PROJECT TYPE: Research and Development: Field Assessment of Natural Oil Pesticides for Tick Control

1. Project Title: Field Assessment of Commercial Natural Oil Pesticides on Ticks and their associated habitats on Suffolk County Properties
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3. Cooperator: Suffolk County Parks

4. Abstract: EPA-Exempt 25(b) natural oil products Cedar Safe and Essentria IC3 were assessed for control of *Ixodes scapularis* and *Amblyomma americanum* (nymphs and adults) with the field based ARENA methods. References and positive controls of Mavrik Perimeter and Talstar (Granular) were used to compare overall efficacy of the assessed natural control products. Reference ARENA tick recovery rates averaged 82% across all species and tick stages assessed for the initial stages of this highly accurate, field based assessment of tick control products.

5. Background and Justification: Current data on natural oil-based products and tick recovery following treatments only utilizes flagging or dragging assessment methods, or is strictly laboratory based direct application mortality trials. Standard method for tracking tick activity has been flagging or dragging. This method tracks 6% of the tick population per sample (Daniels, Falco and Fish. 2000). Along with low sampling efficiency, Schulze Jordan and Hung. 1997 documented various biases of collection rates for tick stages and species while flagging. In addition, Schulze and Jordan. 2001 found tick retention on drags during sampling was negatively correlated with vegetation density. With these complex interactions of sampling biases, in combination with the extreme variability in tick questing activity, and the inability to accurately measure these sampling artifacts, flagging or dragging cannot accurately assess the control of acaricide products under field conditions. In response to these findings, Suffolk County Vector Control developed the ARENA method to accurately assess acaricide products under field conditions, for any specie of tick, while allow direct comparisons between materials, application method and rates, and timing of application. The ARENA method has been shown to effectively track between 80%-90% of tick populations in field settings and allows comparison of calculated control rates between sampling methods and previously published studies. These studies are a continuation of funded (NYSIPM 2016 Tick Treatments) and unfunded 2017 efforts. These efforts address Community IPM priorities as they will identify efficacious least-risk products and application methods to manage ticks in sensitive locations such as schools or other public areas. These data will improve IPM adoption by identifying which natural oil products effectively management tick populations fostering their utilization in integrated tick management programs by pest control operators. Data has been and will continue to be disseminated via educational events and future articles in collaboration with CCE, NYS DEC, NYS Parks, and other entities.

6. Objectives: (1) Assess control rates of natural oil acaricides on lone star and deer ticks. **(2)** Disseminate findings to pest control operators and other entities through educational events and production of Community IPM resources such as factsheets and website linked information. **(3)** Project Evaluation based on: data, its quality, dissemination, and impact on tick IPM.

7. Procedures:

ARENA Methods and 2018 Trials Conducted:

In 2018 a June trial was completed with a single replicate for *A. americanum* nymphs, adults and *I. scapularis* nymphs in ARENA. Due to the sensitivity of *I. scapularis* nymph two pseudo replicates were completed for each treatment. A three replicate trial was completed in November on *I. scapularis* adults. Direct application mortality data was also collected in both trials by placing 10 ticks in insect-slip treated glass culture dishes. Ticks were placed in culture dishes immediately before plot treatment to minimize tick loss. 40 ticks were color coded using UV fluorescent power from BioQuip and placed in an ARENA 48 hours before treatments were applied to allow ticks to resume a natural questing status. Treatment applications were completed using a Maruyama brand backpack blower with the liquid or granular setup. The highest labeled application rates for ticks were used for each product except Talstar XTRA Granular, as the higher rate could not be applied to private poverty and therefore resulting control values would be of no use for pest control operators. ARENA locations were randomized within each 1000 square foot plot and treatments were randomly assigned to plots, where possible.

ARENA based sampling was conducted in four phases:

(1) (after removal of fine mesh screen) ticks questing on the screen, ARENA walls, and leaf litter were collected using forceps and placed in 50 ml conical vials with a moistened strip of unbleached paper to maintain high relative humidity in the vial. A septum was created using latex gloves and placed on the vials to eliminate tick escape and damage to the ticks when placed in vials. UV protective glasses were equipped for safety when using UV flashlights. Tick stage, sex and UV color were recorded on data sheets when collected from ARENAs.

