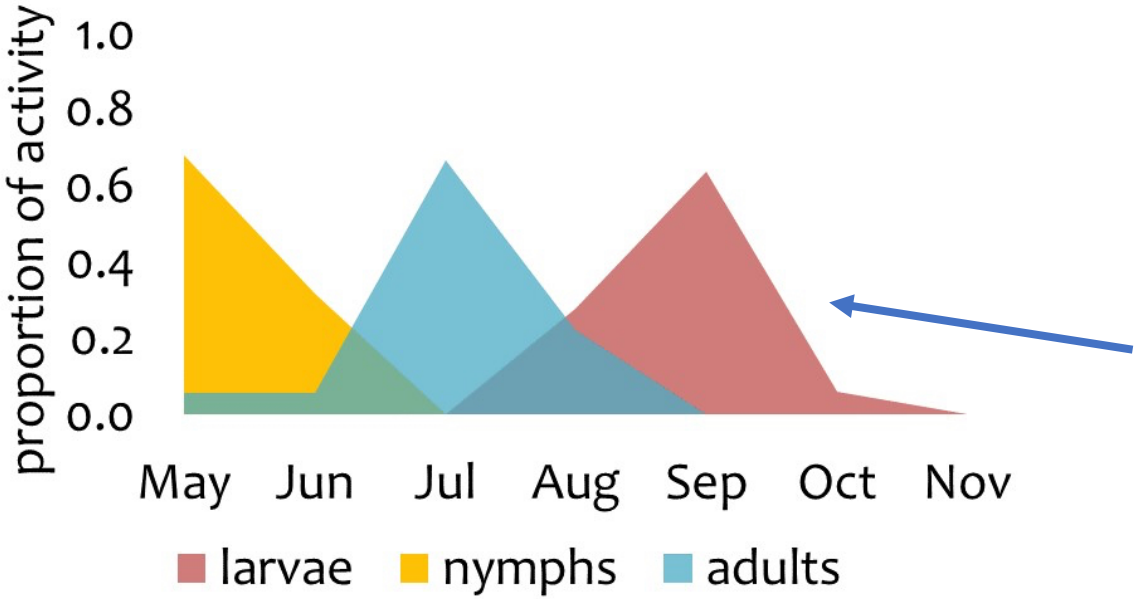
- **No human pathogens** have been detected in US populations of this tick.
- Asian longhorned ticks are **not capable** of transmitting the Lyme bacterium[1]
- Compared to local blacklegged ticks and lone-star ticks, Asian longhorned ticks seem **uninterested in humans[2]**; standard tick repellents and acaricides are effective[3]

Bad news

- Asian longhorned ticks infected with *Theileria orientalis* Ikeda were collected in Virginia in areas where **dead cattle** infected with this pathogen had been found[4]
- Asian longhorned ticks **are capable** of transmitting *Rickettsia rickettsii,* the agent of Rocky Mountain spotted fever, a deadly bacterial disease endemic to the US[5]
- **Larval** Asian longhorned ticks can reach extraordinarily high numbers in the Fall and there are some reports of biting – research is ongoing

[1]Breuner et al. 2020 Ticks Tick Borne Dis. 11(1):101311; [2]Tufts et al. 2019 Emerg Infect Dis. 25(4):792-796; [2]Ronai et al. 2020 Med Vet Ent (ahead of print);
[3]Foster et al 2020 J Med Ent Feb (ahead of print); [4]Oakes et al 2019 Emerg Infect Dis. 25(9):1653-1659; [5]Stanley et al 2020 J Med Ent Apr (ahead of print);

When are Asian longhorned ticks active?



First detections each year
2018 – April 14 (at index site)
2019 – March 30 (Union Co.)
2020 – March 9 (Bergen Co.)

Larval “bombs” = thousands of individuals

Invasive ticks in the US

		Native range	Host range?	Outside native range?	Detected in the USA?	Dangerous? Vector?	**Additional characteristics**
Rhipicephalus annulatus	cattle tick	Middle East/ Mediterranean	One-host tick - CATTLE, deer	YES	YES	*Babesia bigemina; Babesia bovis*	Historically as far north as VA. Eradication effort in first 1/2 of 20th century. Now limited to Texas/Mexico border. Emergent due to Insecticide Resistance (IR)
Rhipicephalus microplus	southern cattle tick	India/ Indonesia	One-host tick - CATTLE	YES	YES	*Babesia bigemina; Babesia bovis*	Eradicated from S US, remains in Mexico. Often detected in the US.
Rhipicephalus sanguineus	brown dog tick	Africa?	"Three"-host tick - DOGS	YES	YES	Canine ehrlichiosis & babesiosis	Worldwide invasive. **Indoors.** **Public Health concern: Rocky Mountain Spotted fever (RMSF)**
Haemaphysalis longicornis	Asian longhorned tick	temperate Asia	Three-host tick; SHEEP; broad host range	YES	Intercepted; NJ in 2017	Yes, in native and extended range	Feeds on livestock but also on small mammals (eg. pets, wildelife). **Public Health concern: RMSF, SFTS**
Amblyomma variegatum	African bont tick	sub-Saharan Africa	three-host tick; CATTLE; broad host range	YES	Intercepted on reptiles	*Ehrlichia ruminatum* (Heartwater disease)	Established in the Caribbean ← **Public Health: African tick-bite fever (*Rickettsia africae*).**

3 main takeaways

- **Standardized tick surveillance** is basic preparedness – needs to be developed
- **Current risk** to us from Asian longhorned ticks is **minimal** compared to endemic species such as the blacklegged tick. Veterinary risk is being evaluated.
- **Prevention** also includes not moving stowaways into the US or into new states/areas
  - Loopholes need to be closed (e.g. companion animals and people are not currently inspected)
  - **Informed public** and **civic responsibility** are needed

A tick ”summit”

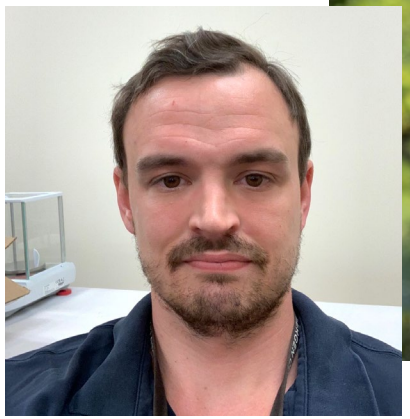
Thanks go to:

The NJ citizen that contacted the local County Health when she became infested with ticks while shearing her sheep, Hannah.

Tadhgh Rainey
Hunterdon County Health

Jim Occi, Rutgers CVB

Rich Robbins, AFPMB
USDA-APHIS



Matt Bickerton
Bergen DOH
Tick Control

Alvaro Toledo
Ticks & TBD

Andrea Egizi
Monmouth Co. Tick-borne Diseases Lab
@ Rutgers CVB, **Tick Genetics**

NJ DOH
CDC
NJ DA
USDA
NJ DEP

Julia Gonzalez
Tick dynamics

Dana Price, **Pathogen discovery**

Rainey T, Occi JL, Robbins RG, Egizi A. 2018. Discovery of *Haemaphysalis longicornis* (Ixodida: Ixodidae) parasitizing a sheep in New Jersey, United States. *J Med Entomol* 55(3):757-759.