Statistical Analysis of 4-Poster™ Data

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Abstract

The prevalence of lone star tick nymphs has grown substantially in New York during the last two decades. The increase of ticks also increases the chance of disease spreading. The ticks main host is the white-tailed deer (*Odocoileus virginianus*) which is the basis for deployment of the 4-Poster™ tick management system. The device is used to control the population of ticks in a roughly 40-acre area by treating the deer with permethrin. To reduce the potential spread of disease among deer, half of the devices were serviced once every three weeks, while the other half were serviced under a normal weekly routine. T-test were used to determine if the altered treatment was effective for the years 2018 through 2021. The data used in each t-test was gathered from tick surveys and placed in to an Excel spread sheet. Each the average of males,

female, and nymphs were compared for each year to determine the amount of reduction in tick life form. Averages were then compared to the very first year results (2013) to see if the population of ticks continued to decrease. Photos from each site were also sorted for the presence of deer or no deer present. The photos indicate the amount of time deer visit the 4-Poster devices. The results concluded that the altered treatment was not as effective as the normal servicing. The 4-Posters™ that were serviced every three weeks showed increases in females and nymphs with little overall reduction in the population of nymphs and female lone star ticks over the life of the experiment.

Keywords: *reduction, lone star tick, and 4-Poster*

Introduction

Ticks are small bloodsucking arthropods. They are parasitic members of the Class Arachnida. Ticks can be found in a wide variety of habitats including coastal beaches, grasslands and wooded areas. In the United States tickborne disease has increased rapidly, however my focus is on the lone star tick (*Amblyomma americanum)* and management efforts to reduce its population at Brookhaven National Laboratory. The *A. americanum* otherwise known as the lone star tick, is one of the most prevalent ticks in the eastern region of the U.S. In previous research the lone star tick was found to be the most prevalent on white-tailed deer in New York. These ticks have expanded in population. Lone star ticks transmit diverse agents of zoonoses, including human monocytic ehrlichiosis, canine granulocytic ehrlichiosis, Rocky Mountain spotted fever, and tularemia (Telford et al., 2019). According to the Centers for Disease Control and Prevention they are widely distributed in the southeastern and eastern United States. The lone star tick feeds

on the blood of humans and mammals such as white-tailed deer, horses, cattle, dogs, skunks, squirrels, raccoons, or any animal they can attach onto. Lone star ticks are three-host ticks, that means they take a blood from different hosts when in their larval, nymphal and adult stages. After feeding once in each stage, the tick falls to the ground and molts or an adult female lays thousands of eggs. Adult lone star ticks find hosts mid-March through late June. The nymphs seek their hosts mid-May through late July, and larvae find their hosts July through September. To reduce the number of lone star ticks on the Brookhaven campus grounds a program using the 4-poster™ tick management device was designed. The devices attract deer with corn and passively apply permethrin, a pesticide, to kill ticks.

As ticks seek their host, they utilize white-tailed deer predominantly for their final blood meal and to find mates. Ticks will often feed in great numbers in the head, ears, and neck area of deer. To begin treatment and reduce the number of ticks, the 4-poster™ devices were set up in various locations at Brookhaven National Laboratory. As seen in figure 6, the 4-poster devices act as a feeding site, by luring deer with corn. The devices were divided into two groups. The first group gets refilled every week, and the second group every three weeks. Each device holds 250 pounds of corn. Each 4-poster™ device have four customized paint rollers. The customized rollers are treated with permethrin, which is a pesticide that kills ticks and mites. While the deer eat, permethrin is rolled on their neck and ears. Along with the 4-poster™ set up there were also cameras positioned at every site to track what times the deer come to eat and how many times they come to eat. Since inception of using the devices the population of lone star ticks have decreased showing that the overall use of the 4-Poster™ system has been successful. The hypothesis of this experiment was not proven to be correct because the number of ticks increased with reduced servicing of the 4-poster™ devices.

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Objectives

Analyzing and comparing tick surveys to record the prevalence of lone star tick for 2018, 2019,2020, and 2021. And to evaluate the effectiveness of the 4-poster™ tick management treatment under two different 4-poster™ servicing schedules.

