Tick population analysis and use of 4-poster devices by white-tailed deer (*Odocoileus virginianus*)

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I. ABSTRACT

Tick populations on Long Island are a problem for its residents because they carry various diseases, such as Lyme (*Borrelia burgdorferi*). Fire Island and Shelter Island have both used 4-poster systems to decrease tick populations in these isolated communities. The 4-poster device feeds deer corn and uses this attractant to apply pesticide to a deer's head, neck, and ears via rollers. Fourteen 4-poster devices have been set-up at Brookhaven National Laboratory, on Long Island, New York, during spring 2013. This study looks at the following questions: What is the current population of ticks at Brookhaven National Laboratory? Do these ticks prefer forested areas or grass fields? How often are white-tailed deer feeding at 4-poster systems? The 4-poster systems were

monitored using wildlife cameras and by monitoring how much corn and permethrin (pesticide) was added. Tick surveys were also conducted at each 4-poster location and two control sites. Deer use was calculated based on photos taken by wildlife cameras and corn use. Forested areas did not contain significantly more ticks then grass areas. On average, twenty-one white-tailed deer visited a 4-poster per day in July 2013 based on corn use, which appears to be the more accurate calculation. This is up from the fourteen deer per day calculated for April. These results show that deer are using the 4-poster systems. This report is the initial data that will be used for comparisons with data collected later in this three year longitudinal study.

II. INTRODUCTION

Brookhaven National Laboratory (BNL) is located on Long Island in New York, and consists of 5,265 acres. BNL is composed of mainly forested areas and open fields. It also has an abundance of white-tailed deer present on site. The forest areas have been fragmented due to building and recreational area development, along with the construction of a solar farm.

Tick populations on Long Island have caused problems for residents for years. These ticks carry various diseases including Lyme (*Borrelia burgdorferi*), Babesiosis (*Babesia microti*), Erhlichiosis, and others. These diseases also are hard to diagnose, leading to serious problems to people going without treatment[1].These diseases are picked up by ticks from animals such as white-tailed deer and white-footed mice, both of which are abundant on the island[2]. The diseases have higher incidences on the island due to the high deer populations, which influence the high tick populations.

Ticks have a multi stage life cycle. They go through a larval stage, nymph stage, and adult stage over a two year period. The tick has to feed twice to progress to the adult stage. The feeding has to occur once in the larval stage and once in the nymph stage[3]. Ticks feed on mammals and birds extensively[4].

Historically ticks were managed using a variety of methods. To control areas that had high tick populations, pesticides are sprayed on the area. Education also helps to protect the public from ticks. They are informed what vegetation types to avoid and how to protect themselves. Personal protective equipment to prevent tick bites include closed shoes, long pants, permethrin treatment of clothing, and long sleeves.

The "4-poster" program that took place at Shelter and Fire Island, which are in the same area as Long Island, were the first studies of "4-posters" in the area. These locations saw the success of the "4-poster" in decreasing the tick population. They monitored deer use of "4-posters" by camera and corn consumption. These areas were carefully monitored for three years and the NYDEC now allows the use of the 4-Poster on Long Island[5].

In an attempt to decrease the population of ticks, BNL has set up fourteen "4-poster" devices around the constructed portion of the site during spring 2013. The 4-poster works by attracting deer to it with a bait source of corn. This corn is stored in the vertical bin and comes out in a feeding tray on either side of the device. A restrictor plate allows the corn to come out in moderation. The feeding tray is accessed by white-tailed deer by sticking their head down along a slanted wall. This slant requires the deer to

tilt its neck, head, and ears against the rollers on each end. These rollers contain a pesticide, permethrin. This permethrin will stay on the deer's neck, head, and ears killing present ticks and ones that come in contact with the deer in the near future. White-tailed deer revisit these devices for the food source and get reapplied with pesticide[6].

A permit from the NYDEC is required to operate the "4-poster" system. To keep this permit, permethrin and corn have to be monitored twice a week, and each 4-poster is required to be monitored for species using the device. Ticks also have to be monitored through tick population assessments to show the tick populations over time.

This study looks at the effectiveness of the first summer's deployment of the "4-poster" devices. The number of deer using the device is calculated, and the first year tick surveys are completed for later comparison. The tick population will also be compared between open grass and forested areas. The two different methods for calculating deer use are compared.

