NEVBD Applied Research

Tackling Vector-Borne Disease Threats and Public Health Challenges in the Northeast

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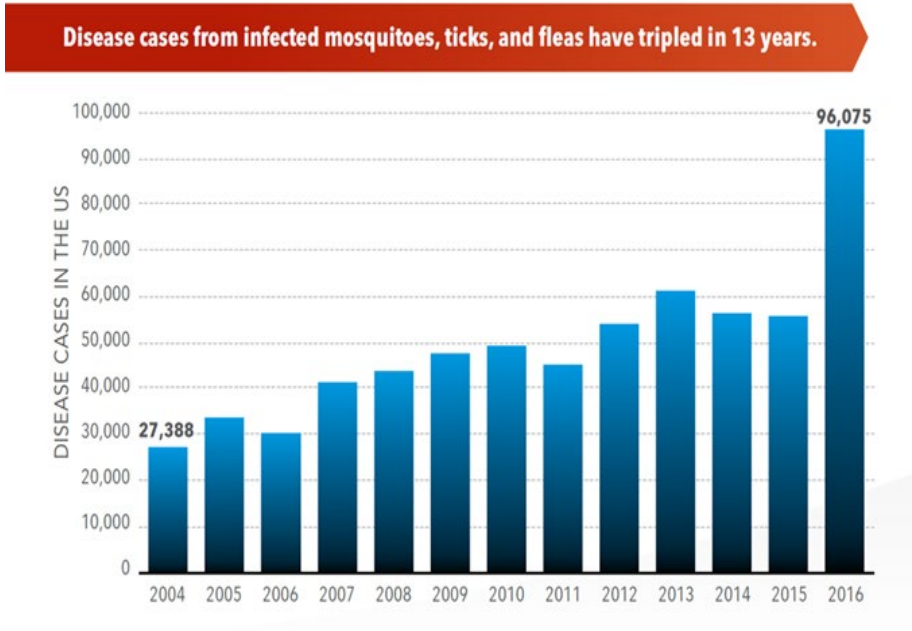
Cornell CALS
College of Agriculture and Life Sciences

Regional Centers of Excellence: The Need

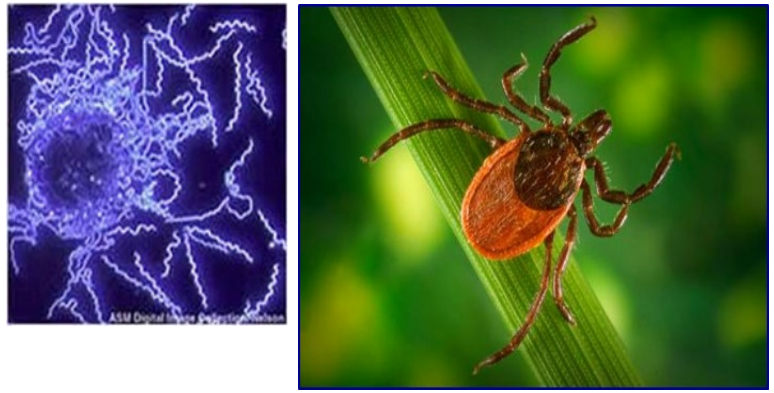
Public Health Critical Needs and Gaps- a decades long crisis in the making

Zika virus epidemic of 2015-2016



Vector borne disease in the USA has tripled in the past 14 years

CDC. 2018 Vital signs. 67:496-501.

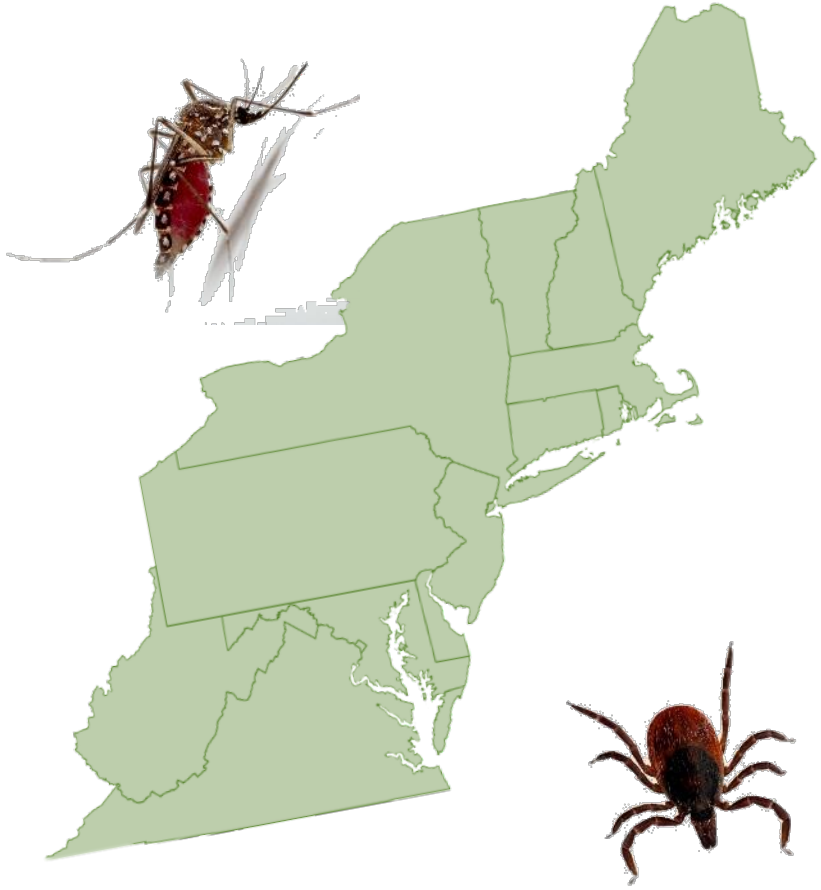


Rise in Lyme disease and tick-borne infections as high as 300,000 infections annually

