The Connecticut Agricultural Experiment Station

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An Integrated and Individual Tick Management Program to Reduce Risk of Lyme Disease in a Residential Endemic Area

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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[1,2]. 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[3-12]. All of these strategies have been shown to reduce entomological risk for exposure to tick-borne pathogens or some component relating to such risk[3-13]. However, only one strategy used in isolation – 4-posters stations for treating white-tailed deer *Odocoileus virginianus* with acaricides - has been shown to reduce acaralogical risk to a level that human tick-associated disease incidence is also reduced[14,15]. 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 acaracides 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[14-19]. 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.

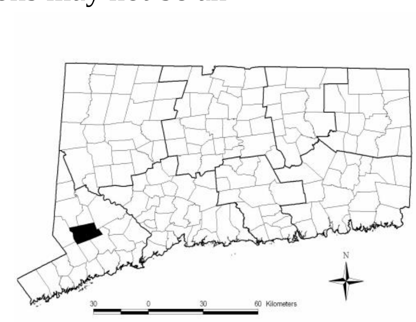

Figure 1. Location of the Town of Redding in Fairfield County, CT.

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*[20,21]. Our goal is to measure the effectiveness of individual and integrated strategies in lowering tick-borne pathogen exposure risk in humans by targeting pathogen and tick hosts and *I. scapularis* populations on residential properties in densely-wooded suburban neighborhoods.

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Hypothesis

An ITM approach that reduces both tick and tick host population sizes results in lower Entomological Risk Indices (density of infected black-legged ticks nymphs[22,23]) for tick-associated diseases than individual approaches focusing on either reducing tick population sizes or population sizes of tick hosts alone.

Objectives

Objective 1. Develop a reduced risk/ITM approach to control ticks using an array of least-toxic measures within a residential community that is effective, safe, inexpensive, and simple to implement.

Objective 2. Measure efficacy of individual methods and an ITM approach to reduce infected ticks, infected reservoirs, and questing tick populations as a means of reducing the risk of tick-borne pathogen exposure and Lyme disease incidence.

Objective 3. Determine most effective timing and method of implementation of each tick control method and analyze costs for individual components of an ITM program, the ITM program as a whole, and individual costs to the homeowner.

Objective 4. Update and revise the tick management handbook published by The Connecticut Agricultural Experiment Station.

Methods

The tick-borne pathogen exposure control measures in our study are the application of synthetic and biological compounds and local white-tailed deer population management. We are conducting the study in four study sites in Redding (i.e. neighborhoods), each of which encompasses approximately 1 square mile of residential property and adjacent forested areas. Sampling units in the study are the individual residential properties within neighborhoods, of which there are at least five per neighborhood. One neighborhood serves as the primary control (untreated) site for the study, and the other three receive one of three control measures, either: a) application of environmentally-safe products (i.e., spraying biological tick control agent, the entomopathogenic fungus *Metarhizium anisopliae* and distributing rodent bait boxes, b) reduction of the local white-tailed deer population, or c) application of environmentally-safe products in combination with local white-tailed deer population reduction (Fig 2).

All Units in a Site receive the same treatment, either:

Individual Treatment A
Bait Boxes + Fungus

Individual Treatment B
Deer Reduction

Integrated Treatment
Bait Boxes + Fungus
Deer Reduction

Control

Figure 2. Experimental Design

Preliminary Results (2013)

Preliminary data from the first experiment year suggest high effectiveness of combining rodent bait box distribution with entomopathogenic fungus application to reduce tick population densities during the summer months, when blacklegged tick nymphs are active. Specifically, there was a 58.3% greater reduction in nymphal tick densities in areas where bait boxes and fungus applications were used compared to where those where they were not between the period before (May 2013) and after (mid-June through August 2013) the interventions. Laboratory testing to assess the effectiveness of the first-year treatments in reducing prevalence of tick infections and reservoir host exposures are ongoing. Results will allow us to estimate effects of treatments on overall Entomological Risk Indices, i.e. the product of nymphal tick density and infection prevalence. Effects of all treatment measures on tick-borne disease risk-associated outcomes will be assessed in year two and year three of the study, in accordance with predictions of differences in timing of the impacts of treatments considered in the study over the three years during which it is being conducted.

Statements of Predicted Impacts:

a. Public Health. CDC/CAES tick IPM study is expected to result in the reduction in entomological risk of tick bites and tick-borne illness among residents participating in the study or living in the neighborhoods where the control measures are being evaluated.

b. Basic Scientific Research. This study will allow the evaluation of an integrated approach on reducing tick abundance, tick infection rates, and therefore the risk of tick-borne illness. One component is also the evaluation of white-tailed deer reduction in combination and alone in a non-insular setting as a tool for tick reduction. These results are expected to provide results that will allow other communities to make science-based decisions on Lyme disease programs. Similar deer reduction programs have been conducted at insular sites in Connecticut (i.e., Mumford Cove, Bridgeport, Bluff Point), as well as in other areas in the eastern United States, and have resulted in significant reductions in tick abundances [14-19]. Studies have also shown that hunters cannot or will not achieve densities at or below 30 deer/mi^2, as such, professional sharpshooters must be used to achieve the scientific objectives of this study[24].

c. Town of Redding, CT. The CDC/CAES tick IPM study is compatible with the goals of the town Deer Management Program (http://www.townofreddingct.org/Public_Documents/ReddingCT_Police/deer). The Town goal was to reduce deer density from around 75/mi^2 to 10-12/mi^2 with managed hunts on town land and by encouraging access to the 70% of private land in Redding. An aerial deer survey in February 2013 by Dr. Scott Williams , CAES, that covered 12.5% of Redding found deer densities to be 30-40/mi^2, the level that has been found achievable by general hunting alone[24]. It was estimated that the CDC/CAES study reduced deer densities to below 10/mi^2 only in 2 square miles of Redding's 32.1 square miles. An aerial survey of 19% of the town of Redding (6 square miles including both study and non-study areas) was conducted on 24 January 2014 and found similar densities. It was also determined that further deer reduction was needed on the targeted 2 square miles to achieve study goals.

d. CT Deer Program Goals. We believe the CDC/CAES study fits into the CT DEEP's mandate and Deer Program Goals to reduce deer population growth…for the public and native and plant and animal communities and *to conserve, improve and protect its natural resources and environment …. in order to enhance the health, safety and welfare of the people of the state*.

e. Short-term Sustainability of Hunter Harvest of White-tailed Deer. The CDC/CAES study impacts the short-term sustainability of hunter harvest in only 2 square miles, or 6%, of the town of Redding. In the years 2010-2013, Redding hunters harvested approximately 855 deer. The success of the town program and other hunters over the past few years has had a far greater impact on the number of deer in Redding and current hunting success than the 51 animals harvested through the CDC/CAES study in February 2013. This project has not impacted sustained yield of deer by Connecticut hunters as the significant reductions thus far have been due to the town's program and likely the extended hunting season (4.5 months) and replacement tag system in effect in Fairfield County.[25] The scale of this scientific

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study impacts only a small fraction of the town and deer were harvested after the regulated hunting season; animals that hunters did not or were not able to take during the season.

f. Long-term Sustainability of Hunter Harvest of White-tailed Deer. The long term sustainability of hunter harvests of white-tailed deer in Redding will be determined by the ongoing success of the state and town deer management programs, not the shorter-term CDC study.

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