III. METHODS

Fourteen 4-poster devices were set up across BNL according to NYDEC regulations. 4-poster devices are maintained with corn and permethrin twice weekly. The amount of corn used, corn added, permethrin added, time, and date were recorded. Each device is monitored by a Wildgame Innovations Model W5EGC wildlife camera.

The cameras were initially set to recycle and collect pictures every minute when there is motion, and on a medium sensitivity for motion. These settings were changed to recycle every five minutes when there is motion and low sensitivity for motion beginning in June 2013. All pictures are on a medium picture quality setting. Memory cards containing pictures were

collected every two weeks until June, after which they were collected approximately every week. The cameras were not checked if rain was falling or vegetation was excessively wet.

Pictures were organized based on content. Categories for sorting included white-tailed deer, wild turkey, raccoon, other animal, or no animal. A picture with a deer always went into the deer folder no matter what other animal was present. Pictures with raccoons may also have contained wild turkey or other animals. Pictures with turkey may also contain other animals. Humans went into the no animals' category.

Pictures with deer were used to calculate deer use. A camera's deer pictures were observed for 24 hours to calculate the average number of deer in each picture. Then a week's worth of deer pictures was evaluated to establish the average number of deer pictures per day. The average deer pictures per day was multiplied by the average number of deer in each picture. The number calculated was the estimated deer per day using a device. This followed the method used on Shelter and Fire Island[5], and was calculated each month. For April and May, the number of deer pictures was divided by five to account for the difference in how often pictures were taken.

Corn consumption was also used to calculate usage of "4-posters" by deer. A week's worth of corn usage was averaged into corn consumed per 24 hours. This was divided by 1.5 to give the deer usage per day. 1.5 takes into account usage by other animals that occurs and was first used for the Shelter and Fire Island study[5].

Tick surveys were completed at the fourteen 4-poster systems and two control sites. The surveys were completed in July. Each tick survey was conducted using a white flag. The flag was dragged through vegetation for thirty seconds and each site had this completed thirty times. The ticks were counted and identified in the field. Larval ticks had numbers estimated instead of fully

counted. Vegetation type was identified for each thirty second sweep. End time and start time were recorded along with direction traveled from the 4-poster.

IV. RESULTS

Pictures from all cameras contained both mammals and birds. Mammals include white-tailed deer, opossums, raccoons, and squirrels. Birds included wild turkeys, blue jays, northern cardinals, American kestrels, and various other species.

