The Effectiveness of Various Trapping Techniques in Collecting *Ixodes scapularis* and Other Species of Ticks

Bios 569- Practicum in Aquatic Biology

Patrick Keaney

1651 Turtle Creek Ct.

Advisor: Dr. Craig

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Abstract

From May 15 to June 16, 1994 four different methods of surveying the tick populations were tested on the UNDERC property. The four methods were flagging, carbon dioxide traps, nest boxes, and animal trapping. 299 ticks of two species, *Dermecentor variablis* and *Ixodes banksi*, were collected. The most successful surveying technique was flagging, which accounted for 259 of the *D. variablis* collected. A trapped beaver produced 39 I. banksi and one *D. variablis* was caught using a CO2 trap. The CO2 traps and nest boxes were not successful, but changes could make these techniques more productive for future research. The results from flagging identified areas of high and low *D. variablis* concentrations on the property. The areas of high concentrations were near Moccasin Lake and along the South Gate road. The areas of low concentrations appear to occur in marshy locations near Tenderfoot Creek and Plum Lake. The population of *D. variablis* appeared to peak in late May and early June then decline in July. This information will be useful to alert researchers and students to *D. variablis* infested areas and possible habitats of the Lyme disease vector, *Ixodes scapularis.*

Introduction

Lyme disease is a illness caused by the spirochete bacterium, *Borrelia burgdorferi.* Lyme disease is characterized by a number of early symptoms including, headaches, nausea, fever, a rash, aching joints, and fatigue. If the disease is not treated with antibiotics, more serious complications, such as heart block, nervous system disorders, and arthritis will occur (Michigan Department of Public Health, 1989).

Borrelia burgdorferi is transmitted to humans through tick bites. The principal vectors of the disease belong to the *Ixodes ricinu* group. In North America, the two species responsible for transmission of the disease are *Ixodes scapularis* in the northeastern and midwestern US and *Ixodes pacificus* in California and the western states. In Europe, the vector of Lyme disease is *Ixodes ricinus; Ixodes persulcatus* is responsible in Asia.

Ixodes dammini was the species most commonly connected with the spread of Lyme disease in the northeast and midwest, but Oliver *et. al.* 1993 demonstrated the cospecificity of *I. dammini* and *I. scapularis*. A study by Wesson *et. al.* 1993 on the sequenced internal transcribed spacer units of rDNA from *I. scapularis* and *I. dammini* has verified that they are the same species. The name, *I. scapularis*, is now commonly accepted over *I. dammini* because it was the older of the two. *I. scapularis* is the primary tick that this study is concerned with, since it is the main cause of the current epidemic of Lyme disease in the northeast and midwest. In 1990, the states with the highest incidence of Lyme disease per capita were Connecticut, New York, New Jersey, Rhode Island, Delaware, Wisconsin, and Pennsylvania (Ginsberg *et. al.* 1993).

B. burgdorferi needs competent animal reservoirs in order to maintain itself in nature. *B. burgdorferi* is found in a wide range of animals, but rodents are a major source of infection for spirochetes that are transmitted to humans. The White-footed Deer Mouse (*Peromyseus leucopus*) is a particularly important host for B. burgdorferi in northeastern and midwestern U.S. The mice harbor the spirochete throughout their lives and where Lyme disease is present, up to 70-80% or more of the mice in the area are infected (Ginsberg *et. al.* 1993). The White-tailed Deer (*Odocoileus virginianus*) has been established as the primary host of the adult *I. scapularis*, but the White-tailed Deer does not provide a adequate reservoir for *B. burgdorferi.*

I. scapularis proceeds through four life stages: egg, larva, nymph, and adult. The larva and especially nymph are the important stages when the ticks acquire *B. burgdorferi.* Larvae and nymphs feed on reservoir competent rodents and other small animals from which they are infected with *B. burgdorferi*. Adults that feed on reservoir-incompetent deer are unsuccessful in infecting humans with the spirochete. *B. burgdorferi* is passed to humans through the saliva of the nymph or adult tick; the amount of time the tick is attached is critical to whether the human is infected with *B. burgdorferi*.

