RESULTS OF 5 YEARS OF INTEGRATED TICK MANAGEMENT IN RESIDENTIAL FAIRFIELD COUNTY, CT

Pioneer Press: Scott Goihl
Integrated Control of Nymphal *Ixodes scapularis*: Effectiveness of White-Tailed Deer Reduction, the Entomopathogenic Fungus *Metarhizium anisopliae*, and Fipronil-Based Rodent Bait Boxes

Scott C. Williams, Kirby C. Stafford, III, Goudarz Molaei, and Megan A. Linske

Abstract

Pathogens transmitted by ticks are the leading cause of arthropod-associated human diseases in the United States and managing the risk of exposure to potentially infected ticks is of vital public health importance. A 3-year integrated tick management program to control blacklegged ticks, *Ixodes scapularis*, the primary vector for the pathogenic agents of Lyme disease, human anaplasmosis, and babesiosis, was implemented in the town of Redding in southwestern Connecticut beginning in 2013. Combinations of white-tailed deer, *Odocoileus virginianus*, reduction, area application of the entomopathogenic fungus *Metarhizium anisopliae*, and fipronil-based rodent bait boxes were evaluated for their ability to reduce nymphal *I. scapularis* over 3 years. Intensive from local hunters prevented sufficient, sustained deer removal previously reported to negatively impact *I. scapularis* abundances (i.e., <5 deer/km²). The combination of fipronil-based bait boxes and broadcast application of *M. anisopliae* had the most impact of any treatment combination; questing nymphs were reduced 78–95% within each year and *Borrelia burgdorferi*-infected questing nymphal *I. scapularis* encounter potential was reduced by 66% as compared with no treatment in the third year of the study. A combination of the broadcast application of *M. anisopliae* and small rodent-targeted fipronil-based bait boxes is an effective low-toxicity integrated approach that significantly reduced encounters with *B. burgdorferi*-infected questing nymphal *I. scapularis* on individual properties.

Keywords: *Borrelia burgdorferi*, fipronil-based bait box, integrated tick management, Lyme disease, *Metarhizium anisopliae*, *Odocoileus virginianus*

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The Connecticut Agricultural Experiment Station
123 HUNTINGTON STREET, P.O. BOX 1106, NEW HAVEN, CONNECTICUT 06504

Putting Science to Work for Society
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An Integrated and Individual Tick Management Program to Reduce Risk of Lyme Disease in a Residential Endemic Area

CDC Cooperative Agreement U01CK00182-01, -02, -03

Kathy C. Stafford III, Scott C. Williams, Gounder Molan, Luan E. Hayes

PROJECT SUMMARY

Motivation
The paucity of cost-efficient strategies to limit tick-associated disease is becoming increasingly problematic for public health in the United States as incidence rates of such diseases continue to rise and new tick-borne pathogens emerge. A number of individual strategies to reduce tick-associated disease risk have been considered previously in field trials, including management of host animal populations, host-targeted chemical control, and area-wide control of ticks. All of these strategies have been shown to reduce entomological risk for exposure to tick-borne pathogens or some component relating to such risk. However, only one strategy used in isolation -- 4-posters stations for treating white-tailed deer

Odocoileus virginianus with acaricides -- has been shown to reduce acarological risk to a level that human tick-associated disease incidence is also reduced. Use of 4-posters stations may not be an economically viable option for a community seeking to control tick-associated disease, and thus alternate strategies may be sought. Reducing white-tailed deer populations directly may be a plausible alternative to treating deer with acaricides at 4-posters stations. However, it is unknown whether it is possible to reduce deer population densities low enough to have an impact on tick-associated disease risk in mainland settings, even though this has been shown to be possible on islands and peninsulas. Combining strategies that have been shown in isolation to be effective in controlling tick-associated disease risk into Integrated Tick Management (ITM) strategies is another possible alternative to the use of 4-poster stations, but no field-based studies yet have thoroughly examined the effectiveness of such ITM strategies.

