Challenges and Progress in Integrated Tick Management Research and Communication

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My Background:
Integrated Pest Management

Past Experience

Plant Hosts vs. Human Hosts

Integrated Pest Management vs. Integrated Tick Management

“"A comprehensive pest technology that uses combined means to reduce the status of pests to tolerable levels while maintaining a quality environment."” (Pedigo 2015)

- Pest technologies (tactics) are based on a fundamental understanding of pest ecology, i.e. distribution and abundance of pests in time and space and relationship to environment.
- Certainly applicable to tick management.

Integrated Pest Management vs. Integrated Tick Management

“"A comprehensive pest technology that uses combined means to reduce the status of pests to tolerable levels while maintaining a quality environment."” (Pedigo 2015)

- Is there a tolerable level of arthropods when they transmit pathogens?
- The level of control required is much higher with a vector of human pathogens.
...it is increasingly apparent that under most circumstances, no one method is likely to be universally acceptable to homeowners or provide sufficient suppression of tick abundance or the prevalence of the pathogen in the vector or reservoir host in order to prevent human disease. *Integrated Tick Management is likely required for tickborne disease prevention.*

**Why do we care about ticks?**

**The pathogens.**

- Lyme Disease - bacterium
- Babesiosis – malaria-like protozoan
- Anaplasmosis - bacterium
- Hard Tick Relapsing Fever (Borrelia miyamotoi): <60 cases confirmed in U.S. - bacterium
- Powassan Virus: 7-12 cases in U.S. each year

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**Reported Cases of Tickborne Disease:**

**U.S. States and Territories, 2004-2016**

[Map image]


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**Number of Anaplasmosis Cases in U.S.**

[Bar chart]

Source: https://www.cdc.gov/anaplasmosis/stats/index.html

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**Google Searches**

Relative Interest in Term “tick” (animal)

[Graph image]

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**Reported Mosquitoborne and Tickborne Disease Cases:**

**U.S. States and Territories**

[Graph image]

Number of Reported Babesiosis Cases


Number of Reported Powassan Virus Cases in the U.S.

Source: https://www.cdc.gov/powassan/statistics.html

How can we stop this increase and prevent tickborne disease?

Reduce Entomologic Risk
- Tick abundance
- Tick infection rates

Understand Human Behavior
- Prevention practices
- Outdoor exposures

Prevent Tickborne Disease

Why is this difficult?

Reduce Entomologic Risk
- Tick abundance
- Sampling
- Patchy distribution
- Movement by hosts
- Tick infection rates
- Lab techniques
- Multiple pathogens
- Infection ≠ transmission

Understand Human Behavior
- Prevention practices
- No method is 100%
- Communication
- Trust
- Outdoor exposures
- Where?

Prevent Tickborne Disease

Ixodes scapularis Life Cycle

- Entomological approach
- Understand vector ecology
- Look for places to break the cycle

Ixodes scapularis Life Cycle

Year One
- Spring
- Summer
- Autumn
- Winter

Year Two
- Spring
- Summer
- Autumn
- Winter

eggs → larvae → nymphs → adults → Adults mate, produce eggs & die

Adults mate, produce eggs & die
Reservoir Hosts

White-footed mice are important reservoir hosts for Lyme bacteria (B. burgdorferi)

Other reservoir-competent hosts:
- Chipmunks
- Squirrels
- Meadow Voles
- Short-tailed Shrews
- Virginia Opposum
- Raccoons
- American Robins
- Cardinals
- Catbirds
- Song Sparrows

Deer are Reproductive Hosts

Deer do not infect ticks with B. burgdorferi!

Deer contribute to the abundance of ticks in an area

Enzootic Cycle of B. burgdorferi

Year One
- Spring
- Summer
- Autumn
- Winter

Meal 1
- Eggs
- Larvae
- Nymphs
- Adults
- X = infection with B. burgdorferi
- Died

Year Two
- Spring
- Summer
- Autumn
- Winter

Tickborne Disease Prevention Laboratory
Western Connecticut State University

- Dr. Neeta Connally, MSPH, Ph.D., Associate Professor
- Intersection of tick ecology and human behavior

Research at WCSU
Tickborne Disease Prevention Laboratory

Reduce Entomologic Risk
- Long-term tick phenology surveillance
- Research better tactics to reduce ticks and tickborne diseases on residential properties
- Research on personal protection measures

Understand Human Behavior
- Record human behaviors associated with tickborne disease
- Increase adoption of tickborne disease practices with better communication

Tick Phenology Surveillance

- Woodland habitats
- 3 sites sampled since 2007
- 1 site added in 2018
- Sampled weekly May-September
- 20-minutes of sampling with drag cloths
- Nymphs not removed
Tick Phenology Surveillance

Average Nymphal Haemaphysalis longicornis Seasonal Activity, 2011-2018

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We live in tick habitat.