This experiment will compare the effectiveness of five methods of trapping ticks: flagging, modified flagging, carbon dioxide traps, nest boxes, and small mammal trapping. The purpose is to find out which method is most economical in terms of man-hours. Another important goal of this experiment is to try to determine areas of high concentrations of the dog tick (*Dermacentor variablis*) on the UNDERC property. These areas might be considered high risk areas for *I. scapularis* and possible infection with *B. burgdorferi*. These areas could then be avoided by students and faculty, thus reducing the chances of acquiring Lyme disease.

Materials and Methods

This experiment was done at Notre Dame's Environmental Research Center in Gogebic County, Michigan. Previous tick surveys have been run in 1992 and 1993 in which students used the small mammal trapping technique to collect the ectoparasites. The results from these experiments show that the most abundant tick on the property is the species *D. variablis*. Only one *I. scapularis* was found on the property in the two years the study was conducted (McCracken *et.al.*1994).

Flagging

Flagging or drag sampling consists of dragging a one meter square piece of cloth (corduroy, flannel, etc.), attached to a wooden handle, over the vegetation being surveyed. Questing ticks will attach to the cloth, they are removed every 20 meters and preserved in alcohol or formaldehyde. The flagging was done essentially along the roads on the property. The majority of the roads on the property were sampled over the course of the experiment.

Carbon dioxide sticky trap

CO2 traps consisted of a one kilogram block of dry ice placed in the center of a dissecting pan and the bottom of the pan contained adhesive paper. The pans were placed in small depressions, so that the lip of the pan was even with the ground. This allowed the ticks to fall into the bottom of the pan. The CO2 trap were placed in locations that were also sampled by flagging. The majority of the traps were placed near Moccasin Lake, Morris Lake, and along the East road between the fire break and Moccasin road. These were all areas that appeared to have high tick concentrations. Some traps were also placed in the high grass on the eastern side Plum Lake just south of the cross.

The source of dry ice was the Polyfoam Insta-Ice Block Dry Ice Machine. This device produced five to six 1 kilogram block from a 50 lb. liquid CO2 cylinder. There were five cylinders on the property, so it was possible to make 25 to 30 blocks over the course of the summer.

Nest Box traps

The nest box design that was used is diagrammed in Fig. 1. Adhesive tape will trap bloated ticks that fall off the animals using the nest box. Nest boxes were placed in locations that appeared to be good habitats for the White-footed Deer Mouse. The boxes were generally placed just inside the tree line near a field. The 12 traps were placed in accessible areas across the property (Fig. 2). The traps were not placed on stakes. Instead the box was placed in a small depression so the opening was level with the ground. The traps arrived on July 4 and were placed in the field on July 5. The traps were checked two weeks later on July 18. There are plans to have the traps checked periodically over the course of the winter and into next year.

Animal Trapping

The animal trapping was done by Curtis Walsh. For information on that type of trapping see his report.

Results

The only trapping method that produced significant results was flagging. Over the course of the summer, 259 ticks were caught by flagging. All the ticks that were trapped using this method were *D. variablis*. The breakdown between the sex of the *D. variablis* trapped was 132 males and 127 females, essentially a ratio of 1:1. The number of ticks captured decreased over the course of the summer. The number of ticks caught and the amount of ticks collected per hour were higher in late May and June than in July (Fig. 3 and Fig. 4). This is also shown by comparing the flagging data from May 22 and July 7. Sampling on both days was done along the trail to Moccasin Lake. The recovery per hour for May 22 was 28 ticks and 8 ticks for July 7 (Fig. 5).

The *D. variablis* were found in higher concentrations in relatively dry areas with high grass. The greatest concentrations of ticks were found in the area near Moccasin Lake and along South Gate road on the hills over looking Tenderfoot Lake(Fig. 6). The greatest number of ticks collected in a day occurred on the East road just south of Bog Pot and the trail to Moccasin Lake (Fig. 5). Low, swampy areas near Tenderfoot Creek and on the east side of Plum Lake did not appear to support large populations of *D. variablis* despite the presence of high grass (Fig. 5).

The CO2 traps were not as effective as flagging. In fact only one female *D. variablis* was caught in the 16 traps that were set during the summer. The traps were set in areas of both high and low tick concentrations, but neither type of site was successful.