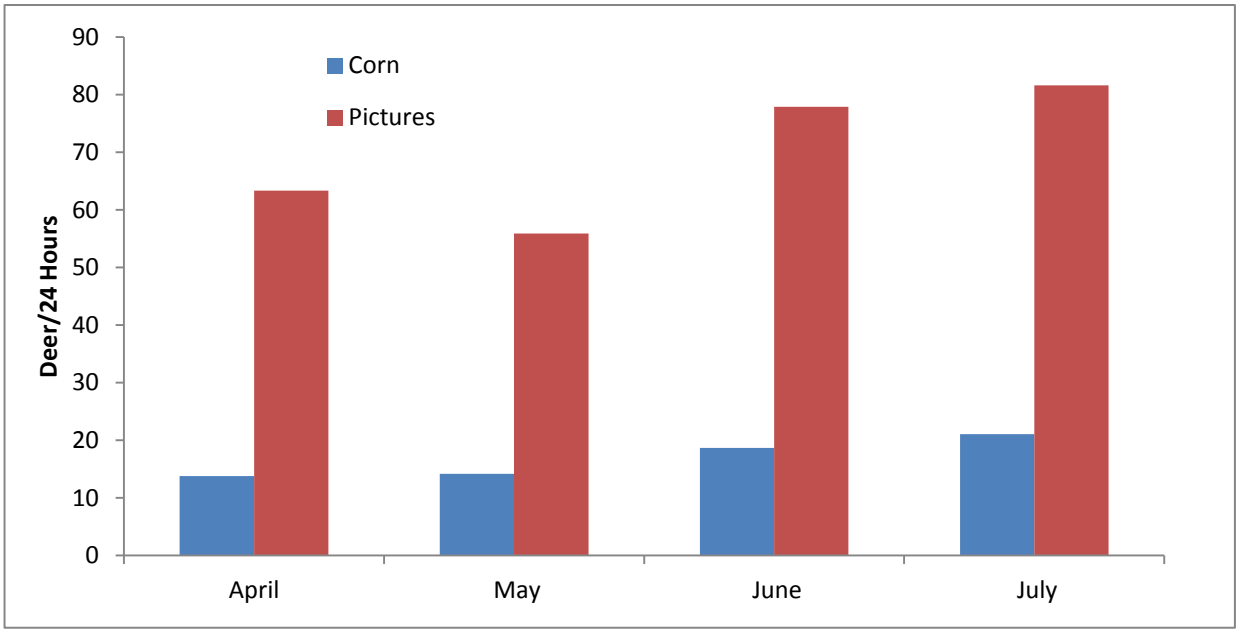

Fig. 1. Bar graph displaying deer use per day analysis by corn use versus by picture analysis. Both pictures and corn analysis are averages across all fourteen "4-poster devices".

The picture deer use analysis is statistically different from the corn deer usage analysis (Table 1). The picture deer use analysis is consistently higher. The corn deer use analysis consistently increases while the picture analysis decreases then increases.

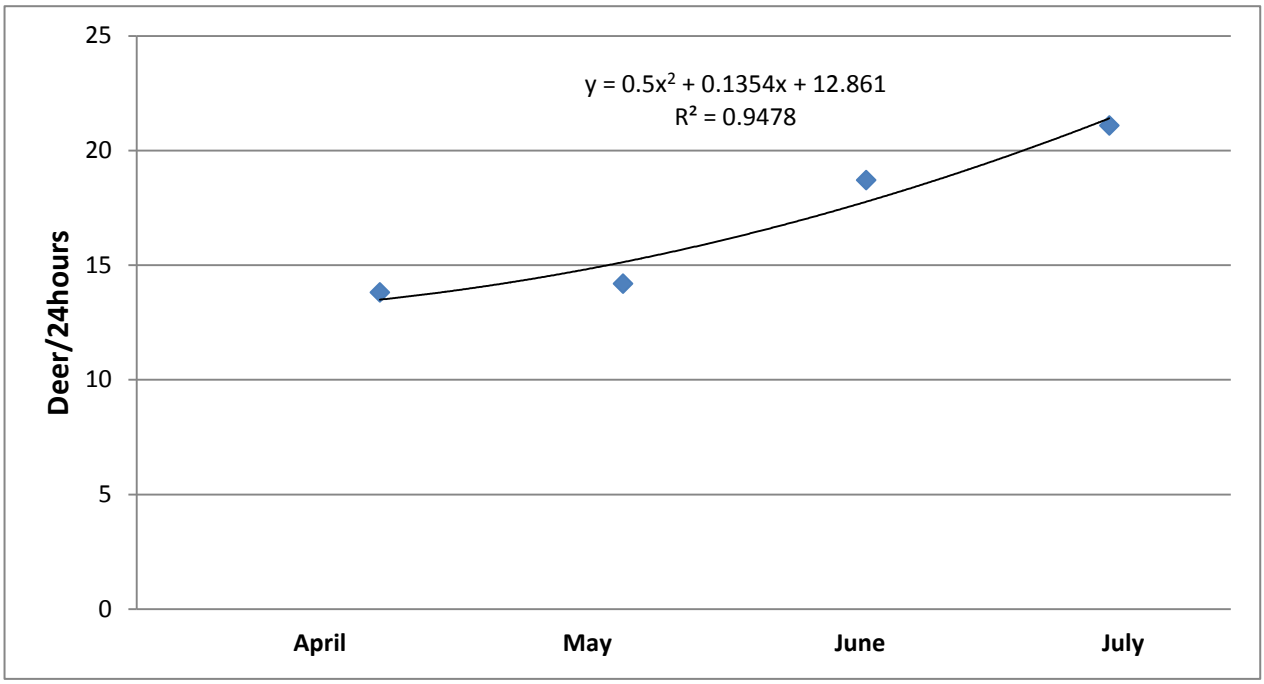

Fig. 2. Line graph displaying the increasing use of "4-posters" by deer based on corn consumption averaged across all "4-poster" devices for four months.