NEVBD: Who We Are

- Funded by CDC 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



- Supporting stakeholders across 13 states and the District of Columbia
  - Population 2.6 million residents

OVERARCHING GOALS

GUIDING PRINCIPLES OF OUR PROGRAMMING

INNOVATIVE TRAINING

Train current and future public health entomologists

Develop programs to address current workforce training and resource gaps

APPLIED RESEARCH

Develop new tools to prevent and control vector-borne diseases

Translate research findings into public health action

FOSTERING COMMUNITY

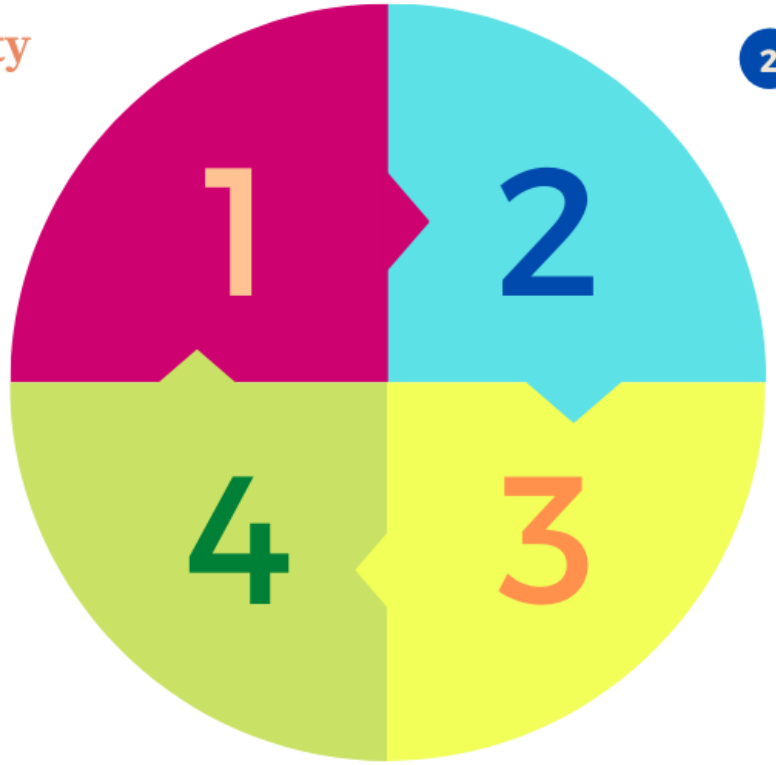
Support connections between public health, academia, and our communities

Build the framework that supports broad connections across a diverse workforce

Community of Practice

Innovative Collaborative Network

UNITING A DIVERSE PROFESSIONAL COMMUNITY



1 Community Partners

15+ partnerships with leading regional and national professional associations

2 State Agencies

90+ collaborators at over 30 state departments of health, agriculture, and environment

4 Academic Units

70+ collaborators at 17 universities and academic medical centers

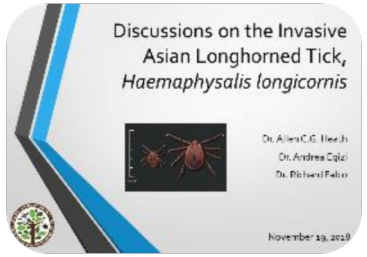
3 Local Agencies

80+ collaborators at over 50 local departments of health and vector control

Training Programs

PROFESSIONAL LEARNERS

- Vector Biology Boot Camp



- Topical Webinars

- Hands-on Workshops

ACADEMIC TRAINEES

- MS in Entomology: Vector Biology & Public Health

- Graduate and Postdoctoral Training Program

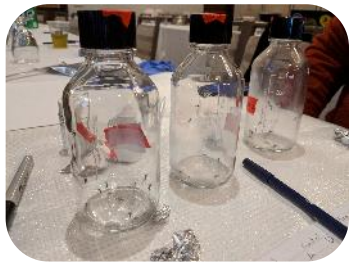
Applied Research Clusters

TRAPPING & SURVEILLANCE

Improving trapping and surveillance techniques and testing field collections for pathogens public health importance

VECTOR-PATHOGEN INTERACTIONS

Vector competence and characterization of genetic diversity of vector and virus populations

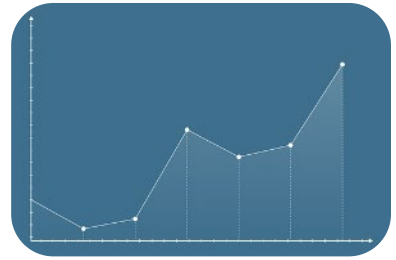


CONTROL AND RESISTANCE

Investigating vector control approaches and pesticide resistance detection

PREDICTING RISK

Descriptive and predictive models for distribution of tick & mosquito vectors and associated pathogens



BIOLOGY, BEHAVIOR & SURVIVAL

Biological and ecological aspects of vector life history and overwintering survival in the Northeast

ASIAN LONGHORNED TICK

Surveillance, biology, ecology, and vector competence of invasive tick species

Applied Research

Project Summaries

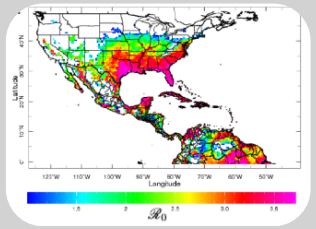
https://www.neregionalvectorcenter.com/research

Applied Research Projects

Over 60 publications in peer-reviewed literature across 64 separate applied research projects

