Metropolitan Mosquito Control District

Ixodes scapularis Distribution Study Report

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1998 *Ixodes scapularis* DISTRIBUTION STUDY

Abstract

A black legged tick (*Ixodes scapularis*) distribution study, designed to detect any changes in *I. scapularis* distribution over a many year period, was conducted in the seven county metropolitan area by the Metropolitan Mosquito Control District. Small mammal sampling was used to collect ticks from 1 00 wooded areas that have all been sampled since 1990 or 1991. At least one *I. scapularis* was collected from 39 of these sites, with a total of 506 *I. scapularis* removed from 1246 mammals for an overall season mean of .406 *I. scapularis* per mammal. Most of the *I. scapularis* collections continue to occur north of the Mississippi River, but the majority of collections occurred in Anoka county (51% of the total (209 larvae; 48 nymphs)), with an additional 42% of the total collected in Washington county. The highest average number of *I. scapularis* per mammal was calculated for the first time from Anoka county; a season mean of 1.066 compared with Washington county's season mean of .757 overall. We detected *I. scapularis* for the first time in Hennepin and Scott counties (one county park each), but *I. scapularis* has been previously detected from each county outside of the scope of this study. Townships maintaining the highest 1990-1998 *I. scapularis* per mammal averages (all > .500) continue to include New Scandia, May, Hugo, (all Washington county), Linwood, and East Bethel (both Anoka county) townships. While the number of sites where *I. scapularis* is detected every year continues to decrease, we continue to detect *I. scapularis* at several new sampling locations each year. This is one reason we are at present uncommitted to a single interpretation of the detection of *I. scapularis* in Hennepin and Scott counties. We found it interesting that both sites are located within county park systems; areas that contain larger wooded areas and that theoretically could more easily support *I. scapularis* populations than may occur elsewhere in these counties. We feel that we need to collect more data in upcoming years to make a clearer judgment of our 1998 results. We feel that minimumly these results support our public education policy of informing the public to take precautions whenever they have been exposed to *I. scapularis* habitat and not to base taking prevention measures solely on areas where this study has found *I. scapularis* to be present or absent. We compiled our data to detect any extreme changes in our *I. scapularis* or small mammal collection results. In particular, 1998 *I. scapularis* collections appear similar to 1994 results while *P. leucopus* consistently has been the predominant mammal species collected each year. These data are not significantly higher than those found in past years. The average number of 12.46 small mammals collected per site in 1998 compared with the overall compiled average of 14.51 (13.76 if using only the 100 repeat sites) leads us to conclude that the small mammal population has apparently rebounded back to normal levels from a several year low. However, since small mammal populations tend to naturally fluctuate, we are unsure what impact, if any, the warm El Niño weather conditions may have had on survivability. In any case, unlike some predictions made for the summer of 1998 in other areas, we do not believe that we detected any significant impact of the El Niño weather conditions on either the small mammal or ultimately *I. scapularis* populations in our 1998 study.

Introduction

In 1990 the Metropolitan Mosquito Contol District initiated a Lyme Disease Tick Surveillance Program to determine the distribution and prevalence of *Ixodes scapularis* and *Borrelia burgdorferi* within the Minneapolis- Saint Paul metropolitan area. District re-structuring in 1996 integrated the former tick surveillance program activities into the District's overall field processes. Small mammal trapping has been the primary sampling method used, with examination of road-killed mammals and dragging flannel cloth along vegetation both used in the past as secondary collection methods.

A total of 545 sites were sampled from 1990 through 1992, including 100 sites that had been selected for repetitive sampling prior to the 1991 or 1992 field season. Baseline *I. scapularis* distribution data for our area was determined from the 1990 and 1991 studies with most of the ticks collected north of the Mississippi River in Anoka, Washington, and northern Ramsey counties. The 1992 study was

designed to inspect areas that had not been sampled as intensely in the past, with emphasis on locations south and west of the Mississippi River, but the majority of *I. scapularis* continued to be collected in the northeastern counties.

Since 1993, our distribution study has focused on the re-sampling of 100 sites to detect any potential changes in *I. scapularis* distribution over time. Seventy-five of these sites were re-sampled beginning in 1991 and were selected from the previous study based on three criteria: representative habitat of an area, locations that were unlikely to be developed, and areas where small mammal collections had been sufficient in the past. An additional twenty-five sites were selected from Dakota, Hennepin, Scott, and Carver counties in 1992 to increase our data collections south of the Mississippi River. We plan to monitor these sites indefinitely and will intensify our sampling effort in areas that have shown potential *I. scapularis* range expansion.

Two additional sites were sampled from 1995-1997; section 7 of New Market township in Scott county (where a single adult *I. scapularis* tick had been collected in 1995) and section 19 of West Saint Paul township in Dakota county (Dodge Nature Center-- to foster improved relations through providing a general risk assessment). Sampling at these two locations was discontinued in 1998 since zero *I. scapularis* had been collected in either location during this three year period.

Materials and Methods

Of the 100 repeat sites, 56 are located north of the Mississippi River in Anoka (28 sites), Washington (25 sites), and Ramsey (3 sites) counties. The 44 repeat sites located south of the Mississippi River are distributed throughout the counties of Dakota (15 sites), Hennepin (14 sites), Scott (8 sites), and Carver (7 sites).