(2) Five 'tick landings' (similar in function to mosquito landings), were conducted by holding one's hand under the ARENA leaf litter for 1 minute and collecting and placing found ticks in the vial after identifying with a UV flashlight. Permethrin treated wrist bands were placed near the elbow on the forearm for safety. The location of the tick landing was adjusted in a clockwise motion for each consecutive landing, to cover the majority of the ARENA.

(3) After tick landings were complete, leaf litter was gently moved to expose the duff/A-horizon soil interface. The loose duff and A-horizon soil layer were searched with forceps and the UV flashlight. Any found ticks were identified on data sheets and placed in a collection vial. After 30 minutes of effort (placing ticks in vials and filling out data sheets was not counted), live ticks and those where morbidity was not certain were placed back in the ARENA at the duff/leaf litter interface and the leaf litter was returned back to a natural state. Ticks confirmed as dead were removed from the ARENA and placed in labeled 1.5ml screw cap vial.

Final Search:

(4) Fine mesh screen was left in place at this time and ARENAs were carefully removed from the field by trenching alongside the exterior of the ARENA and cutting horizontally under the ARENA with a machete or similar single edge cutting tool. To minimize soil core disturbance

after cutting, a solid aluminum circular tray was pushed under the ARENA. The ARENA and the intact soil core was carefully placed in a small clear plastic bag and secured for transport back to the laboratory. Once in the laboratory steps 1-3 were repeated three times over three separate days to collect and record the remaining live and dead ticks which were placed in a 50ml conical vial. During final searches, leaf litter was placed into rectangular white bins and searched with forceps and UV flashlight. The soil core and duff layer within the ARENA was removed from the PCV ARENA wall and carefully excavated with forceps and UV flashlight to detect ticks and tick fragments in cryptic locations.

8. Results and Discussion:

Field Artifact: Field artifacts listed in the below graphs are the portion of the tick population that was not recovered. Some recovered ticks were found to have been either preyed upon when in a vulnerable state or after morbidity. Numerous UV powdered tick body fragments were recovered during the final searches in treatment ARENAs. It is likely the *I. scapularis* and *A. americanum* ticks had lower total percent recovery in treatments (compared to references) due to a treatment-induced vulnerability in the tick, or morbidity, which allowed arthropod detritivores, predators, scavengers, and bacteria/fungi to breakdown the ticks into fragments which were not recovered during the final search. Also, it was noted in this and previous ARENA trials that ticks seemed to specifically target cryptic locations such as rolled leaves, acorn husks/caps and similar spaces to retreat to after coming in contact with treatments, especially synthetic pesticides. In several cases the recovered rate in synthetic treatments was considerably higher than the FIFRA 25(b) products. This could potentially be due to more non-target effects taking place in synthetic treatment ARENAs limiting the deterioration or breakdown of deceased ticks.