Trapping & Surveillance

- Novel lures for container-breeding mosquitoes
- Community composition of mosquitoes & arboviruses in Northeast
- Optimization of tick surveillance approaches



Predictive Modeling

- Climate-related risks for *Ae. albopictus* establishment and spread
- *Aedes*-borne virus seasonal suitability forecasts
- Predictive model for presence and spread of WNV

Vector-Pathogen Interactions

- Competence studies for exotic and endemic vectors for ZIKV, DENV, CHIKV, JCV, CVV, Mayaro
- Impact of temperature on vectorial capacity
- Phylogenetic analyses of vector and virus populations

Vector Biology & Behavior

- Overwintering *I. scapularis* & *A. americanum*
- Drivers of diapause & blood feeding habits, *Ae. albopictus*
- Habitat, host preferences, phenology *H. longicornis*

Resistance & Control

- Pesticide resistance testing network established
- Field efficacy trials control *Cs. Melanura*
- Evaluation catch basin larviciding control WNV
- Assessment acaricides in control *H. longicornis*

Surveillance of tick species in urban parks

NEVBD Project Lead:
Erin Hassett, MS
Cornell University

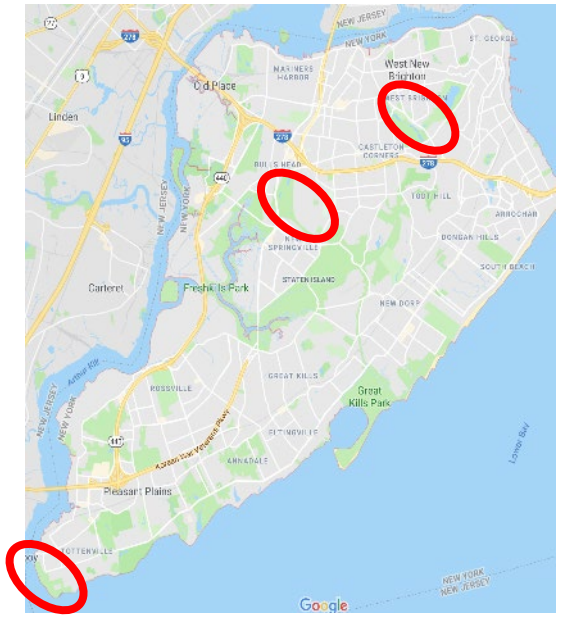
Primary Research Questions:

- How does tick hazard change by space and habitat for three tick species in Staten Island parks?
- What is the risk for tick exposure based on human usage of park spaces?
- Does knowledge and attitudes regarding ticks and tick-borne disease influence park visitor tick prevention behavior?

Ixodes scapularis
Blacklegged/ Deer Tick

Amblyomma americanum
Lone Star Tick

Haemaphysalis longicornis
Asian Longhorned Tick



Hassett et al. in manuscript.

Surveillance of tick species in urban parks

Results:

- Ticks most abundant in unmaintained herbaceous areas (invasive *H. longicornis* in south)
- Areas of high tick hazard were the least visited by park users
- Men were in high-risk habitats most frequently
- Most could not identify nymphal ticks
- Interviewees identified parks as main location for tick exposure (43%), but most felt at minimal risk for tick encounter (43%)
- 42% of park visitors do not conduct tick checks

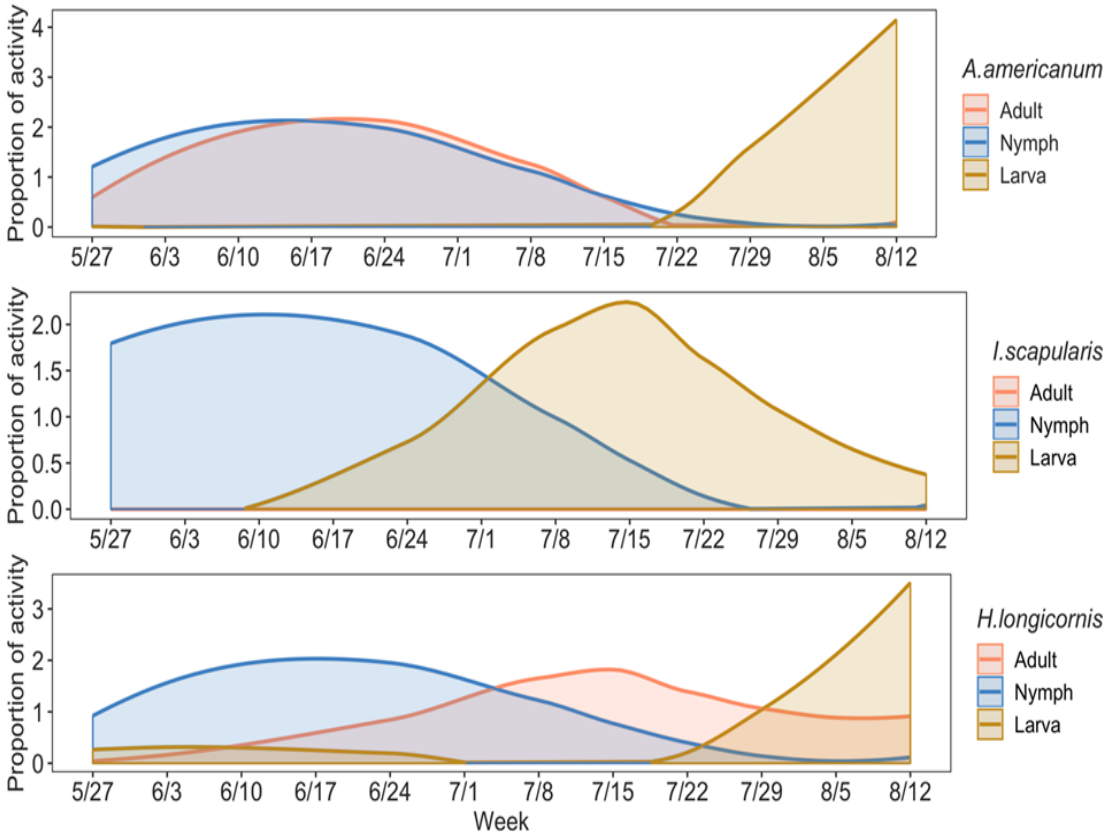


Figure 2. Tick phenology in three Staten Island parks.