In July "4-poster" 11 and 12 had the greatest deer use (Table 2). "4-Poster" 2 had the greatest increase in deer use from April to July. "4-Poster" 9 had the lowest deer use in July, as it was too low to be measured. "4-Poster" 1 had the second lowest use by deer in July. The average use by deer increased each month.

The difference between tick numbers in grass versus forest is not statistically significant. Two-way ANOVA was run giving a p-value of 0.39 for rows and 0.47 for columns. The data collected shows higher tick numbers switching between forest and grass (Table 3). Larval ticks seemed to prefer grass, but more testing is required for conclusive data.

The current tick surveys show a variety of ticks and stages present at Brookhaven National Laboratory (Table 4). For dog ticks only adult males were found on site. Only one adult black-legged tick was found, a female. Nymphs and larval black-legged ticks were found in higher abundance. All stages of lone star ticks were found.

V. DISCUSSION

A. Picture vs. corn analysis

The two methods of calculating daily deer use of a “4-poster” device yield significantly different results. The picture analysis calculates at the minimum 20 more deer per day on average then the corn deer use analysis. Both have flaws in the calculation. The corn use analysis is not precise because it is impossible to tell how much corn is consumed precisely in each “4-poster.” Each “4-poster” has lines telling how much corn is present inside the bin. These lines are not exact. In some feeders corn will be eaten slowly enough that it does not noticeably lower the level. This is what occurred for the July “4-poster” unit 9 estimation. To help compensate, an average can be taken over a period of at least a week instead of using only one maintenance report, but this is still not perfect.

Picture analysis leads to a high estimate of deer use. This is due to the multiple images that are captured of a single or same group of deer at a device. The deer do not always leave after 5 minutes, and get recorded again on the camera. This is not accounted for in the calculations, and is hard to account for since each deer stays for a different amount of time. Deer will also stand by the device even if there is no corn in it. With no corn, they will probably not use the device, but still get included in the picture calculation.

The corn analysis seems to be the more reliable method for recording deer use of the “4-poster” device. It is also the easier method to calculate. Pictures took a few hours to calculate all the months, after the time spent sorting pictures. Corn use was easily completed within an hour of work.

B. Deer use

As time has gone on with the "4-posters", more deer use them each month on average. This trend shows that deer at BNL are using the device, and more deer on site are finding the devices over time. Supplemental feeding can bring deer closer together then during normal grazing[7]. It is discouraged and even banned in some states due to the possibility of transmitting diseases around the population of deer[8]. Feeding deer is illegal in New York. Therefore a permit is required for the use of the 4-Poster device in Suffolk and Nassau counties allowing feeding of deer in association with the use of the device. This possibility means disease is an issue to be aware of going forward in this project. Careful observation of the deer should mitigate the issue, though. The disease of main concern is chronic wasting disease. Chronic wasting disease is a prion disease that causes weight loss and change of behavior before death[9].

C. Forest vs. grass ticks

No significant difference were found between forested and grass field tick surveys. While numbers change between forest and grass in a couple sites, they were not close to significant changes. One sight had close to identical numbers for grass and forest, though. A study done in Argentina found more ticks in forested areas then open areas. This could be the result of a preference for forested areas[10]. It is also possible that higher temperatures in open areas lead to dehydration of the ticks, decreasing the life span[11]. It is possible more data will reveal different results at BNL.

D. Tick survey

Tick surveys were completed as the baseline in a three year longitudinal study. They will be used for comparison in later years. Only one adult black-legged tick was found this year, and three adult dog ticks. No nymph or larval dog ticks were found this year. These results were not expected. It is possible they will be found in higher abundance in later surveys.

E. White-tailed deer and white-footed mice

White-tailed deer are believed to be the main cause of the tick problem. A study done at parks on Long Island shows nymphal ticks were 93% less abundant when deer were absent. Larval ticks were also only at 2% of the levels at where deer were present[12]. If the deer population at BNL could be lowered it would likely help with the tick problem.

BNL is also a site consisting of many fragmented sections of forest. These sections are fragmented by roads and buildings, along with the open fields created. White-footed mice reach higher densities in fragmented forest habitat, and they are one of the animals that carry Lyme (*Borrelia burgdorferi*). Larger patches of forest carry a lower risk of disease transmission, as nymphal ticks are also more abundant in smaller patches of forest. Habitat fragmentations can influence people's health[13]. This problem is hard to see a solution to.