Sampling was initiated on April 29, 1998 and ended on October 31, 1998 with small mammal trapping used as the primary sampling method. As in past years, the twenty-seven week study was divided into three nine-week sampling periods, and all sites were sampled for twenty-one trap nights (7 traps x 3 consecutive nights) per period. Weeks of site visitation were randomly selected within each sampling period.

One three-hundred foot transect was established at each sampling location, and Sherman live traps (H. B. Sherman Traps, Inc., Tallahassee, Fla.), baited with peanut butter and oats, were placed along these transects at fifty foot intervals. We euthanized all small mammals caught in the traps, removed any ticks found, and stored the ticks in alcohol for later identification.

Results

1998 Study (Repeat Sites):

We found at least one *I. scapularis* at 39 of 100 sampling sites, with 35 of these positive sites located north of the Mississippi River in Anoka (20 sites positive/28 sites sampled), Washington (14 sites positive/25 sites sampled) and Ramsey (1 site positive/3 sites sampled) counties. Four positive sites were detected south of the river, with *I. scapularis* collected for the first time using distribution study methodology at one location each in Hennepin and Scott counties. The remaining two positive sites were located in Dakota county.

Overall, 1246 mammals (Figure 1) were inspected: 562 from north of the Mississippi River and 684 from south of the river, and a total of 506 *I. scapularis* (Figure 2) were collected from them. The Anoka county sampling locations accounted for 51% (209 larvae; 48 nymphs) of the total with the greatest number of *I. scapularis* obtained from Andover (66 larvae; 5 nymphs), Linwood (30 larvae; 31 nymphs), and Ham Lake (39 larvae; 6 nymphs) townships. Collections from Washington county accounted for an additional 42% (215/506) of the total (202 larvae; 13 nymphs), with May (123 larvae; 4 nymphs) township collections the highest, followed by Oakdale/Lake Elmo (36 larvae; 2 nymphs)

and New Scandia (21 larvae; 4 nymphs) townships. Another 6% (22 larvae; 6 nymphs) were collected from Dakota county, with collections occurring for the first time in one site each in Hennepin (1 larva) and Scott (3 larvae) counties.

The overall season mean number of *I. scapularis* collected per mammal in 1998 was .406 (larvae: .352, nymphs: .054). The mean increases to 1.150 (larvae: .998, nymphs: .152) when all sites that were negative for *I. scapularis* are excluded (see 1998 results in Figure 6). The highest average number of *I. scapularis* per mammal was calculated for Anoka county, which had a season mean of 1.066, compared with Washington county's season mean of .757 overall (see 1998 results in Figure 3).

Compiled 1990-1998 Results (Repeat Sites):
The 1990-1998 season mean number of *I. scapularis* collected per mammal was .228, with the highest averages continuing to occur north of the Mississippi River. The yearly season mean for Anoka county as a whole were the highest for the first time in 1998 and were followed by Washington county. Averages for Ramsey county have been consistently low, yet greater overall than those occurring south of the river (Figure 3). The 1990-1998 township averages for Hugo, New Scandia, and May townships of Washington county were > 1.0 *I. scapularis* per mammal, while the averages for East Bethel, Linwood (both Anoka county) and Grant (Washington county) townships were > .500 *I. scapularis* per mammal (Figure 4).

I. scapularis status at the 100 repeat sampling locations is shown on Figure 5.
I. scapularis status has changed at 58 of the sites since 1990 or 1991. In particular, we determined that:

- *I. scapularis* was found all years (+) at 5 sites
- *I. scapularis* was found most years at 27 sites
- *I. scapularis* was found least (but + at least 1 year) at 31 sites
- *I. scapularis* was not found any year (-) at 37 sites

While the number of sites where *I. scapularis* is detected every year continues to decrease, we continue to detect *I. scapularis* at several new sampling locations each year (Table 1).

Table 1: Comparison of *I. scapularis* presence/absence status at 100 Repeat Sampling Locations: 1992 - 1998

	1992	1993	1994	1995	1996	1997*	1998
No. sites changing status	26	34	38	40	47	53	58
ticks found:							
all years	21	19	17	16	11	6	5
most years	5	15	15	15	19	27	27
least	21	19	23	25	28	26	31
(not found)	53	47	45	44	42	41	37

*1997 numbers have been corrected

We collected the highest percentages to date of both *Peromyscus leucopus* (Table 2) and *I. scapularis* (Table 3) in 1998, but these data are not significantly higher than those found in past years. In particular, 1998 *I. scapularis* collections appear similar to 1994 results (Table 3 & Figure 6) while *P. leucopus* consistently has been the predominant mammal species collected each year with some variability in the total percentages collected[1]. The average number of mammals collected per site in 1998 of 12.46 appears to have approached our normal collection levels. Our compiled average small mammal collection success level per site for 1990 through 1998 is 14.51 (1991-1998 average of 13.76 ($p < .0001$) for 100 repeat sites only), with results ranging from the low of 7.28 mammals collected per site in 1997 to the high in 1991 (average of 20.61 small mammals collected per site).