Hassett et al. in manuscript.

Optimal collection methods for Asian longhorned ticks, *Haemaphysalis longicornis*

NEVBD Project Lead:
Phurchhoki Sherpa, MS
Cornell University

Primary Research Questions:

- What is the best way to monitor this invasive tick in its new range?
- Do methods already in use for other tick species work well?

- Assessed collection methods for *H. longicornis* in West Chester County NY
- Compared dragging, sweeping and CO^2 baited traps
- Compared 5, 10 and 20 m check distances

H. longicornis was collected from varied environments

Optimal collection methods for Asian longhorned ticks, *Haemaphysalis longicornis*

Results

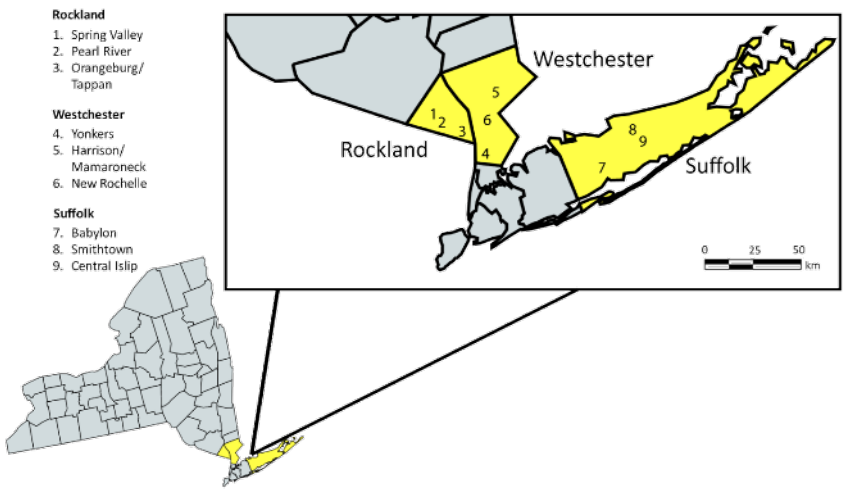
- Short check distances (5 m) were best for adults and nymphs
- Dragging was better than sweeps
- CO2 traps attracted *H. longicornis*, but they quickly left the source
- https://ecommons.cornell.edu/handle/1813/66885

Asian tiger mosquito- can we streamline surveillance

NEVBD Project Lead: Talya Shragai, PhD Cornell University (now an Epidemic Intelligence officer for CDC)

Primary Research Questions:

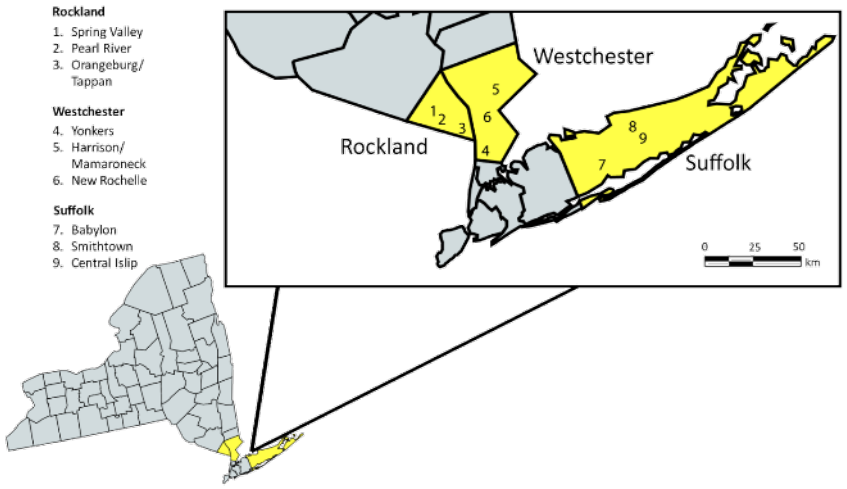
- What conditions are associated with Ae. albopictus larvae along its northern range
- Are there “key” containers that could be prioritized for surveillance



Asian tiger mosquito improving surveillance

NEVBD Project Lead: Talya Shragai, PhD Cornell University (now an Epidemic Intelligence Officer for CDC)

- No evidence for “key” container habitats
- Mosquito larval/pupal abundance increases with impervious surface and decreasing income
- Egg morphology can be used to streamline surveillance
- Northern populations of *Ae. albopictus* are active well into the fall (November) increasing biting risk to humans

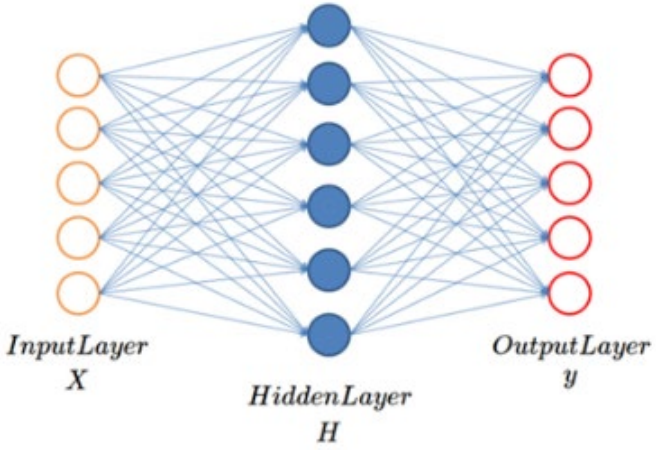


Shragai et al. 2018. Egg identification guide for *Ae. albopictus* in the Northeast, USA. https://hdl.handle.net/1813/60750
Shragai et al. 2019. J. Med. Entomol. 56(2): 472-482.
Shragai in preparation.