Due to belated delivery, the nest boxes were only in place for two weeks when they were checked for the first time, and none of the boxes had been occupied at that time. The nest boxes will probably be checked again in the spring.

Curtis Walsh's paper discusses the results of the animal trapping. Curtis and I examined a beaver together at the beginning of the summer. The results of that examination were 39 *Ixodes banksi*, which is a species common to beavers. There were 5 adult males, 19 adult females, 13 nymphs, and 2 larvae on the beaver.

Discussion

The map of the *D. variablis* concentrations based on the flagging data is the most important result of this research. It can be used to inform researchers and students of areas of high tick concentrations so they can take precautions. Although the only tick found this summer was *D. variablis*, that does not mean *I. scapularis* is not present. The map indicates possible areas of high concentrations of *I. scapularis*, since *D. variablis* and *I. scapularis* share similar habitats.

Concentrations of *D. variablis* not only changed based on location, but also over time. The population of questing adult *D. variablis* seemed to peak in late May and early June. This probably indicates that May and June are the peak questing months for *D. variablis*, but it could also be due to environmental factors. The weather in the first two months of the summer was very dry and warm, but the property received more rain and was cooler in July. These weather conditions could have some influence on the questing behavior of *D. variablis*. Still, it is important for people on the property to realize that tick populations appear to be higher in May and June.

The most effective trapping technique was flagging. Flagging produced 15 ticks per man hour compared to negligible amounts for both CO2 traps and nest boxes. Flagging provides information for a greater land area per unit effort than does either animal trapping or CO2 traps (Falco and Fish *et. al.* 1989). This does not mean that those techniques are useless. In fact, CO2 traps and nest boxes can probably be just as effective as flagging. There needs to be changes in the designs, in order for the CO2 traps and nest boxes to produce better results.

The CO2 trap was not effective for two reasons: (1) the use of a dissecting pan as the base and (2) the lack of insulation for the dry ice. The CO2 trap design from Falco and Fish *et. al.* 1989 corrects these problems. Trap bases should be constructed of 33.5 * 33.5 * 3.5 cm wood. Adhesive tape with the sticky side up are placed on the wood base. The wood is a more natural substance than the white porcelain. Also the ticks would not have to climb over the slippery lip of the pan. The dry ice reservoir should be constructed of Styrofoam with holes drilled halfway up the walls. This will slow the release of the gas and allow the ticks more time to move towards the trap before the block has evaporated.

The nest boxes need to be placed in the field earlier in the summer, in order to give the field mice team to occupy the box. Another problem with the boxes is that they were not on stakes, which allows easy access to the sticky paper without disturbing the mice. This appears to be a very effective method based on the results from the boxes placed in the South Bend area. The majority of these traps were occupied after being in place for two months.

Animal trapping is a proven method for capturing ticks. It is very important to continue to survey the Deer Mouse population on the property, since it is a important host for the nymph and larvae of *I. scapularis*. Animal trapping and nest boxes are both important because they collect the nymphs and larvae as well as the adult ticks. Flagging appears to be most effective in collecting adult ticks.

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Table 1: Tick Collection Data

Date	#of *D. variablis*	Time	Ticks Per Hour	Location
May 21	11	1 hr 50 min	6	Moccasin Rd.
May 22	21	45 min	28	Moccasin Rd.
May 27	13	30 min	26	Rd. by Morris L.
May 28	23	1 hr 20 min	17	Southern East Rd
May 30	61	1 hr 30 min	41	East Rd.
June 6	3	45 min	4	Lab to shed
June 7	0	30 min	0	Behind camp
June 8	27	1 hr 20 min	20	Northern East Rd
June 9	11	40 min	17	Southern West Rd
June 9	0	15 min	0	Plum Rd.
June 12	20	1 hr	20	South Gate Rd.
June 16	39	50 min	46	South Gate Rd.
June 19	0	30 min	0	Kickapoo Rd.
June 22	7	30 min	14	South of Morris L.
June 25	1	30 min	2	Northern West Rd.
June 27	0	1 hr	0	Field near camp
July 3	9	1 hr 15 min	7	Area near weir
July 7	4	30 min	8	Gravel pit Rd.
July 12	7	1 hr 20 min	5	Moccasin Rd.
July 15	2	45 min	3	Cranberry Rd.
Totals	**259**	**17 hr 30 min**	**15**	

Figure 1

An artificial nest box for collecting ectoparasites from small mammals.