[1]See the discussion sections in the 1993 (*I. scapularis* population estimates) and 1994 (mammal density equality across sites *I. scapularis* distribution study reports.

Discussion

Our results seem to indicate that *I. scapularis* populations are established within northeastern Anoka and northern Washington counties while remaining localized or nonexistent in areas south of the Mississippi River. Although our study was not designed to specifically answer the question of tick establishment, we feel that our relative *I. scapularis* density estimates are accurate enough for a general risk assessment. Given the consistency of our results over the years, where greater numbers of *I. scapularis* continue to be collected in the northeastern metropolitan area each season, we believe that the greatest Lyme disease risk continues to occur in the northeastern metropolitan area.

Although we detected *I. scapularis* for the first time in Hennepin and Scott counties (one county park each) using this study methodology, we are at present uncommitted to a single interpretation of these results. While we could have detected the beginnings of *I. scapularis* range expansion into new areas, we believe it is possible that we simply detected small, localized tick populations that either were previously undetected due to the insensitivity of our sampling methods, or perhaps occurred as a result of a temporary tick population level increase through assumed enhanced overwintering tick survivability due to the unusually warm winter of 1997-1998[2], despite the fact that our data does not appear to support this theory-there seems to have been no substantial increase in *I. scapularis* collected. We found it interesting that both the Hennepin and Scott county sites are located within county park systems; areas that contain larger wooded areas and theoretically may support more positive life cycle components (large and small mammal hosts as well as leaf litter and accompanying vegetative habitat) that could more easily support *I. scapularis* populations than may occur elsewhere in these counties. The possibility that we detected transient tick populations exists, also, although we feel it is probably a less likely scenario than detecting ticks from an area where a tick population already exists. In any case, we do know that our *I. scapularis* population level estimate for 1998 appears to be similar to 1994 and seems to be representative of an above average collection season. We also know that we have continued to detect *I. scapularis* at one or more new sampling locations each year, as well as that *I. scapularis* has been previously detected from each county outside of the scope of this study.[2] For these reasons, we feel that we need more data in upcoming years to make a clearer judgment of our 1998 results and to make a determination whether increased sampling should occur. We feel that regardless of the circumstances leading to the detection of *I. scapularis* from these areas, minimumly these results support our public education policy of informing the public to take precautions whenever they have been exposed to *I. scapularis* habitat and not to base taking prevention measures solely on areas where this study has found *I. scapularis* to be present or absent.

Since our detection of *I. scapularis* in both Hennepin and Scott counties could have been a result of the warm El Niño weather pattern in the winter of 1997-1998 causing increased overwintering survivability, as well as since much was written and verbally transmitted regarding this subject and the potential expansion of *I. scapularis* populations at the time[4], we compiled our data to detect any extreme changes in our *I. scapularis* or small mammal collection results. Although we collected the highest percentages to date of both *Peromyscus leucopus* and *I. scapularis* in 1998, these data are not significantly higher than those found in past years. The average number of 12.46 small mammals collected per site in 1998 compared with the overall compiled average of 14.51 leads us to conclude that the small mammal population has apparently rebounded back to normal levels from a several year low. However, since small mammal populations tend to naturally fluctuate (The Mammals of Minnesota. Hazard, 1982. p. 87.) we are unsure what impact, if any, the

[2]global area-averaged mean temperature for January-April 1998 was the warmest on record according to the National Climatic Data Center (El Niño webpage www.ncdc.noaa.gov). Increased rainfall in portions of the United States was also associated with this weather pattern.

[3]*I. scapularis* has been collected in Hennepin county (immatures) in a collaborative study with Dr. R. Johnson of the University of Minnesota and in Scott county (adult) by District staff who were performing pest mosquito activities and inadvertently collected the tick.

[4] The Centers for Disease Control predicted for 1998 that although there was no guarantee that weather conditions and the rodent population density would follow the 1991-1992 El Niño pattern, that if unusually warm and wet conditions were to continue, the rodent population densities in their monitored areas of the southwestern US could continue to increase (CDC El Niño webpage--www.cdc.gov/ncidod/diseases/hanta/hps/noframes/elnino). It was speculated at least in the media (newspapers and radio) that the warm weather pattern could have positively influenced overwintering tick survivability, also, leading to increased numbers of *I. scapularis* in 1998.

warm El Niño weather pattern may have had on small mammal overwintering survivability. In any case, unlike some predictions made for the summer of 1998 in other areas, we do not believe that we detected any significant impact of the El Niño weather conditions on either the small mammal or ultimately *I. scapularis* populations in our 1998 study.

Metropolitan Mosquito Control District- additional updates:

A. *Ixodes scapularis* Distribution study:

Our multi-year distribution study will continue (sites unchanged from 1993).

B. Collaborative *Ehrlichia* Studies:

A collaborative effort with Dr. Russell Johnson, University of Minnesota, Minneapolis campus.