Asian tiger mosquito improving surveillance

NEVBD Project Lead: Elizabeth Case, MS and Talya Shragai, PhD Cornell University

- New surveillance approaches are desperately needed
- Could drones (UAVs) be useful for container surveillance for the Asian tiger mosquito?



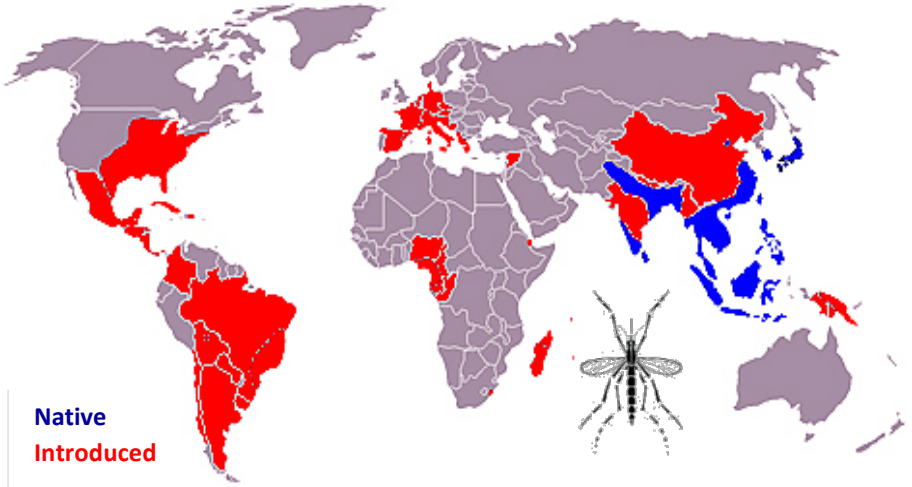
- UAV/neural network up to 67% precision
- classified whole properties as positive or negative 80% of the time
- Tree or roof cover obstructed some views

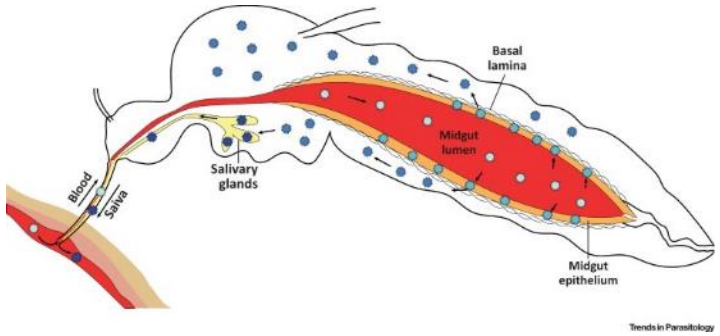
Case et al. 2020. J. Med. Entomol. 57(5):1588-1595.

Vector competence
Ae. albopictus

NEVBD Project Leads:
Maria Onyango, PhD – Wadsworth Center Arbovirus Laboratory
Andrea Gloria-Soria, PhD – CT Agricultural Experiment Station

- Mosquito population and virus strain impact vector competence
- *Ae. albopictus* from NY and CT are highly competent for CHIKV under environmentally relevant conditions
- NY populations efficient vectors of ZIKV, but CT had low infection rates
- DENV competence studies are ongoing





Publication pending

Feeding ecology *Ae. albopictus* in Long Island

NEVBD Project Lead:
Kara Fikrig, MPH, Cornell University

Research questions:

How frequently do *Ae. albopictus* feed on humans in Long Island, NY?

What other hosts does it feed on?

How do blood meals compare with host availability?

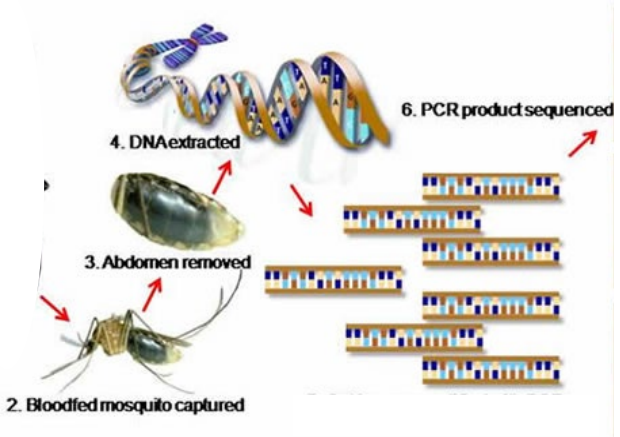
How often does *Ae. albopictus* feed on sugar?