Method and Materials

Using Statistix 10, a statistics software, I was able to compare and analyze data collected from 2018, 2019, 2020, and 2021. The data was collected from tick flagging surveys and then placed into a spreadsheet with categories, male, female, nymph and larvae. I took the data from the Microsoft Excel spreadsheet and placed it into Statistix 10 to compare years using a T-test. To find the percent of effectiveness for each year, the average of one year is taken divided by the average of first year (2018) or initial year of the project (2013). Fourteen 4-Poster™ devices were placed throughout the BNL property. For each device, 91 kg (200 pounds) of corn were placed in the central bin and the paint rollers were soaked in 133 mL of permethrin [33 mL per roller; 1 mL per 0.7 kg (1.5 pounds) of corn consumed]. The sites were split into two groups. The first group was the north group, and the devices were serviced, corn and permethrin added, every week. The second was the south group and those devices were serviced every 3 weeks. Deer were treated with permethrin as they visited the devices to eat. A Moultrie M-50i game camera was placed at each device and set to take photographs every five minutes during a 24-hour period resulting in 288 photos every 24 hours. Once a month, memory cards from the cameras were collected and replaced with new ones. Photos retrieved from the memory cards were then

manually sorted and separated into two folders based on the presence/absence of deer in the photo: deer or no deer. This paper focuses on the analysis of tick reduction based on the two servicing regimes.

Results

The nymphs show the best record of effectiveness because they are the most prevalent life form. After 2018, the population of nymphs increased and continued to increase for the next three years. the nymph on the north group decreased showing the treatment was effective in 2018 and 2020. In 2018 and 2021 the north group had increases in the population of nymphs. In Figure 1, the population of male lone star ticks for the south (every 3 weeks treatment) is higher than the north group (weekly treatment). The result from this graph is that the weekly servicing is more effective than servicing every 3 weeks. In Figure 2, the 4-Poster™ devices were ineffective in the south group for 2019, 2020, and 2021. The males burn control show the population of male lone star ticks were decreasing in 2018, and 2019, but the number of ticks increased in 2020, and 2021. In Figure 1, the males non-burn control group show an increase from 2018 to 2019. There was a decrease in 2020, then an increase in population of male lone star tick in 2021. In Figure 3, the result shows the population of female lone star tick for the north group has continued to decrease from 2018 to 2020 and a very small increase in 2020. The population of female lone star ticks in the south group decreased for two years 2018 and 2019, but in 2020 and 2021 the graph shows an increase in population. The burn control indicates the population of female lone star ticks decrease in 2018-2020. In 2021, the population increased. The females in the non-burn control increased in 2018 and 2019 decreased in 2020 and 2021. Figure 4 shows the percent decrease in tick life form. For this graph it shows comparison from year to year for nymphs the

population increased by 60%. In 2020, males decreased by 20% and nymphs decreased by 25%. In 2018 and 2019, in the males there was only a 1% decrease. In 2019 and 2020 there was 18% decrease in male population. In 2020 and 2021 there was a 14%. There was a decrease in males for 2019 but, for females the population increased by 35%. In 2020, males decreased by 20% and nymphs decreased by 25%, female population did not increase or decrease. In 2021 the male population decreased by 15% and females decreased by 18% but the nymph population increased by about 39%. Figure 5 shows the percent reduction in tick life form *A. americanum*. All four years are compared to 2013 which is the first year of 4-Poster™ deployment. Compared to 2013 there was only a reduction for males in 2019. The population was reduced by 18 percent. For all the other years there was no reduction for male, female, and nymph populations.

Discussion

Reduced device servicing was used to reduce the potential spread of disease between deer while attempting to reduce the number of ticks that could transmit disease to humans. Statistical analysis has indicated that reduced servicing is not effective, and our hypothesis is rejected. The goal of the current experiment was to reduce the population of ticks even with reduced servicing of the 4-Poster™ devices. Deer treated by devices serviced every week showed the continued effectiveness, while those visiting devices serviced every three weeks showed decreased effectiveness and in some instances an increase in the number of ticks A potential alternative treatment would be to test servicing the devices every week, but use less corn, which would also mean the amount of permethrin would decrease as well but the application of permethrin to deer would occur more routinely.