We are currently conducting a three-year field experiment in Redding, Connecticut (Fig. 1) to explore the feasibility of three measures to control tick-borne pathogens, both individually and together as an ITM strategy. Our focus is on Borrelia burgdorferi, etiological agent of Lyme borreliosis (i.e., Lyme disease), and two other pathogens transmitted by the blacklegged tick Ixodes scapularis -- Anaplasma phagocytophilum and Babesia microti. Our goal is to measure the effectiveness of individual and integrated strategies in lowering tick-borne pathogens exposure risk in humans by targeting pathogens and tick hosts and L. acaricaprini populations on residential properties in densely-wooded suburban neighborhoods.

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Figure 1. Location of the Town of Redding in Fairfield County, CT.

- CDC-funded
- Redding, CT
- Differing combos
  - Deer reduction
  - Fipronil bait boxes
  - Metarhizium anisopliae
TREATMENT COMBINATIONS

- 4 Neighborhoods
  - Control (n = 12 residences)
  - Deer removal only (n = 8)
  - Met 52 + Bait box (n = 13)
  - Deer removal, Met 52, Bait box (n = 5)
This has been discussed pretty heavily, and was the subject of a thread here last week. Ed, my property in Redding is quite close to one of the shoot areas. Save your corn, there are no deer left.

They are shooting in the same two spots they did it last year. White Birch Lane and Sunset Ridge. They are baiting now and plan to shoot after the bow season ends. Hopefully they'll do a count before the next round of killing.

(Kirby Stafford and Scott Williams 2 VERY ARROGANT PhDs),

Bob Crook was there, the current Redding Deer Warden and lots of upset Redding Hunters.

I felt that Rick Jacobson was pretty surprised by a lot of what was said, and he seemed to be listening. A letter came out of it that suggests that while the Deer Kill disguised as a Tick Study will continue; At least the DEEP will keep an eye on them.

This is being addressed from a number of different angles by several people. I'll keep whoever is interested updated on interesting developments.
Does Scott Williams really have a PHD or just a 5th grade education?
Redding Residents:

2013 has been a year of transition as the four prior Deer Warder in protest against the Town of Redding’s blatant lack of transpare the CAES ITM-CDC study. At the inception of the Redding Deer Management Program in 2005, there was an over-abundance of Tailed Deer in Redding as well as surrounding communities. Over the primary focus of the program response to a heightened concern vehicle collisions. Over the dedicated group of Deer Warders the white-tailed deer populat

In recent weeks it was very apparent that First Selectman Pemberton became extremely irritated with me as the inconsistencies in the operations of the CEAS ITM-CDC study were brought to her attention. This was exhibited in her retaliatory actions and based on her fabricated allegations about transparency in the management of the Redding Deer Program. It has been confirmed that the “rules and regulations” referred to, in recent articles, were written by Ms. Pemberton on January 29, 2014 within a period of one week prior to my termination.

With regard to Ms. Pemberton’s
- Marginal deer reductions on the 2 square miles
  - 51 in 2013
  - 25 in 2014
  - 11 in 2015
- Met52 sprayed on select properties 2013-2015
- Bait boxes deployed 2013-2016
- Rodent trapping 2013-2016
- Nymphal scapularis lawn-edge dragging 2013-2016
RESULTS - ENCOUNTER POTENTIAL ≥ 1
QUESTING SCAPULARIS NYMPH

2013

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<thead>
<tr>
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<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>3-Year Mean</th>
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<tr>
<td>Control</td>
<td>45%</td>
<td>21%</td>
<td>32%</td>
<td>32%</td>
</tr>
<tr>
<td>Deer Removal</td>
<td>51%</td>
<td>30%</td>
<td>35%</td>
<td>35%</td>
</tr>
<tr>
<td>Deer/Bait Box/Met52</td>
<td>52%</td>
<td>28%</td>
<td>32%</td>
<td>32%</td>
</tr>
<tr>
<td>Bait Box/Met52</td>
<td>19%</td>
<td>21%</td>
<td>17%</td>
<td>21%</td>
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</table>

Letters indicate significant differences.
RESULTS-ENCOUNTER POTENTIAL ≥ 1
BORRELIA-INFECTED QUESTING NYMPH