Methods:

- blood meal collections from residential and farm areas across the island
- Host availability surveys, camera traps
- Sugar feeding assays

Feeding ecology *Ae. albopictus* in Long Island

NEVBD Project Lead:
Kara Fikrig, MPH, Cornell University

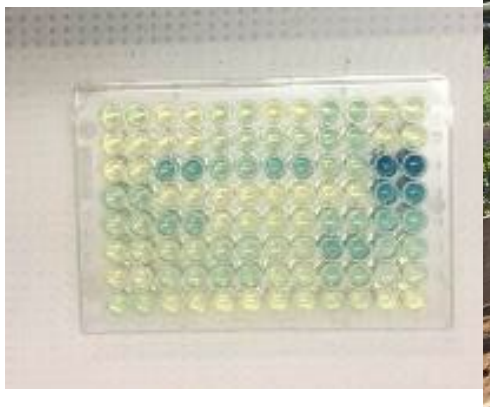


***Ae. albopictus* feeds on a diverse array of animals (9 species)**

- 30% human meals, 24% cat, 13% opossum, 5% dog
- Host feeding indices suggest *Ae. albopictus* feeds on cat and dog disproportionately often compared to human

Large percentage of both male and female *Ae. albopictus* sugar feed

- Potential for toxic sugar baits for vector control



Publication pending for blood feeding analysis

Fikrig K, Peck S, et al. 2020. *PLOS Neglected Tropical Diseases* 14(10):e0008244. doi:10.1371/journal.pntd.0008244

Pesticide Resistance Monitoring Program

NEVBD Project Lead: James Burtis, PhD, Cornell University (now with CDC Division of Vector-Borne Diseases)

Despite the importance of resistance monitoring to inform mosquito control programs, no large regional monitoring programs exist in the United States

Pesticide Resistance Monitoring Program

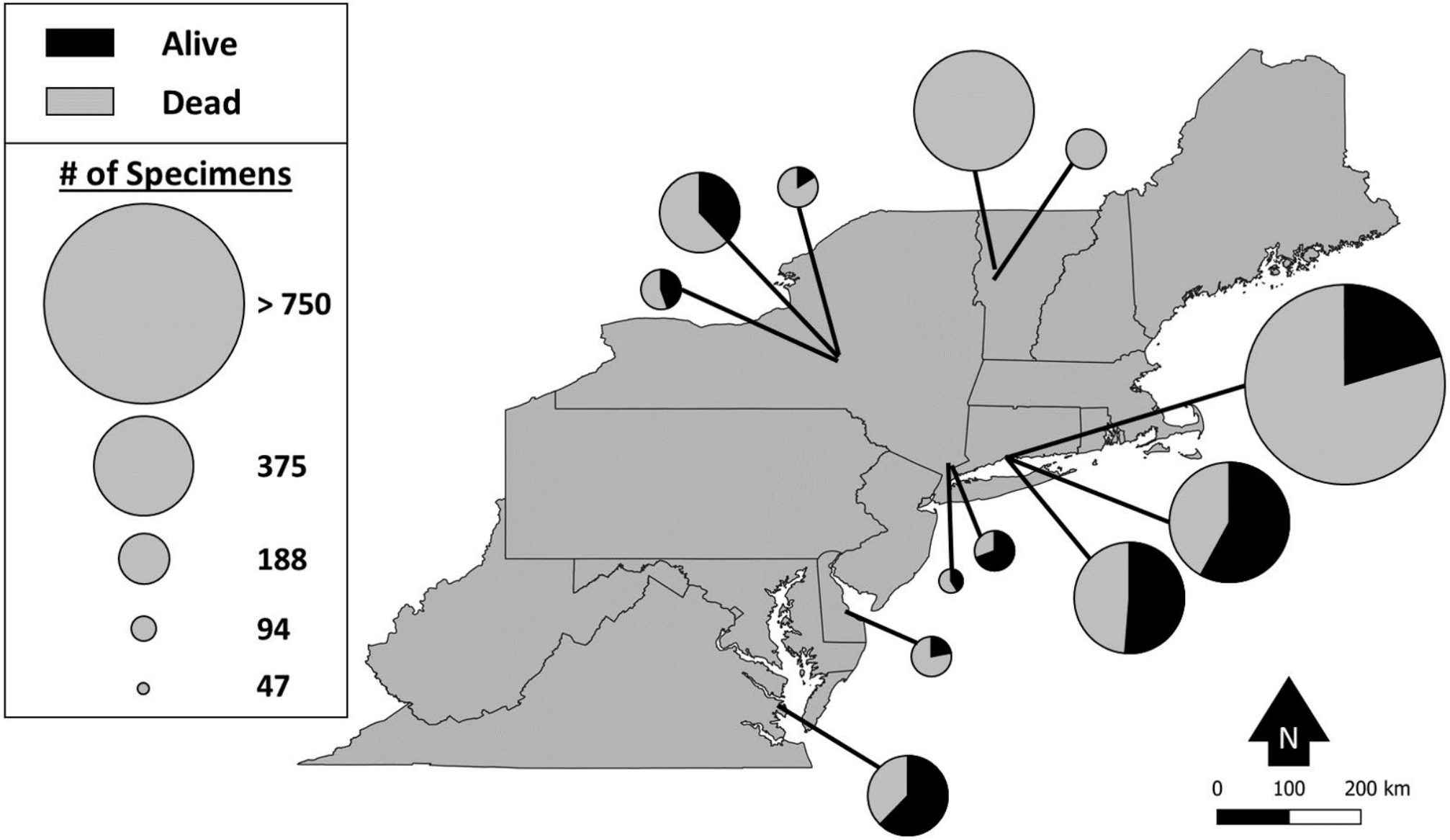
NEVBD Project Lead: James Burtis, PhD, Cornell University (now with CDC Division of Vector-Borne Diseases)

Our Program:

- Regionwide survey to determine needs and refine program development
- Specimen submission system established
- Established larvicide resistance diagnostics for *Bacillus thuringiensis israelensis* (*Bti*), *L. sphaericus* and methoprene.