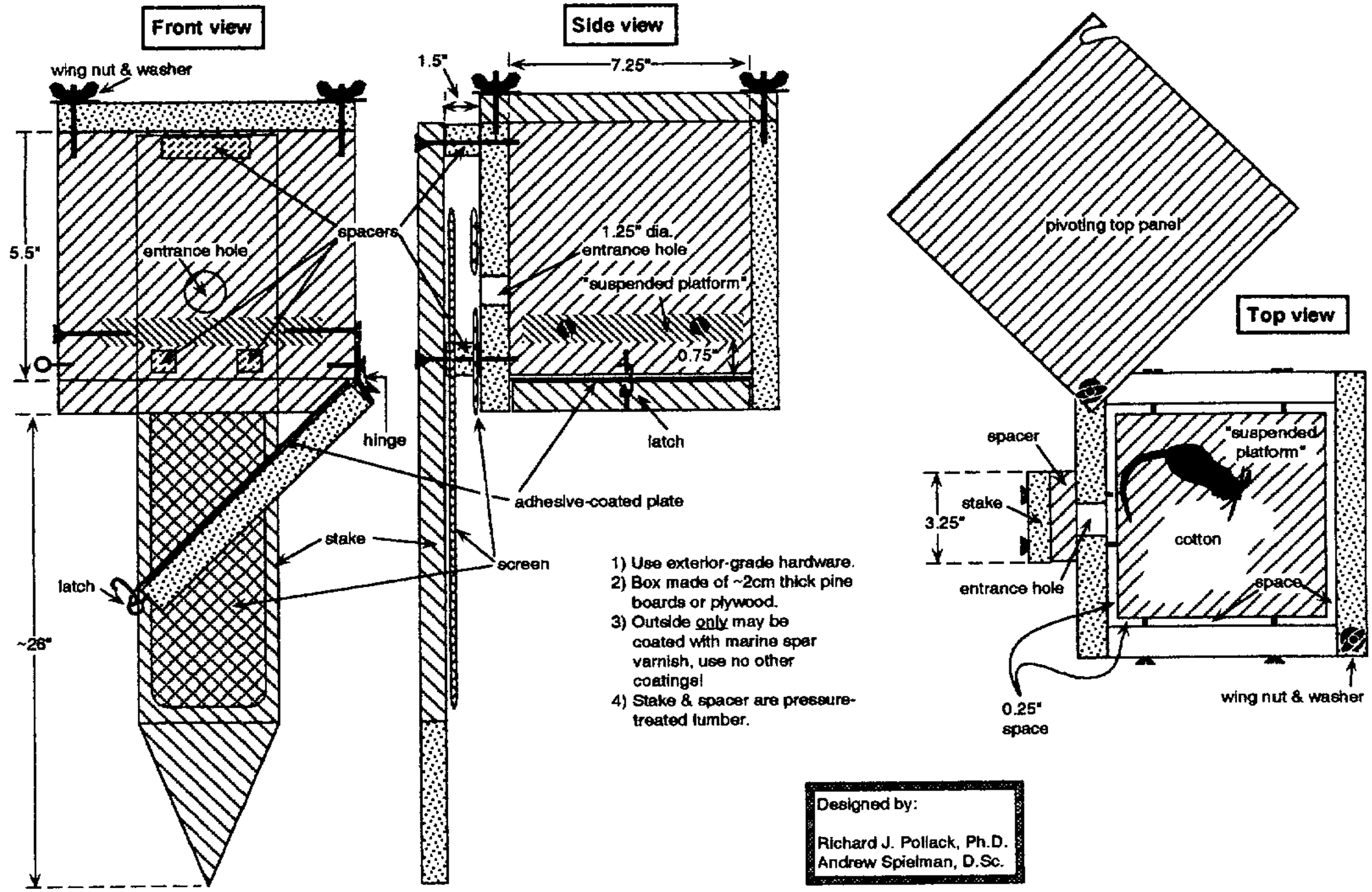