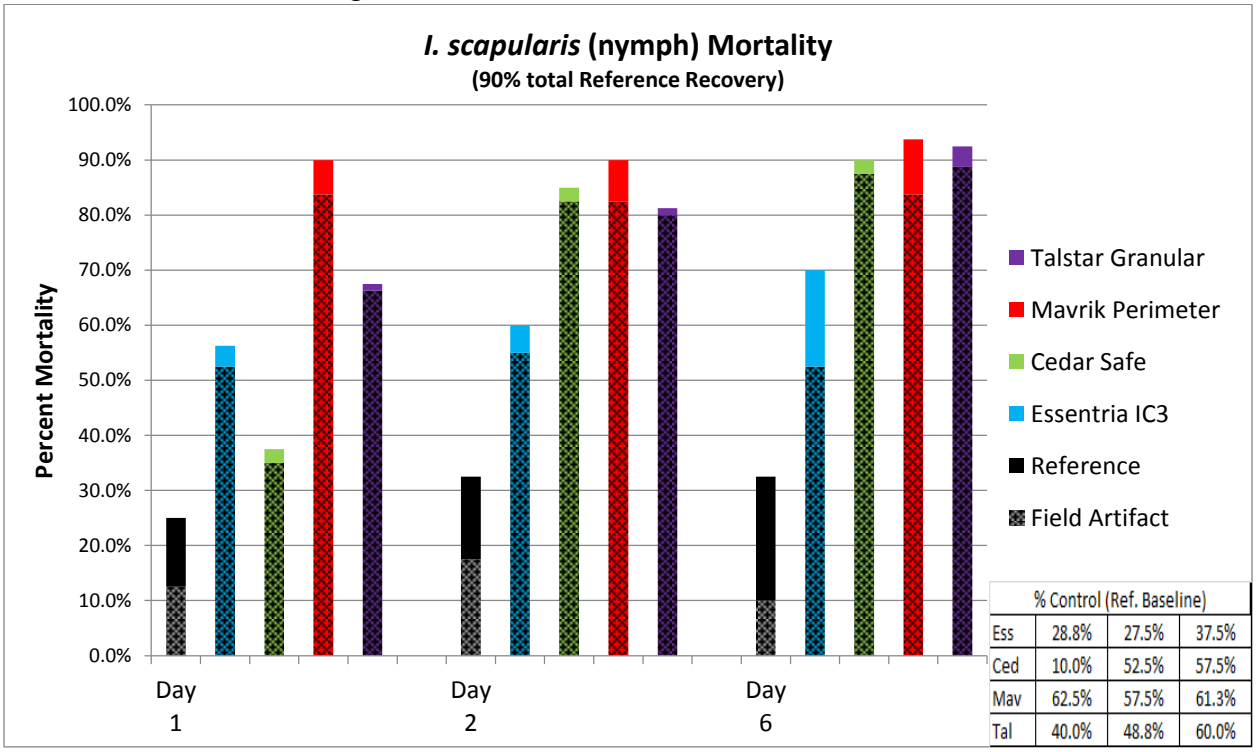


Fig. 1. Day 1 to Day 6 mortality rates for *I. scapularis* nymphs in ARENAs. Percent control in lower corner table.