Ehrlichiosis is a newly discovered bacterial disease caused by several species of *Ehrlichia*, with various regional tick vectors suspected in the United States, including *I. scapularis*, the tick vector of Lyme disease in Minnesota. Cases of human ehrlichiosis have occurred in Minnesota residents and *I. scapularis* populations are established within portions of the metropolitan area. Human granulocytic ehrlichiosis (HGE) agent DNA was found in rodent blood samples drawn from small mammals collected for our distribution study in a 1995 collaboration with Dr. Barb Greig DVM, formerly of the University of Minnesota, Saint Paul campus. Results of *Ehrlichia* testing by Dr. Russell Johnson of the U of MN, Mpls. campus, were negative for mammals collected in 1996 during our cooperative Lyme disease studies in North Oaks. Therefore, the District was interested in further collaborative effort to aid us in assessing the potential of ehrlichiosis risk for metropolitan area residents.

- **1997-1998 Blood sample analysis of distribution study-collected *Peromyscus leucopus*:**

In 1997 and 1998, *Peromyscus leucopus* collected for our *I. scapularis* distribution study were used to obtain blood samples that were analyzed for the presence/absence of antibodies to *Ehrlichia* species. District staff performed the majority of the blood sample collections while the University performed the laboratory analysis. 1997 results yielded eleven samples that reacted positively to immunofluorescent antibody (IFA) testing and two more borderline positive samples. **1998 results:** Confirmation testing on the 1998 results are still in progress.
1999 plans: This work was discontinued in 1999*.

- **Intensive sampling at three Washington county locations (2 May twp; 1 Hugo twp):**

Intensive sampling occurred at three locations in Washington county from April - October 1998 to determine the infection rate status of the small mammal population to *Ehrlichia* species. Testing for *Borrelia burgdorferi* exposure was an added component into the study. Site selection was based on past research results (two positive *P. leucopus* samples had been detected in 1997 at each of two sites, one in May and one in Hugo townships; one additional May township site was selected based on past research efforts in the area by University staff). **1998 results:** Final results are still in progress, but preliminary results indicated an overall low *Ehrlichia* infection rate*. The infection rate status for *Borrelia burgdorferi* is enclosed on a primitive map.

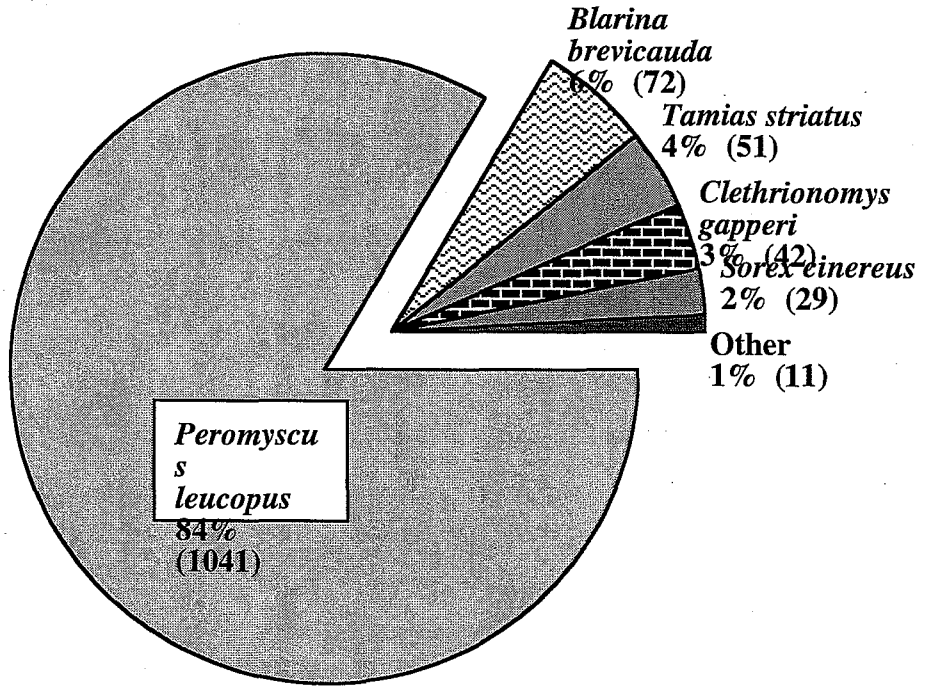
***Additional note:** A recent article (*Disparity in the Natural Cycles of Borrelia burgdorferi and the Agent of Human Granulocytic Ehrlichiosis*. Michael L. Levin, Franka des Vignes, and Durland Fish. Emerging Infectious Diseases (vol. 5, no. 2), March-April, 1999.) suggests that *P. leucopus* may not be as an effective amplifying reservoir for the HGE agent as they are for *B. burgdorferi*. **1999 plans:** Both District and University staff felt that *Tamias striatus* would be the next most likely culprit, and the use of larger (3x3x10inch) Sherman traps was encorporated into the 1999 study design in an attempt to increase chipmunk collections. This intensive sampling study is taking place from July 14 through August 18, 1999, with the same three sampling locations (2 in May; 1 in Hugo township) utilized.