Approx. 90% of backyard ticks are found in the wooded edge and ecotone where lawns meet woods

Backyard Integrated Tick Management Study 2016-2020

STUDY GOALS
1. Evaluate integrated management program with two tick management tick tactics
   - at single vs. contiguously treated backyards
2. Understand how people use outdoor environments

BITM Study Design

- Placebo-controlled
- Properties/households in western CT and southern RI
- Inclusion criteria include no prior tick control for 2 years, property adjacent to forested/brushy habitat
- Outcome measures:
  - Entomologic: tick abundance and infection rates
  - Human: self reported tick encounters and human disease; daily activity log of outdoor activity
Single, Springtime Application of Acaricide

- Field studies: Reduction of questing nymphal *I. scapularis* 68-100% after a single application of synthetic pyrethroid (multiple studies).
- Best control using high-pressure sprayers.
- Not strong evidence that tick reduction related to decreased human disease, because not evaluated or many other possible factors.

Tick Box™ Tick Control System

- Fipronil-treated wick (0.7% active ingredient)
- Passive application to mouse and chipmunk reservoir hosts
- Studies
  - Lab evaluation: prevented tick bites for 4-6 weeks after single application to mice in lab (Dolan et al. 2004)
  - Field evaluation (Schulze et al. 2017; Dolan et al. 2004)
    - 62-97% reduction of host seeking *I. scapularis* nymphs,
    - 60% reduction in *B. burgdorferi* infection prevalence in ticks
- Treated properties were in close proximity to one another
- Human disease/tick encounter outcomes not measured

BITM Study Design

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Active Ingredient</th>
<th>Targets:</th>
<th>Time of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tick Box™ Tick Control System</td>
<td>Fipronil</td>
<td>Larval ticks parasitizing mice and chipmunks</td>
<td>July</td>
</tr>
<tr>
<td>Targeted application of acaricide spray</td>
<td>Beta-cyfluthrin</td>
<td>Questing nymphs</td>
<td>May</td>
</tr>
</tbody>
</table>

Residential Treatment Groups

- SINGLE TREATED YARD (acaricide spray, active bait boxes)
- CLUSTER OF TREATED YARDS (acaricide spray, active bait boxes)
- SINGLE PLACEBO YARD (water spray, bait boxes without treatment)
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Tickborne Disease Prevention Laboratory

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**BITM Study: Understanding How Human Behavior Affects Tickborne Disease Risk**

- Monthly surveys administered to measure tick encounters and disease diagnosis
- Ticks detected on humans/pets submitted to URI TickSpotters for confirmatory ID
- Daily activity survey administered for one week in June

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**BITM Study Design**

Time spent in outdoor locations:
- In backyard:
  - Forest edge
  - Lawn adjacent to edge
  - Lawn far from edge
  - Gardens
- Non-backyard locations

**BITM Study – Current Status**

132 properties enrolled
- Single treated (n=28)
- Treated clusters (n=29)
- Single placebo (n=26)

Ticks sampled twice at all enrolled properties (pre-treatment) in late May-July 2017 (~2000 ticks tested by CDC DVBD)

Ticks sampled twice (post-year 1 treatments) late May-July 2018, ticks sent to CDC for testing.

Monthly tick encounter surveys conducted May 2017 – July 2018
Daily activity survey conducted in June 2017 and 2018
Bait boxes installed in late July 2017 and 2018
- Weighed 4 weeks post-installment
Acaricide applied mid-May 2018

**BITM Study – Next Steps**

- Weigh Bait Boxes, August 2018
- Bait box visitor monitoring
- 2nd Acaricide-spray May 2019
- Continue surveys, TickSpotters, residential tick sampling
- 2020: no treatments, tick sampling continued

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Permethrin-treated Clothing and Repellents

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Prevent Tickborne Disease

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Human Exposure Study

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Partnership with Communities

Uncertainty about Pesticide Use

Use of Pesticides on Properties

- Apache/Strongly Agree
- Disagree/Strongly Disagree
- Not Sure
EPA Healthy Communities Grant
Spray Safe, Play Safe

Social Media

- 9 in 10 adults use the Internet
- 70% use social media platforms (e.g., Facebook, Twitter, Instagram, LinkedIn)
- 75% of Facebook users visit the site multiple times per day

Social Media has Farther Reach than Traditional Scientific Communication

Lyme Prevention Social Media Survey

OBJECTIVE:
- Understand how social media users interact with Lyme prevention information

Initial Response Results

Survey posted for 12 days:
- 456 responses
- 92% from high-incidence states in the Northeast/Mid-Atlantic
- 80% ages 30-60, predominantly female
- 70% visit social media sites several times per day

- Survey was shared directly from source page 84 times
- Post "organically" reached ~12,000 users (showed up on newsfeed)
- 1560 direct interactions with the post
What is next for effective ITM?

- Results from current ITM projects…what really works?
- Understanding entomological factors alone may not be adequate to prevent disease
- Understanding human behavior to ensure recommendations can prevent disease in the scope of activity that puts humans at risk
- Improving communication: evidence-based prevention tactics are only as good as our ability to communicate and encourage adoption
- Build trust with the general public about the scientific basis for recommendations

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