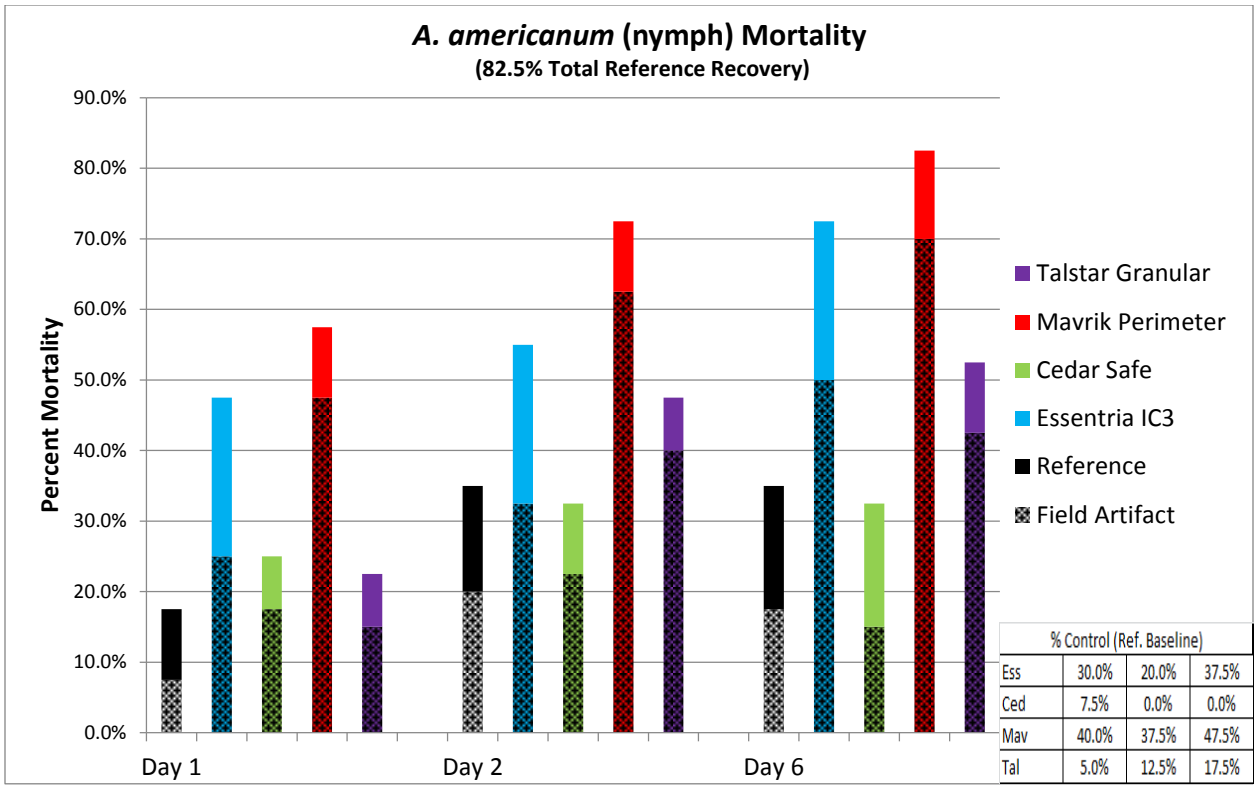


Fig. 2. Day 1 to Day 6 mortality rates for *A. americanum* nymphs in ARENAs. Percent control in lower corner table.

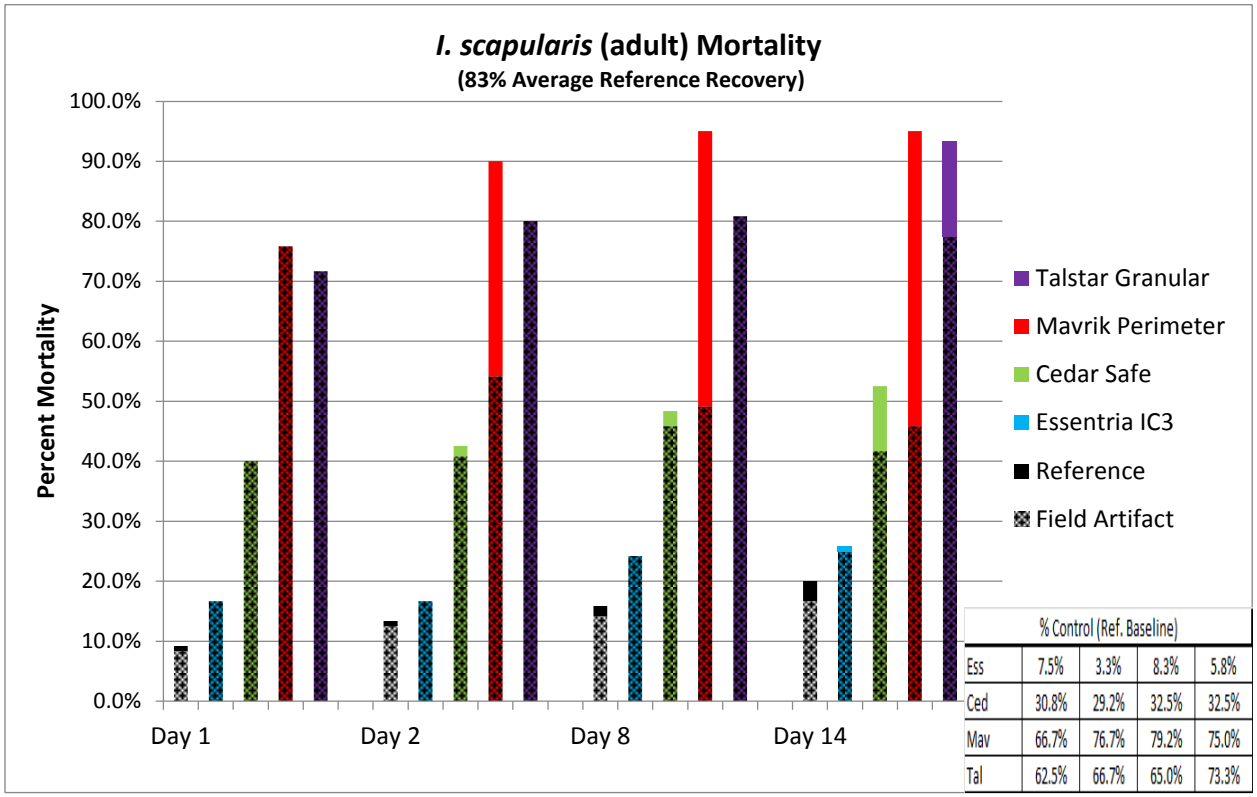


Fig. 3. Day 1 to Day 14 mortality rates for *I. scapularis* adults in ARENAs. Percent control in lower corner table.