C. 1999 update- a potential collaborative study in Crow Wing county beginning in 2000:

Plans are underway to form a cooperative relationship with staff at Camp Ripley (Brainerd area) to understand more about the epidemiology of tick-borne diseases in a higher risk area. The District's ultimate goal would be to create a risk model that could then be extrapolated down for use in the metropolitan area. No specifics of any projects to be undertaken are available at this time. Dr. Johnson of the University of Minnesota and Dave Neitzel of the Minnesota Department of Health are also interested in studies in this area.

Small Mammals Collected
1998: 1246 total

Figure 1



Ticks, by Species and Stage, Removed from Small Mammals 1998: 1389 total

Figure 2

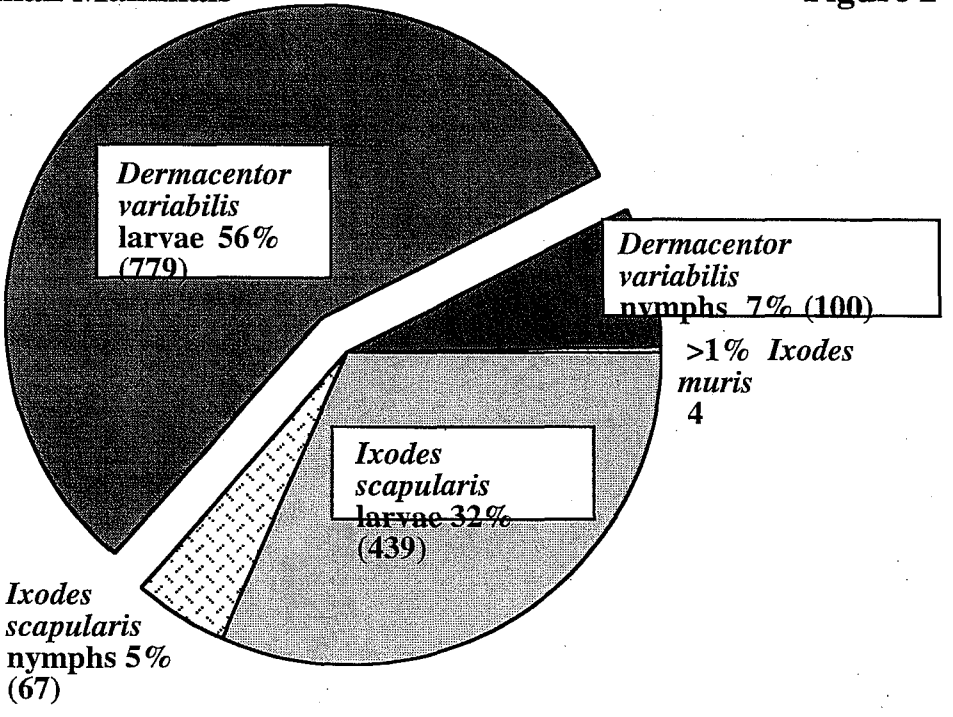
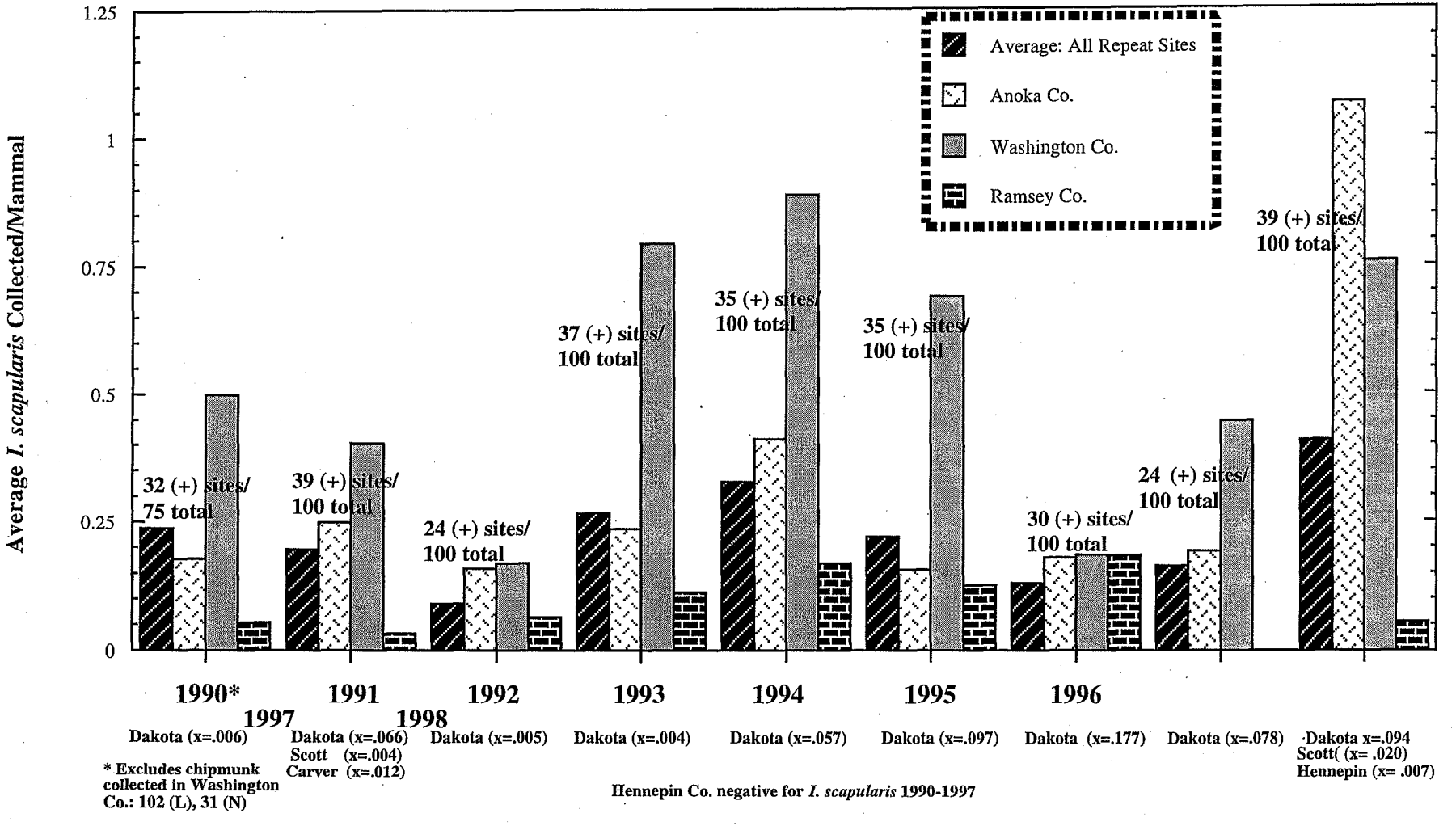
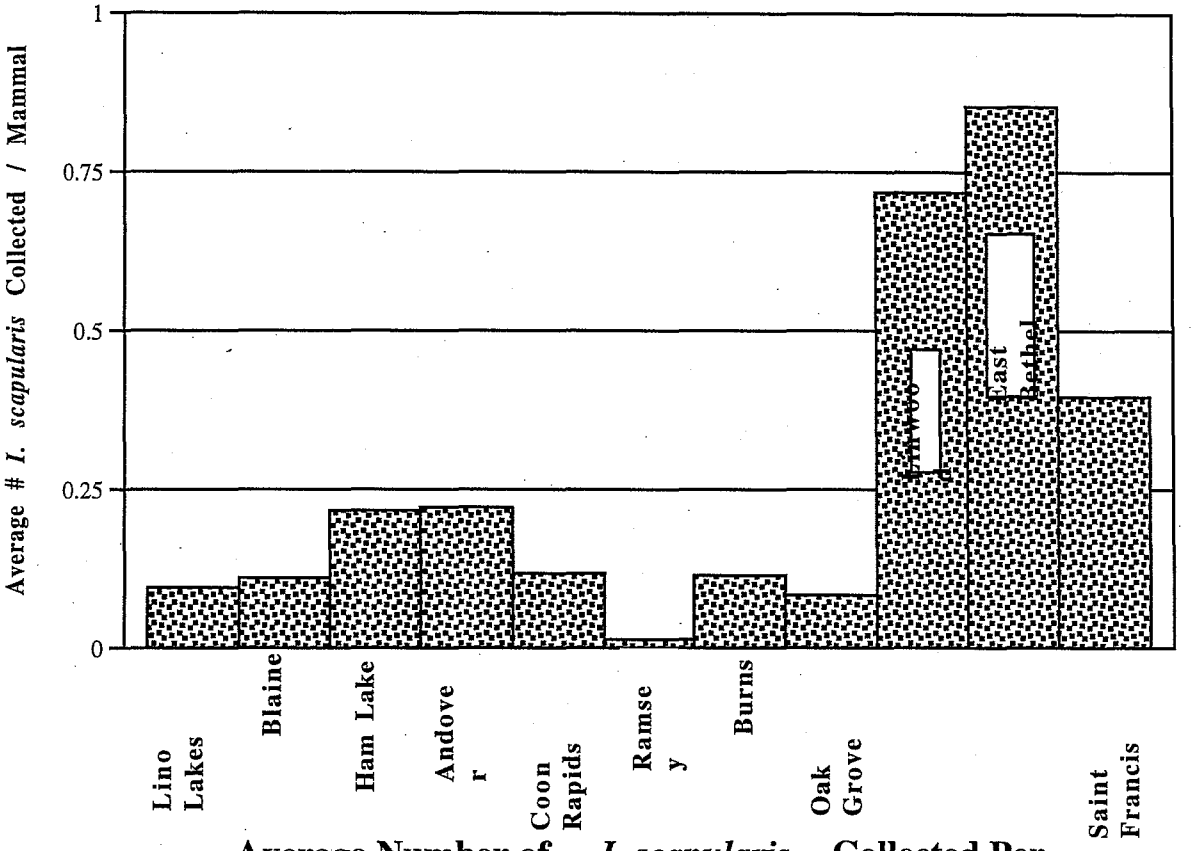