Conclusion

In conclusion the northern group where the deer visited devices serviced every week showed a continued reduction in lone star tick numbers. The southern group where deer visited devices serviced every three weeks was not as successful in tick reduction, the southern group showed an increase in numbers for nymphs and females.

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References

Telford, S. R., Buchthal, J., & Elias, P. (2019, August). *Early questing by Lone Star Tick LARVAE, New York and Massachusetts, USA, 2018*. Emerging infectious diseases. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6649318/.

Statistical Analysis of 4-Poster™ Data

FIGURES

Figure 1: Males North vs Males South

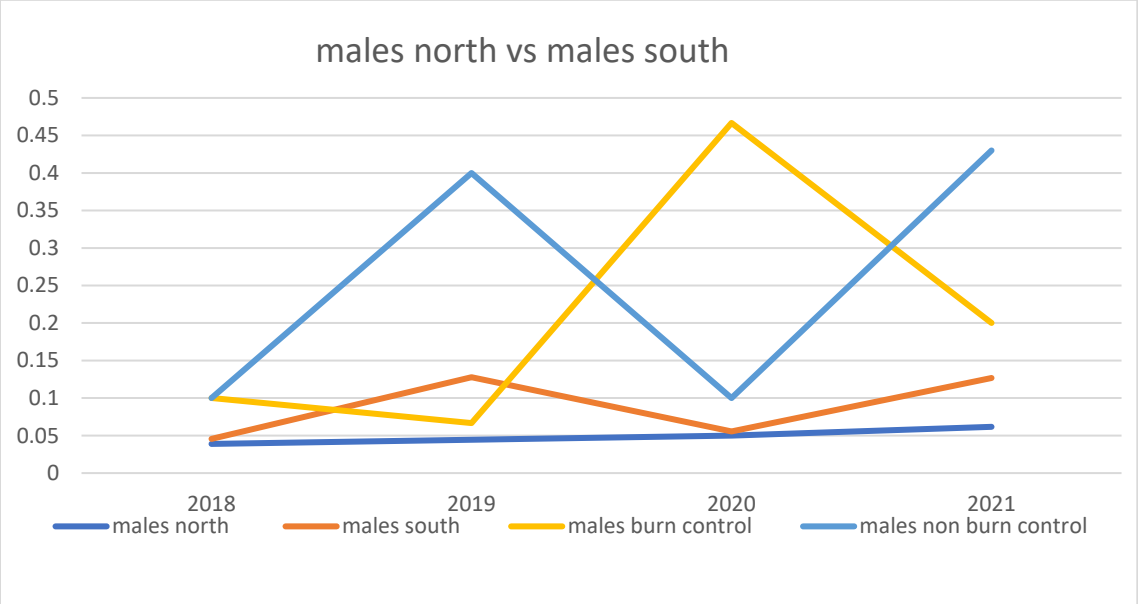


Figure 2: Nymphs north vs Nymph south

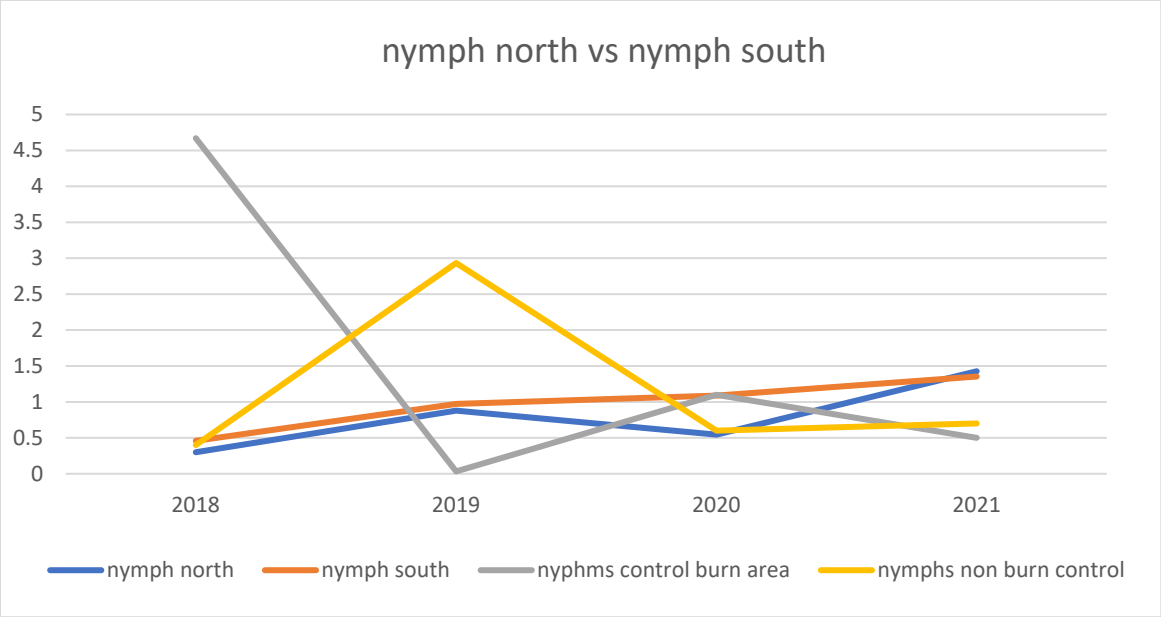


Figure 3: Female north vs Female south

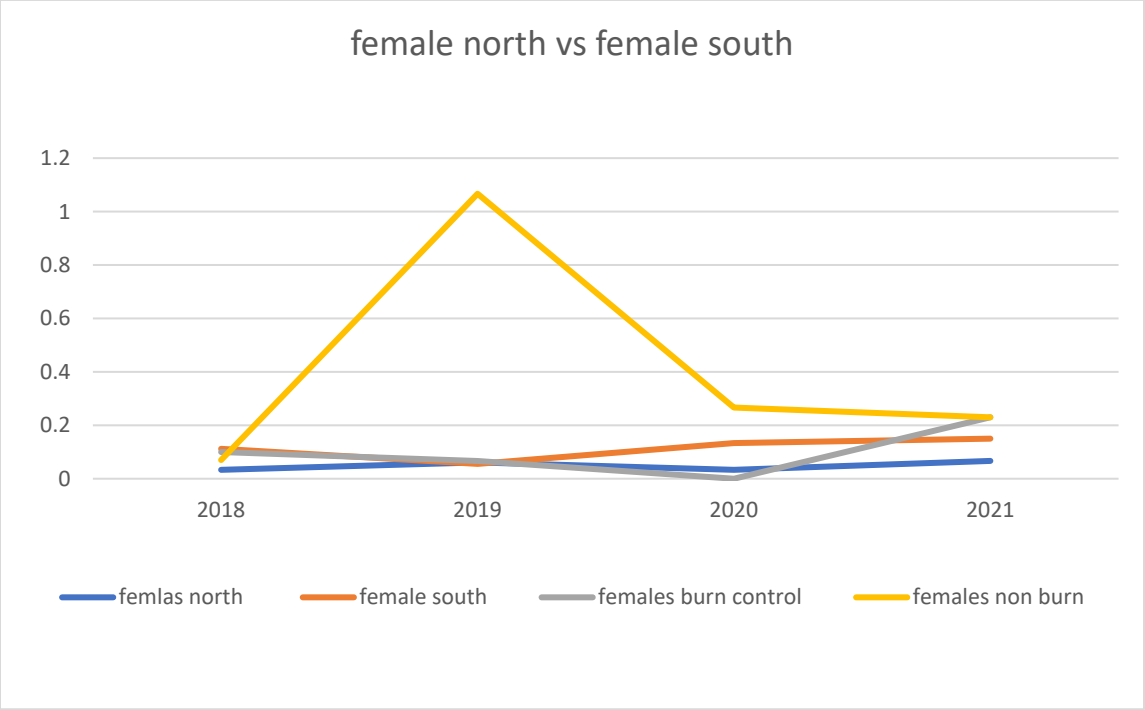


Figure 4: Percent decrease in tick life form *A. americanum*

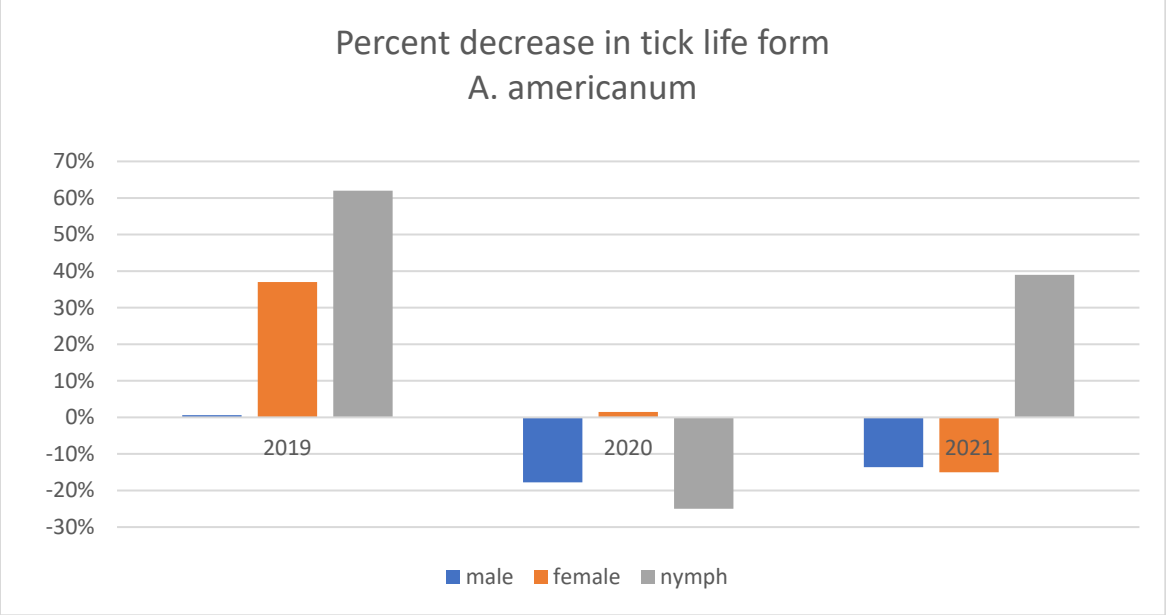
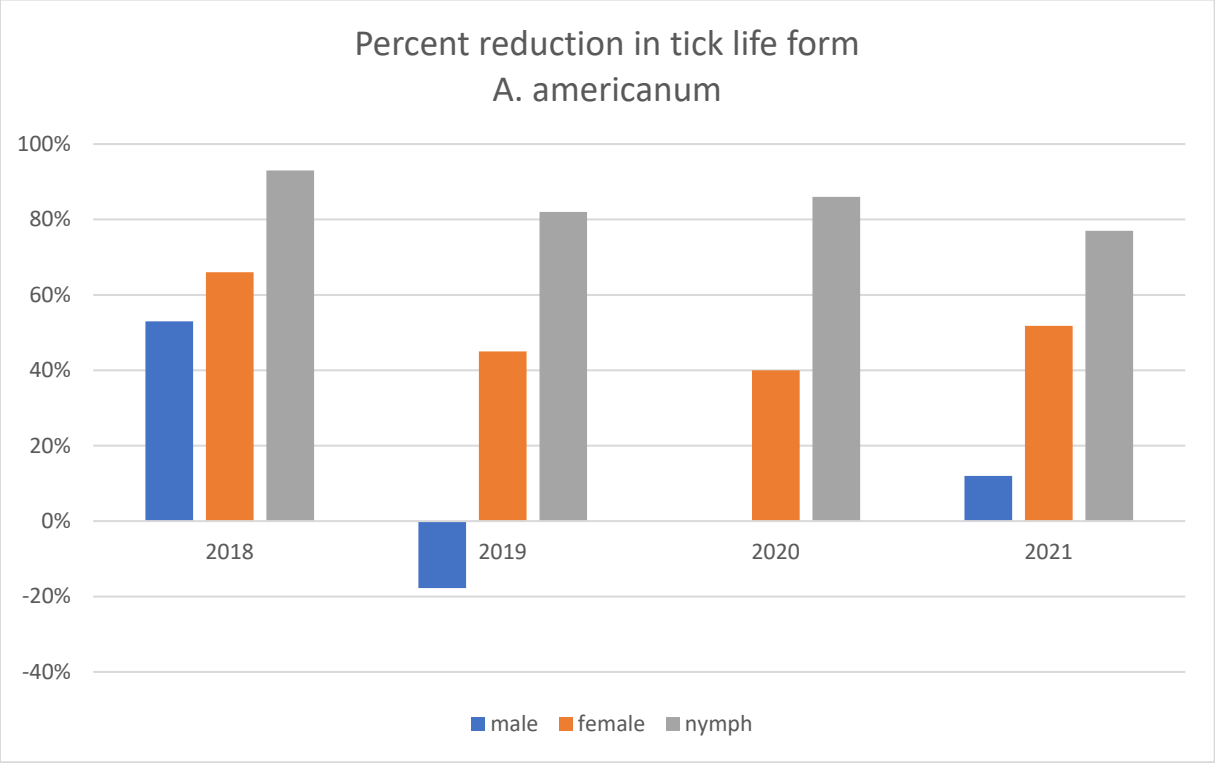