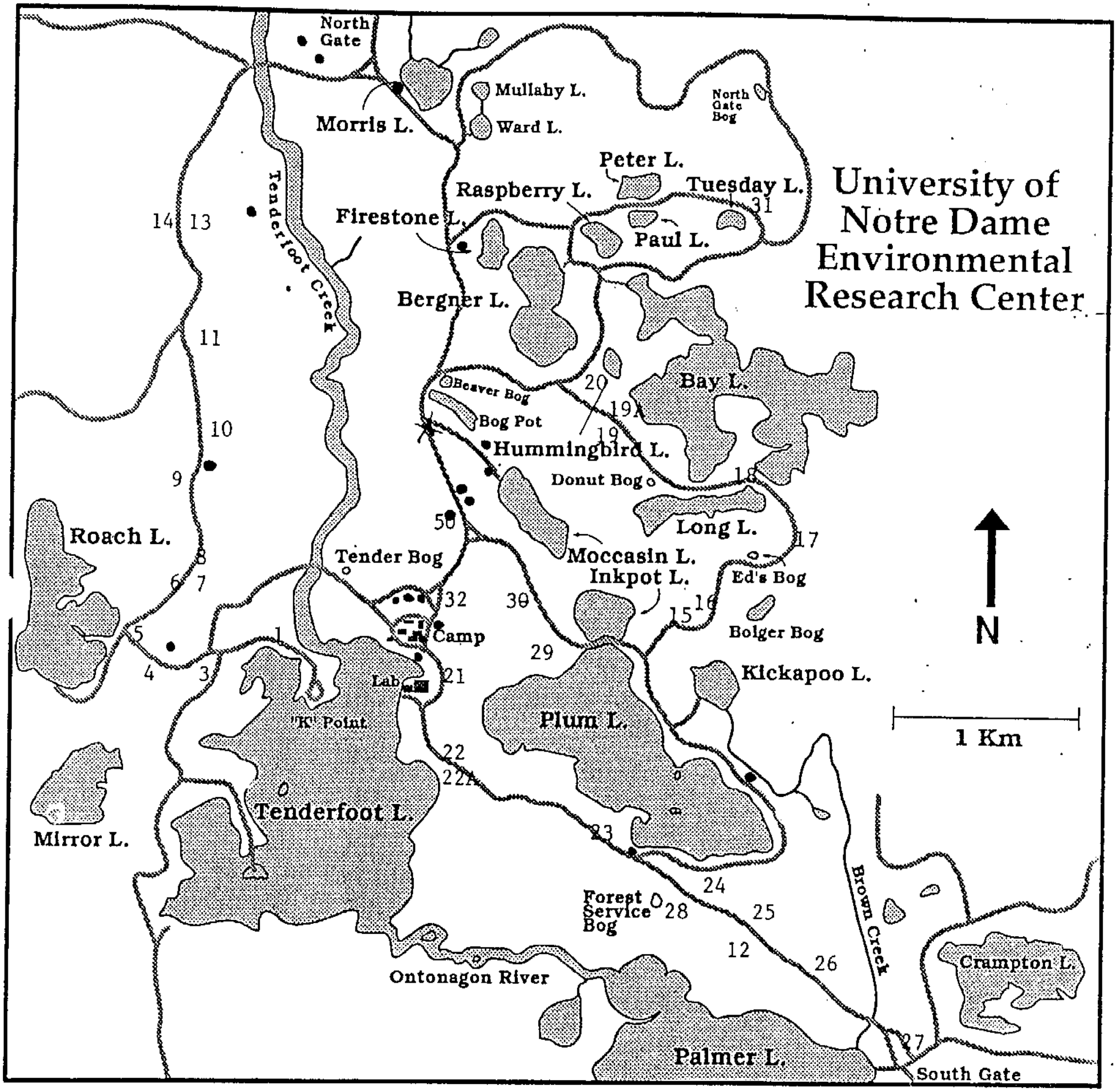