Figure 3

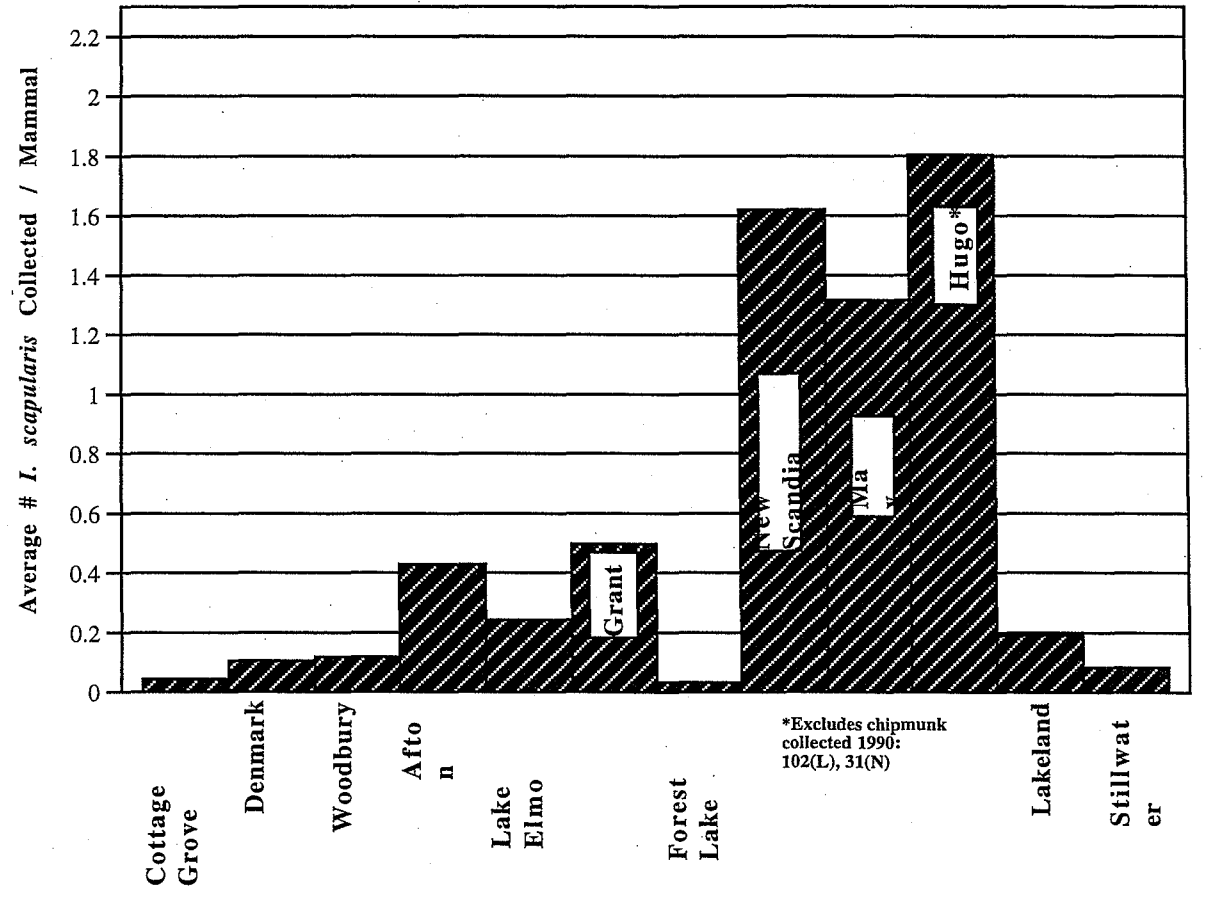
Average Number of *I. scapularis* Collected Per Mammal in Anoka, Washington, and Ramsey Counties: 1990-1998



Average Number of *I. scapularis* Collected Per Mammal in Anoka County (by Twp): 1990-1998 **Figure 4**



Average Number of *I. scapularis* Collected Per Mammal in Washington County (by Twp): 1990-1998



No Figure 5 available

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Figure 6

Average Number of *Ixodes scapularis* Collected Per Mammal in 100 Repeat Sampling Locations-overall vs. sites where at least one *I. scapularis* was collected in a season (positive sites): 1990-1998