Deer and Nymphs

2013

<table>
<thead>
<tr>
<th>Area</th>
<th>Nymphs</th>
<th>Bb +</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>68</td>
<td>18</td>
<td>26%  (A)</td>
</tr>
<tr>
<td>Deer Removal</td>
<td>68</td>
<td>40</td>
<td>59%  (B)</td>
</tr>
<tr>
<td>Deer/Box/Met52</td>
<td>26</td>
<td>13</td>
<td>50%  (B)</td>
</tr>
<tr>
<td>Box/Met52</td>
<td>9</td>
<td>0</td>
<td>0%   (C)</td>
</tr>
</tbody>
</table>

2015

<table>
<thead>
<tr>
<th>Area</th>
<th>Nymphs</th>
<th>Bb +</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deer Removal</td>
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<td>Deer/Box/Met52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Box/Met52</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3-Year Mean
JUVENILE SCAPULARIS PARASITIZING CAPTURED P. LEUCOPUS
PEROMYSCUS LEUCOPUS SEROLOGICALLY POSITIVE FOR BORRELIA ANTIBODIES
Connecticut’s Bounding Deer Herd

Year
1880 1900 1920 1940 1960 1980 2000

CT deer population
0 20000 40000 60000 80000
NATIONWIDE LYME DISEASE CASES

300,000-329,000!

Year
Ixodes scapularis - Vector
- Deer are reservoir incompetent for:
  - Borrelia burgdorferi
  - Anaplasma phagocytophilum
  - Babesia microti

Amblyomma americanum - Vector
- Deer reservoir competent for:
  - Ehrlichia chaffeensis
  - Ehrlichia ewingii
  - MO, OK, TN, NC, VA
  - CT?

Lyme disease is transmitted by a deer tick (Ixodes)
- Deer tick: a 2-years life cycle
DEER AS DILUTION HOSTS

- Abundance of incompetent hosts (not diversity of) will dilute pathogen presence
- Result in a lesser % of infected ticks
- More hosts = more ticks
- Significant deer management:
  - Fewer reservoir incompetent hosts
  - Ticks desperately host-seek
  - Temporary perceived amplification in abundance
  - Ticks switch to available remaining competent hosts
  - Infection increases

http://cacocog.blogspot.com/2011/06/deer-ticks.html
DEER AND TICKS POSITIVELY CORRELATED

Fig. 4. Nymphal tick density and deer densities in the MC community in Groton, CT, 1996–2007.

Deer density < 10 deer/square mile
Will see collapse of ticks
Tick-borne illness ALWAYS used as justification for hunting
Moderate reductions with regulated hunting not effective
Hunting suburbia results in 40 deer/square mile before it becomes “work”
Diminishing returns

FACTS:
Deer/Car collisions, Lyme disease occurrence, and property damage are all increasing. Hunting is the ONLY proven population management technique available for Deer.

In Southwest Connecticut, the density of deer ranges between 40 and 100 deer per square mile. Densities in excess of 20 per mile can result in suppression of forest regeneration and reduction of biological and structural diversity. Lowering the number of deer per square mile reduces the risk of Lyme Disease.
Deer management draws out public emotion
Marginal deer reduction results in perceived increases in *scapularis*
In the absence of deer, ticks host-switch to competent reservoirs and infection increases
- In mice too
Met52/Bait box combination alone resulted in significantly fewer:
  - Encounters with questing nymphs
  - Encounters with *Borrelia*-infected questing nymphs
  - Ticks/mouse
DIVERSITY AND DISEASE:
THE ROLE OF WILDLIFE IN THE
LYME DISEASE ECOLOGY

Megan A. Linske
Center for Vector Biology & Zoonotic Diseases
The CT Agricultural Experiment Station

Megan.Linske@ct.gov
Increased host diversity results in decreased pathogen presence

Large forested “intact” ecosystems foster more diversity

Increased host diversity displaces competent reservoirs (white-footed mice)

Fragmented residential areas fewer hosts = more pathogen presence
- Woodlands are less hospitable
  - Mature, old-age tree stands
  - Loss of habitat stratification
    - Shrub layer composed of invasives
- Residential properties are more diverse
  - Promotes habitat heterogeneity
STUDY SITES AND METHODS

- **18 woodland sites**
  - 325 to 2,800 ha
  - Geographically spaced throughout CT
    - Organized into 6 clusters

- **30 residential sites**
  - < 2.0 ha
  - Redding, CT
    - Organized into 8 clusters

- Small mammal trapping
- Camera trapping