Figure 2: Location of CO2 traps and Nest Boxes



● Location of CO2 Traps

● Location of Nest Boxes

Figure 3

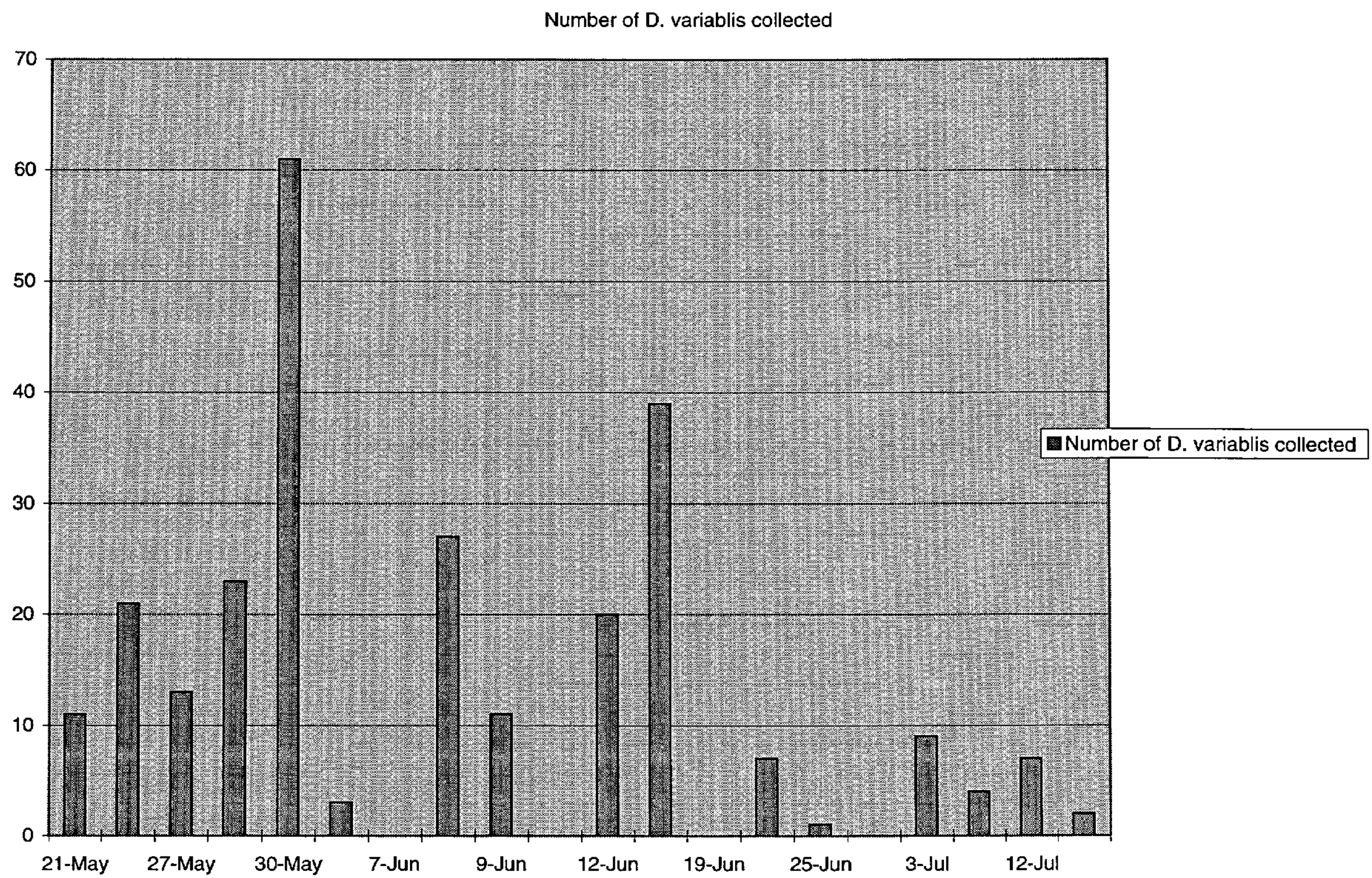
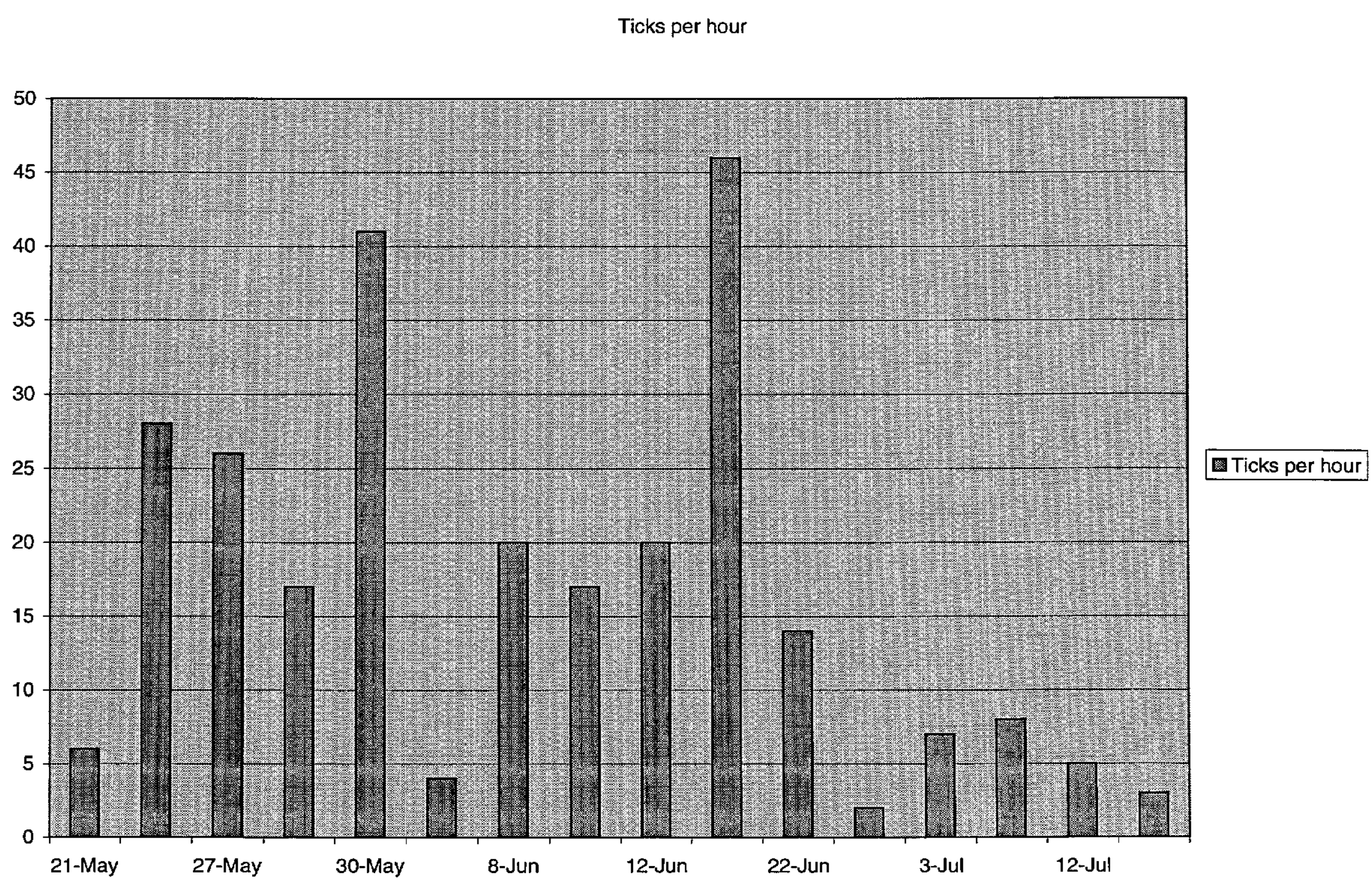
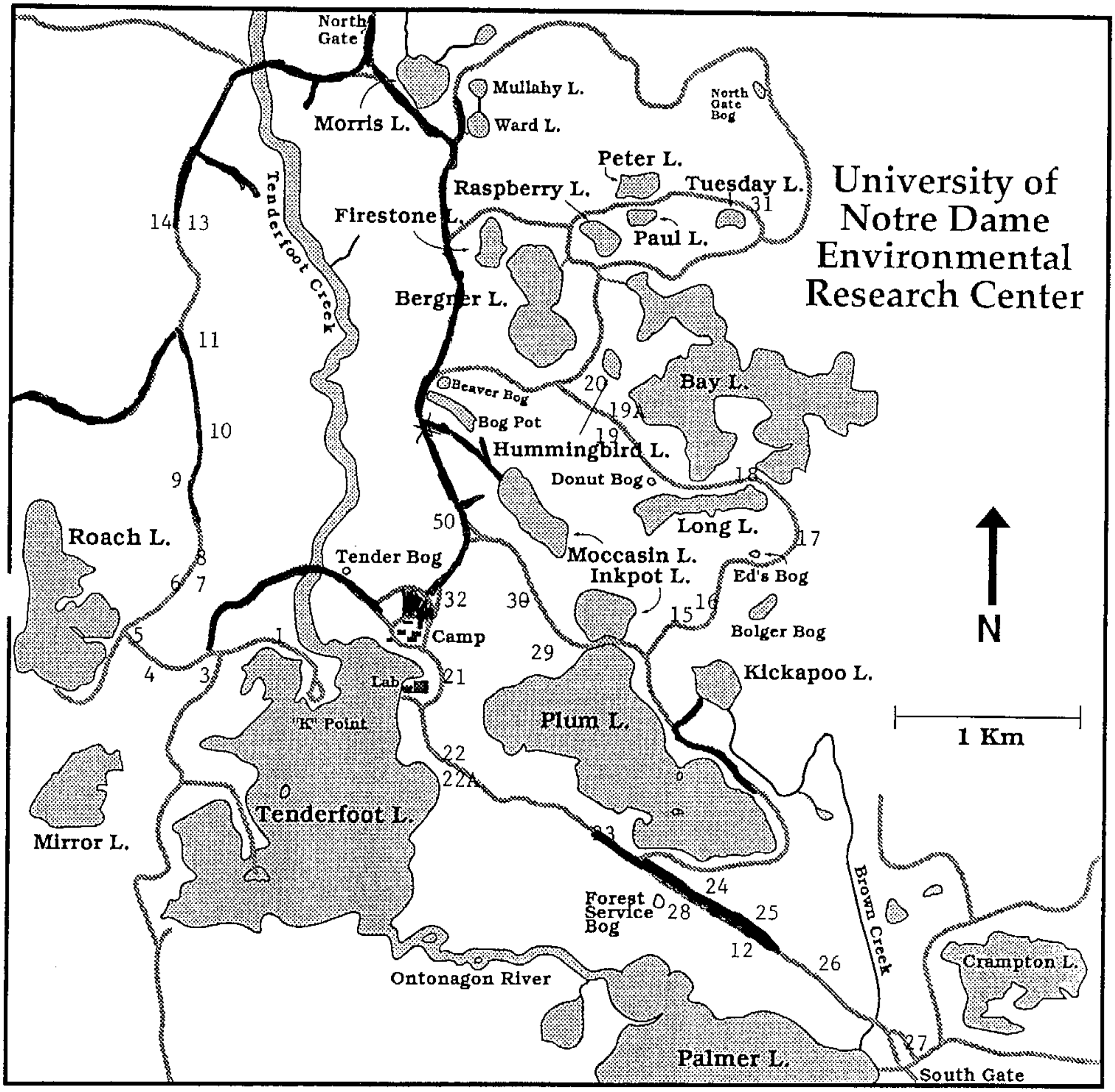

Number of D. variablis collected
70
60
50
40
30
20
10
0
21-May
27-May
30-May
7-Jun
9-Jun
12-Jun
19-Jun
25-Jun
3-Jul
12-Jul
Number of D. variablis collected

Figure 4



Ticks per hour
50
45
40
35
30
25
20
15
10
5
0
21-May
27-May
30-May
8-Jun
12-Jun
22-Jun
3-Jul
12-Jul
Ticks per hour

Figure 5: Tick Concentrations on Property



High Concentrations (greater 20 ticks/hour)

Medium Cocentrations (6 to 15 ticks/hour)

Low Concentrations (5 and less ticks/hour)