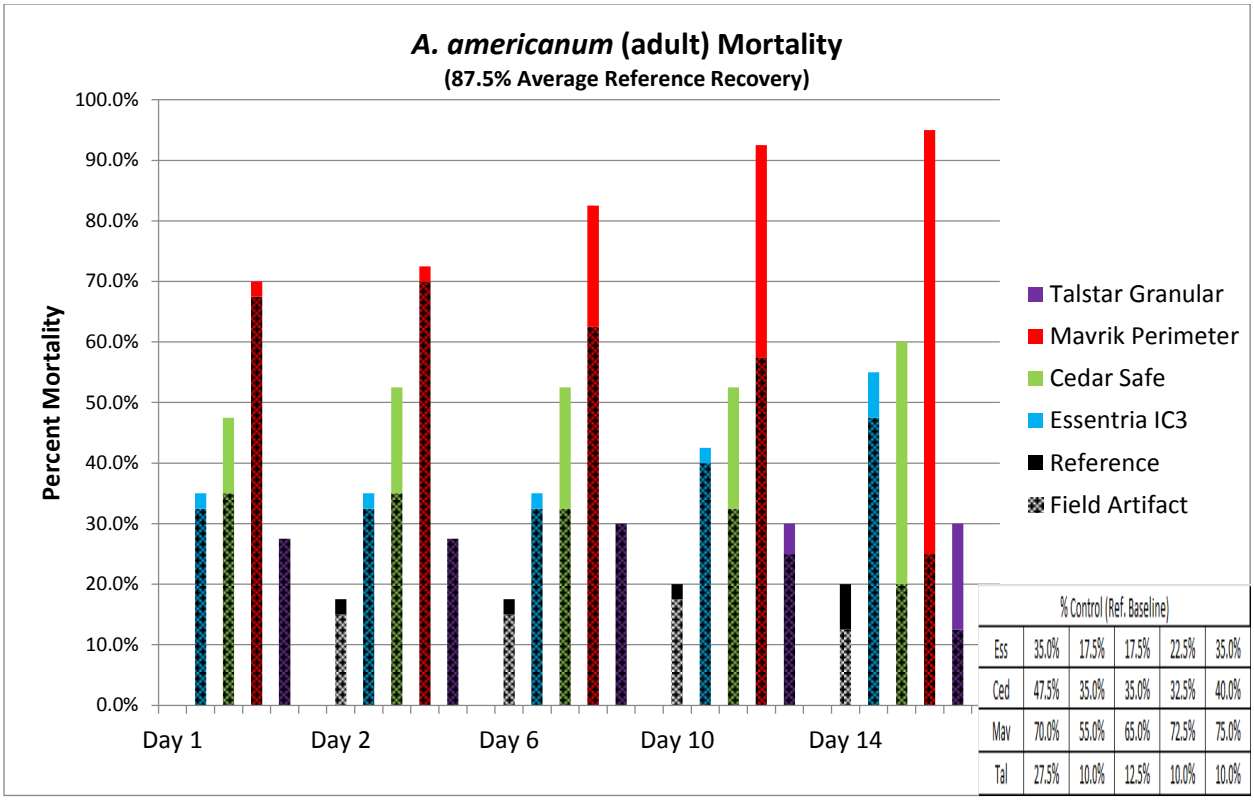


Fig. 4. Day 1 to Day 14 mortality rates for *A. americanum* adults in ARENAs. Percent control in lower corner table.

Table 1: Average ARENA and direct application control rates for all tested products. Average ARENA control calculations are based on mortality from day 1 to day 6 for nymphs and day 1 to day 14 for adults.