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VII. NOTES

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VIII. TABLES

Table 1. Paired two sample t-test analyzing corn deer use analysis versus picture deer use analysis.

	Variable 1	*Variable 2*
Mean	16.94898	69.67566
Variance	83.20889	2667.414
Observations	56	56
Pearson Correlation	0.804018	
Hypothesized Mean Difference	0	
df	55	
t Stat	-8.83824	
P(T<=t) one-tail	1.92E-12	
t Critical one-tail	1.673034	
P(T<=t) two-tail	3.84E-12	
t Critical two-tail	2.004045	

Table 2. Deer use of each "4-poster" device across four months based on corn consumption.

Device #	April	May	June	July
1	3.809524	4.666667	4.761905	4.761905
2	3.809524	10	14.28571	23.80952
3	23.80952	20	28.57143	23.80952
4	19.04762	23.33333	23.80952	23.80952
5	14.28571	13.33333	23.80952	19.04762
6	14.28571	16.66667	23.80952	23.80952
7	14.28571	13.33333	4.761905	14.28571
8	9.52381	10	14.28571	14.28571
9	4.761905	6.666667	9.52381	0
10	9.52381	17.33333	19.04762	23.80952
11	38.09524	26.66667	33.33333	38.09524
12	19.04762	16.66667	19.04762	38.09524
13	9.52381	13.33333	23.80952	28.57143
14	9.52381	6.666667	19.04762	19.04762
Average	13.80952	14.19048	18.70748	21.08844

Table 3. Shows the tick surveys from three different areas comparing ticks found in open grass versus ticks found in forested areas by species. LS is lone star tick, BL is black-legged tick, and dog is the dog tick. C1 and C2 are the controls, which are across the road from each other.

Sample	C1 Grass	C2 Forest	4P-11 Grass	4P-11 Forest	4P-13 Grass	4P-13 Forest
LS Male	0	0.667	0.643	0.733	0	0.133
LS Female	0.033	0.533	0.733	0.6	0	0.133
LS Nymph	0.6	13.167	1.867	4.067	0.467	4.667
LS Larval	148.667	6.667	0	0	0	0
BL Male	0	0	0	0	0	0
BL Female	0	0	0.0667	0	0	0
BL Nymph	0.033	1.233	0	0.333	0	0
BL Larval	0	0	0	0	0	0
Dog Male	0.033	0	0	0	0.067	0
Dog Female	0	0	0	0	0	0
Dog Nymph	0	0	0	0	0	0
Dog Larval	0	0	0	0	0	0

Table 4. Shows the 16 tick samples completed in July 2013 at each "4-poster" device and at two control sites. Divided by species and tick stage. LS is lone star tick, BL is black-legged tick, and Dog is dog tick.

Sample	4P-1	4P-2	4P-3	4P-4	4P-5	4P-6	4P-7	4P-8	4P-9	4P-10	4P-11	4P-12	4P-13	4P-14	C-1	C-2
LS Male	0.1	0.133	0.067	0	0.133	0.267	0.067	0.067	0.067	0.233	0.69	0.433	0.067	0	0	0.667
LS Female	0.067	0.167	0.233	0.033	0.067	0.2	0.233	0.033	0.167	0.167	0.667	0.467	0.067	0.033	0.033	0.533
LS Nymph	1.367	25.6	2	0.567	6.167	8.4	1.533	0.433	0.6	7.4	2.967	2.233	2.567	4.367	0.6	13.167
LS Larval	0	0	0	0	0	0	0	0	2.533	0	0	26.667	0	0	148.667	6.667
BL Male	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BL Female	0	0	0	0	0	0	0	0	0	0	0.033	0	0	0	0	0
BL Nymph	0.467	0.633	0.167	0	0.667	0.7	0.133	0.033	0.233	0.067	0.167	0	0	0.333	0.033	1.233
BL Larval	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Dog Male	0	0	0	0	0	0	0	0.033	0	0	0	0	0.033	0	0.033	0
Dog Female	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dog Nymph	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dog Larval	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0