Figure 5: Percent reduction in tick life form *A.americanum*



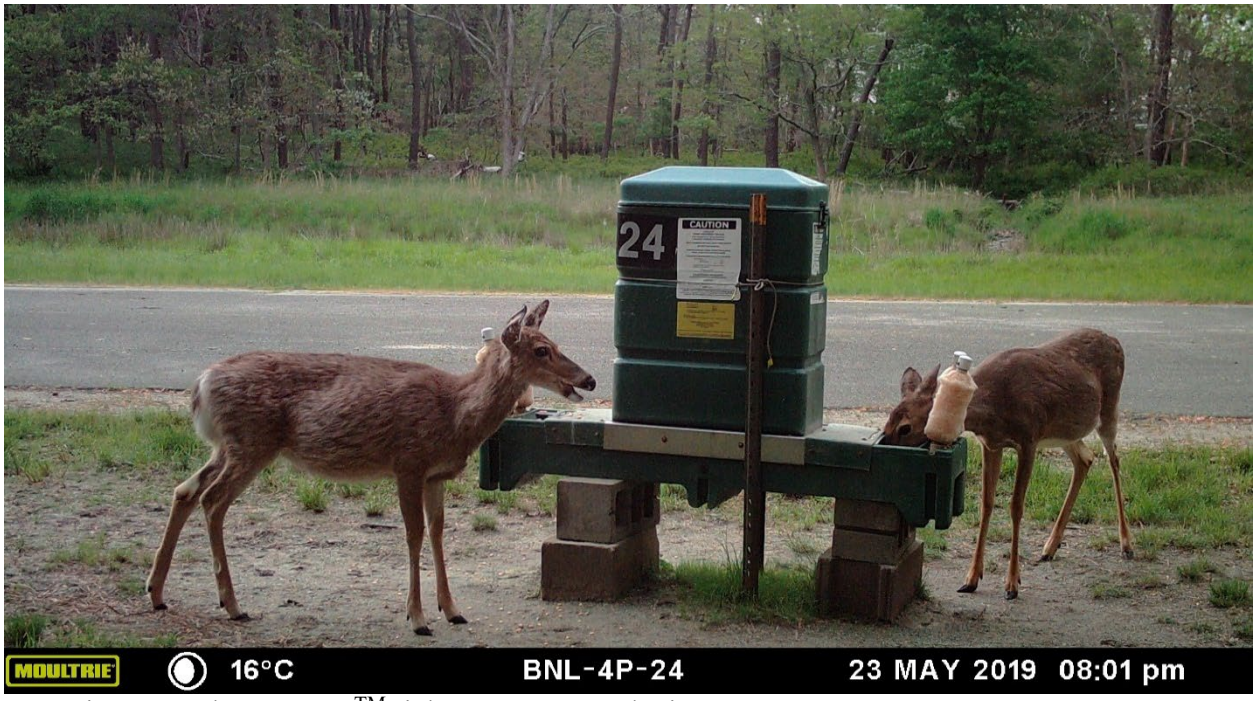


Figure 6: The 4-poster™ tick management device.