Average ARENA Control					Average Direct Application Control				Active Ingredients
Treatment	*I. scapularis*		*A. americanum*		*I. scapularis*		*A. americanum*		
	Nymph	Adult	Nymph	Adult	Nymph	Adult	Nymph	Adult	
Essentria IC3	31%	6%	29%	26%	98%	87%	100%	87%	Rosemary, Geraniol, Peppermint
Cedar Safe	40%	31%	3%	38%	88%	60%	44%	25%	Cedar oil
Mavrik Perimeter	60%	74%	42%	68%	100%	97%	100%	100%	Tau-fluvalinate
Talstar XTRA Granular	50%	67%	12%	14%	100%	83%	44%	84%	Bifenthrin, Zeta-Cypermethrin

Average Control Rates for Trialed Products

I. Scapularis nymphs and *A. americanum* nymphs exhibited similar control rates when treated with Essentria IC3 (31% and 29%), but Cedar Safe caused considerably more control in *I. scapularis* nymphs, compared to *A. americanum* nymphs (40% vs 3%) (Table 1). Slight control (7.5%) was noted in the *A. americanum* nymph ARENA day 1 after treatment, but a slight increase in Reference mortality negated found control on Day 2 to Day 6 (Fig 2). Considering

Cedar Safe caused 38% mortality in *A. americanum* adult trials, the low level of control in nymphs may be due to a low level of activity during and prior to the treatment, limiting their exposure. Positive control Mavrik Perimeter caused 60% and 42% control in *I. scapularis* and *A. americanum* nymphs, respectively. Talstar XTRA Granular caused considerably higher mortality in the *I. scapularis* nymph ARENA than the *A. americanum* (50% vs 12%) (Table 1). This may be due to the differences in questing aggressiveness and overall requirement for rehydration between the species. *I. scapularis* is more sensitive to desiccation and often retreats deep into the leaf litter and duff layer to rehydrate, which would put it precisely where a granular product, like Talstar, would end up after treatment.

Adult *A. americanum* exhibited considerably lower mortality over *I. scapularis* adults to Essentria IC3 treatments (6% vs 26%). Cedar Safe treatments caused slightly higher mortality in *A. americanum* adults (38% vs 31%), which may be due to the more aggressive questing nature of this species leading to more direct contract during treatment and to residual surfaces prior. Mavrik Perimeter caused slightly lower control levels in *A. americanum* adult populations (74% vs 68%). Talstar XTRA Granular treatment caused considerably more mortality in *I. scapularis* adults, compared to *A. americanum* (67% vs 14%). This finding is similar to control found in nymph populations which would align with the behavioral differences between the two species (Table 1).

FIRFA 25(b) Exempt products Essentria IC3 and Cedar Safe appear to exhibit some control on *I. scapularis* and *A. americanum* populations but the remaining populations appeared to fully recover from the deleterious effects of treatment. Also, an excited state was noted for the ticks in several ARENAs treated with Essentria IC3 where questing activity and speed was notably higher than their respective references. An excitorepellent or excited status, if caused by a treatment, would directly combat the purpose of a control treatment and should be examined further. Mortality for these two products only appeared to increase over time in ARENAs with stressful environmental conditions, particularly longer periods of leaf wetness. In treatments with both Essentria IC3 and Cedar Safe, affected ticks displayed deteriorated movement and questing ability. If combined with periods of leaf wetness, this caused over hydration in the ticks unable to locate a more suitable microclimate. Over hydration will quickly kill ticks (personally observed in the laboratory) and likely would increase their susceptibility to predation or degradation from detritivore, or other opportunistic arthropods common in leaf litter.

Average Direct Application Control Rates for Trialed Products

Control rates for direct applications of each trialed product were considerably higher than those found in the field based ARENA setups for almost all treatments, ticks species and stages. The only exception was a slightly lower control rate for Cedar Safe on *A. americanum* adults in direct application when compared to ARENA control data (25% vs 38%). Control on *I. scapularis* and *A. americanum* adults exhibited by Essentria IC3 was 87% and above but theses considerable levels of control were not found in the field based ARENA setups (31% control and below). Control rates for Cedar Safe varied considerably across tick species and stages for direct application but again these control rates were not corroborated with field based ARENA setups, except on adult *I. scapularis* which exhibited slightly higher mortality in the ARENAs (38% vs 25%). Mavrik Perimeter direct applications all resulted in considerable control (97% and above)

across both ticks species and stages. Talstar XTRA Granular direct application control ranged from 44% on *A. americanum* nymphs to 83% and above for both *I. scapularis* stages and *A. americanum* adults (Table 1).