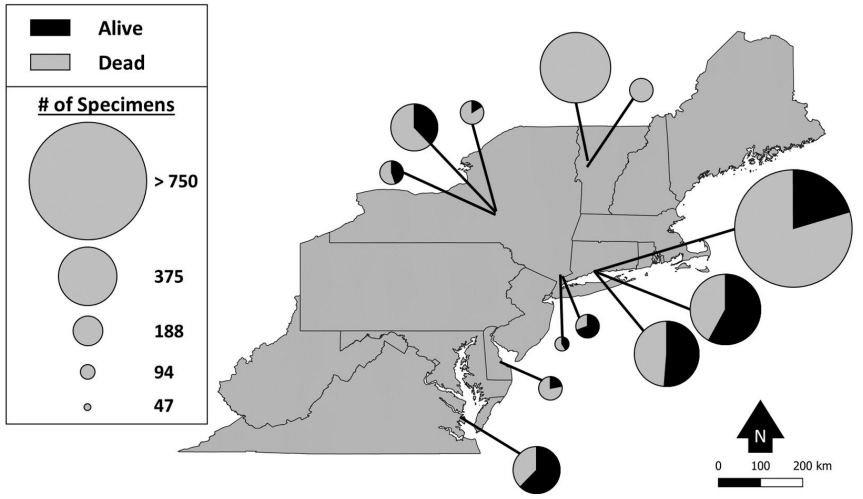
- **A. Needs Assessment**
  - Identify most common practices and target species in the Northeast
  - Identify barriers to sustaining resistance monitoring programming
  - Develop bioassays and services for species of highest importance
- **B. Submission System**
  - Test specimens on behalf of low-resource programs
  - Upload results into ArboNet on behalf of submitting agencies
  - Disseminate results across network in regional meetings and publications
- **C. In-House Kits**
  - Guidelines for field collection and rearing of mosquito specimens
  - Instructions for conducting resistance bioassays in-house
  - Technical assistance as-needed
- **D. Education**
  - Hands-on workshops in partnership with regional society meetings
  - On-site technical assistance and mentorship
  - Online tutorials and seminars
- **E. Control Efficacy**
  - Collaboration on field trials with local vector control agencies
  - Enabling programs to evaluate active ingredients and delivery
  - Assessing impact of control efforts on local disease burden

Permethrin resistance



Pesticide Resistance Monitoring Program

Burtis JC, Poggi JD, et al. 2020.. *J. Med. Entomol*. https://doi.org/10.1093/jme/tjaa236



Conclusions:

- Need for increased pesticide resistance testing in the US
- Larvicides deployed more frequently than adulticides, but rarely paired with resistance monitoring
- Widespread low-level (1 × LC-99) methoprene resistance in *Cx. pipiens*, but not in *Ae. albopictus*
- Resistance to pyrethroids was detected in many locations for both species, no resistance to *Bti* or *L. sphaericus* detected
- Provided recommendations centralized pesticide resistance monitoring network and developed maps
- Let us know if you want to participate in the 2021 season!

Acaricide resistance monitoring

- Fully engorged I. scapularis collected in November 2019 from hunter killed deer
- Ticks were held at 24 °C, 70% RH, and a 16:8 (L:D) light cycle until they laid egg masses and the larvae hatched.
- CDC's colony material was used as a susceptible control (field collected in 2003, maintained without pesticides but refreshed periodically with field collected material)
- Larvae aged 14-18 days were used in bioassays using the larval packet assay

Acaricide resistance monitoring

- Shelter Island ticks were significantly less susceptible than those from CIES, but the difference in RRs was relatively small
- We did not find evidence of permethrin resistance in ticks from an area of intense 4 poster pressure for many years (1.9 km^{-2} early on (Curtis et al. 2011, and then 1.2 km^{-2} most recently)
- More work needs to be conducted to develop RRs and interpret how they relate to operational control of *I. scapularis*