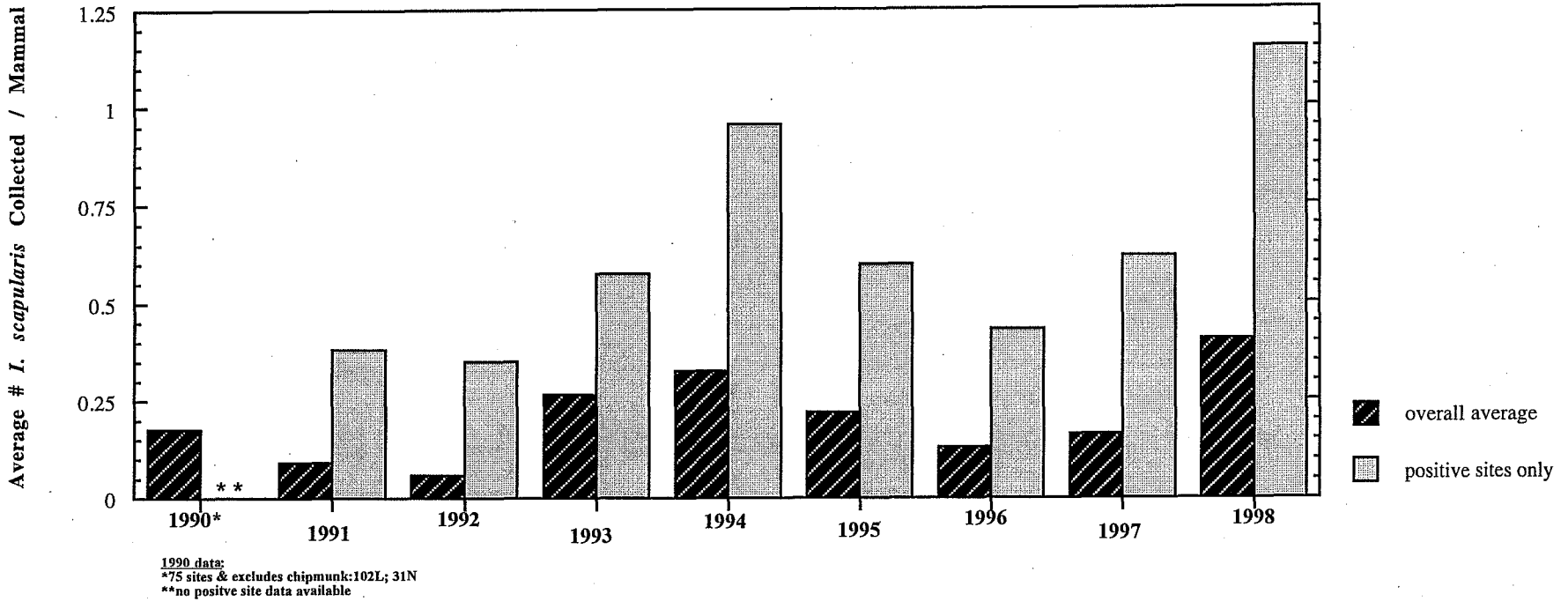

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Table 2. Numbers and Percentages of Small Mammals Collected by Year

Year	No. sites	Total mammals collected	Ave collected per site and [at 100 repeat sites only]	*Peromyscus leucopus* percent (n)	*Tamias striatus* percent (n)	*Clethrionomys gapperi* percent (n)	*Blarina brevicauda* percent (n)	Other* percent (n)
[1] 1990	250	3651	14.6 [17.15 (75 sites)]	80% (2921)	6% (224)	7% (240)	4% (155)	3% (111)
1991	270	5566	20.61 [23.54]	77% (4308)	7% (395)	5% (264)	7% (402)	4% (197)
1992	200	2544	12.72 [12.68]	71% (1804)	9% (223)	4% (103)	13% (329)	3% (85)
1993	100	1543	15.43 [15.43]	81% (1243)	4% (69)	7% (101)	7% (107)	1% (23)
1994	100	1672	16.72 [16.72]	78% (1309)	10% (171)	5% (79)	5% (76)	2% (37)
1995	100	1406	14.06 [14.06]	79% (1115)	11% (156)	4% (55)	4% (61)	1% (19)
1996	100	791	7.91 [7.91]	79% (628)	11% (84)	3.5% (29)	3.5% (28)	3% (22)
1997	100	728	7.28 [7.28]	71% (515)	13% (98)	3% (24)	10% (71)	3% (20)
1998	100	1246	12.46 [12.46]	84% (1041)	4% (51)	3% (42)	6% (72)	3% (40)

*Other includes *Microtus pennsylvanicus, Spermophilus tridecemlineatus, Zapus hudsonius, Mustela erminea, Tamiasciurus hudsonicus, Glaucomys volans, Sorex articus,* and several ground-feeding bird species.

Table 3. Numbers and Percentages of Tick Species Collected by Stage and Year

Year	No. sites	Total ticks collected	*Dermacentor variabilis* L* percent (n)	*Dermacentor variabilis* N** percent (n)	*Ixodes scapularis* L* percent (n)	*Ixodes scapularis* N** percent (n)	Other species*** percent (n)
[1] 1990	250	9957	83% (8289)	10% (994)	6% (573)	1% (74)	0% (27)
1991	270	8452	81% (6807)	13% (1094)	5% (441)	1% (73)	0% (37)
1992	200	4130	79% (3259)	17% (703)	3% (114)	1% (34)	0% (20)
1993	100	1785	64% (1136)	12% (221)	22% (388)	1% (21)	1% (19)
1994	100	1514	53% (797)	11% (163)	31% (476)	4% (67)	1% (11)
1995	100	1196	54% (650)	19% (232)	22% (258)	4% (48)	0% (8)
1996	100	724	64% (466)	20% (146)	11% (82)	3% (20)	1% (10)
1997	100	693	73% (506)	10% (66)	14% (96)	3% (22)	1% (3)
1998	100	1389	56% (779)	7% (100)	32% (439)	5% (67)	1% (4)

*L = larvae

**N = nymphs

***Other species mostly *Ixodes muris*

[1] 1990 data exludes one *Tamias striatus* with 102 larval & 31 nymphal *I. scapularis*