Recapture rates ranges from 82.5% -90% for the nymph replicate completed and adult recapture rate averages ranged from 83% -87.5% for the three adult replicates for each species completed for each treatment. Due to the consistency of recapture rates (82% and above) across both species and stages of ticks assayed the ARENA systems and associated sampling procedure allows for direct comparison of treatments, application methods, timing, and formulations of products to be directly compared. More accurate assessment of acaricide may cause pest control operators to adjust their treatment types, timing of application or perhaps change products.

In the case of Talstar XTRA Granular which is widely used for tick control; Pest control operators managing both *I. scapularis* and *A. americanum* should not use the granular formulation of this product as is displayed a maximum of 14% control on this species. Switching to a EC or other liquid application would likely improve control rates over the granular. The timing of natural oil application with activity questing ticks appears to directly linked to control rates for these products and the recommendation of flagging directly before application to assess questing activity may improve overall control rates for these products and in some cases it may limit or prevent application during low questing activity. Restricting the application of natural oils for tick control strictly during active questing periods would minimize low efficacy treatments allow a greater level of environmental stewardship from the agricultural and pest management industry. This assessment of the natural oil products may also provide citizens who prefer these pest control options to have a realistic expectation for control which may also reinforce personal protection measures they may not otherwise take when at home.

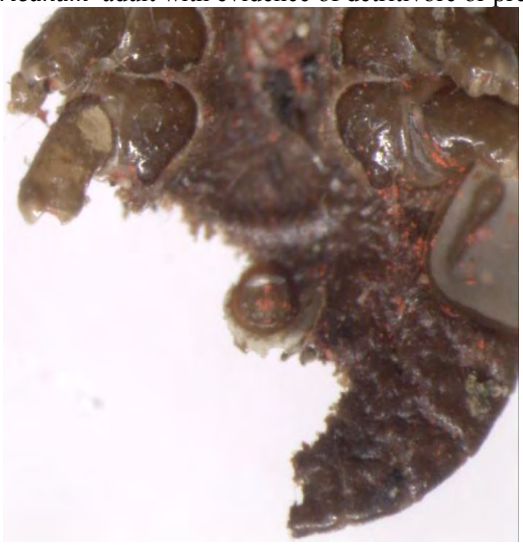
9. Project Location:

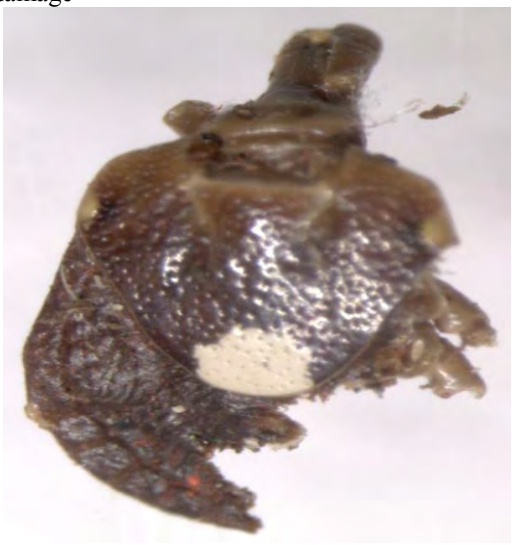
Suffolk County - South Haven, County Park in Yaphank NY, 11980

10. Samples of Resources Developed:

Control figures (above)

A. Americanum adult with evidence of detritivore or predation damage





ARENA setups in laboratory during final search stage

Currently scheduled presentation covering these findings
January
10th Long Island Agricultural Forum
17th Professional Certified Applicators of Long Island
24th Nassau Suffolk Landscape Grounds Association
24th Northeast Regional Center for Excellence in Vector-Borne Diseases - Annual Meeting
30th Arrow Exterminating – Workshop Training
March
7th Long Island Horticultural Conference
14th New Jersey Mosquito Control Association – 106th Annual Meeting
April
4th Category 8 Training Course