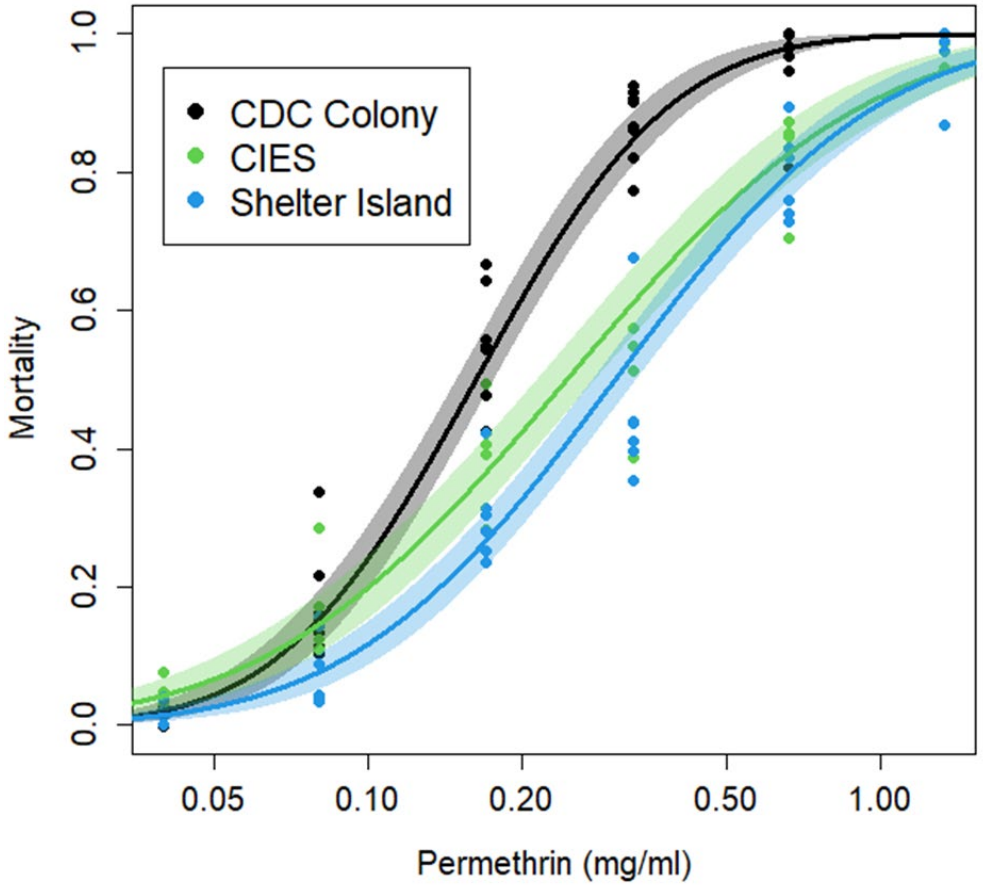


Figure 1: Scatterplots displaying permethrin susceptibility curves for *Ixodes scapularis* larvae from the two field populations, probit analysis prediction lines and 95% confidence intervals.

Nationwide tick surveillance and control practices survey

A SURVEY OF TICK SURVEILLANCE AND CONTROL PRACTICES IN THE UNITED STATES

OVERVIEW

Prevalence of illnesses spread by ticks is increasing in the United States

The US lacks system of nationally standardized tick surveillance

METHODS

Survey sent to 140 vector-borne disease professionals working in US, asking for details on:

Tick surveillance program objectives
Pathogen testing methods
Tick control practices
Data communication strategies
Program barriers

RESULTS

Greater support for tick management programming is critical

Programs face barriers to proactively collecting ticks from the environment, testing ticks for pathogens, and communicating findings to communities

Mader et al. Journal Medical Entomology. June 2020. DOI: 10.1093/jme/tjaa094

NEVBD Applied Research

Additional information on our ongoing applied research projects and programs is available on the NEVBD website:

https://www.neregionalvectorcenter.com/research

Acknowledgements

CAES
The Connecticut Agricultural Experiment Station
Putting Science to Work for Society since 1875

RUTGERS

FORDHAM UNIVERSITY
THE JESUIT UNIVERSITY OF NEW YORK

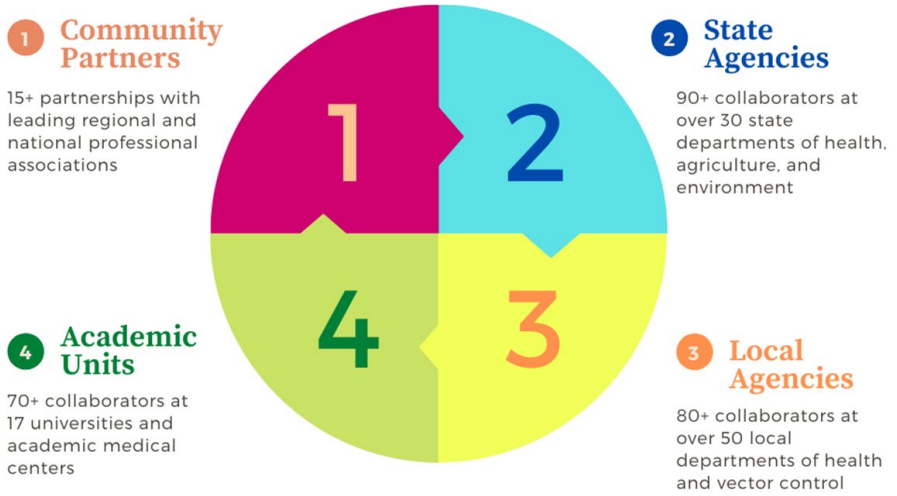
NEW YORK STATE | Department of Health | Wadsworth Center

Louis Calder Center
Biological Field Station • Fordham University
"50 Years of Science Research"
1967 - 2017

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

Innovative Collaborative Network

UNITING A DIVERSE PROFESSIONAL COMMUNITY



Virginia Partners

Tim DuBois

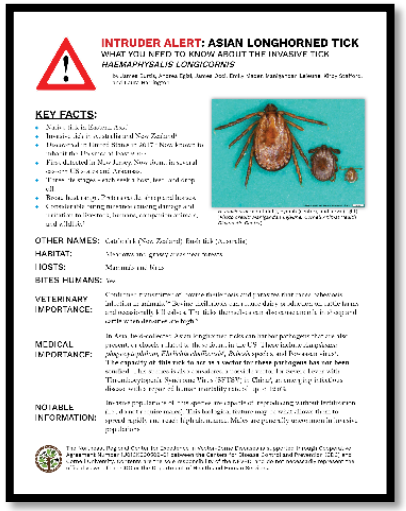
David Gaines
Lisa Wagenbrenner
Jennifer Barritt

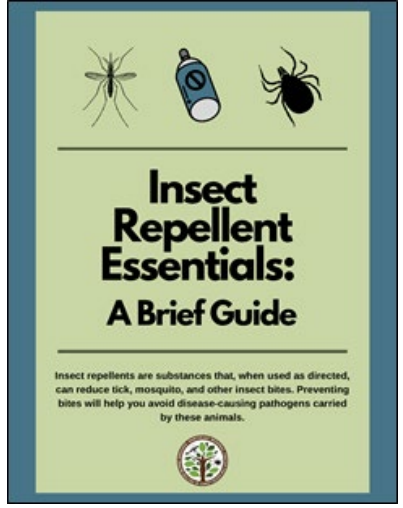
Janice Pulver

Jamie Mangan
Thesis: Ecology of EEE in Virginia

Thank you!

lch27@cornell.edu





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- Program contact nevbd@cornell.edu

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