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Metropolitan Mosquito Control District

Ixodes scapularis Distribution Study Report

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IXODES SCAPULARIS DISTRIBUTION STUDY
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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 100 wooded areas that have all been sampled since 1990 or 1991. At least one *I. scapularis* was collected from 56 of these sites during 2002; the highest tabulated site total since 1990 but comparable to 2000's 55 positive sites. South of the Mississippi River our positive site number increased up to 12 from 10 in 2001 (in a typical season we detect 3 to 4 positive sites). A total of 1099 *I. scapularis* were removed from 1236 mammals for an overall season mean of .889 *I. scapularis* per mammal; the highest mean compiled to date but comparable with the 2000 (.806) and 2001 (.826) averages. The Anoka County sites accounted for 66% of the total *I. scapularis* collections (607 larvae; 113 nymphs), with 331 larvae and 65 of the nymphs collected at just one Coon Rapids township site. We collected an additional 30% of the total (227 larvae; 57 nymphs) from our Washington County sites. The highest average number of *I. scapularis* per mammal (2.215) was calculated for Anoka County, compared with Washington County's season mean of 1.445. Ramsey County maintained a season mean >1.0 *I. scapularis* per mammal (1.083) for the first time in 2002. Townships maintaining the highest (all $\geq$ 1.0) *I. scapularis* per mammal averages were Coon Rapids (6.348), Ham Lake (3.824), Blaine (2.846), East Bethel (1.850) and Oak Grove (1.278) of Anoka County, and May (3.840), Afton (2.207), Lakeland (1.0), and Hugo (1.0) of Washington County, with Andover (.804), Saint Francis (.714), Linwood (.607), and Ramsey (.583) of Anoka County, and Grant (.647), Cottage Grove (.645), and Forest Lake (.500) townships of Washington County averaging $\geq$ .500 *I. scapularis* per mammal. Our 1990-2002 *I. scapularis* per mammal township averages (all > 1.0) include Hugo (1.557), New Scandia (1.516) and May (1.489) of Washington County, and East Bethel (1.145), Coon Rapids (1.128), and Blaine (1.023) of Anoka County. *P. leucopus* consistently has been the predominant yearly mammal species collected, with yearly variability in the total percentages collected. No major shifts in the diversity of our small mammal or immature tick collections seems to have occurred, although we collected a lower percentage of *Dermacentor variabilis* (49%) than *I. scapularis* (50%) for the first time, and our total *I. scapularis* nymph count was in the hundreds (177) for only the second time. The 2002 average number of mammals collected per site (12.36) appears to represent an average yearly small mammal collection level. Examining human tick-borne disease case numbers, the Minnesota Department of Health has tabulated higher than typical numbers since 2000. Their 2002 human case totals (Lyme 867 and ehrlichiosis 152) are the highest recorded tabulations in their databases and represent an 84% increase over the previous high levels of 2001. We did not detect a similar upward spike in our *I. scapularis* collections in 2002. Based on our results over the years, *I scapularis* populations seem to have maintained the same basic elevated levels since 2000.

Introduction

In 1990 the Metropolitan Mosquito Control 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* collections continued to be obtained 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 in that 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 22, 2002 and ended on October 24, 2002 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

➢ 2002 Study (Repeat Sites):

We found at least one *I. scapularis* at 56 of 100 sampling sites, with 44 of these positive sites located north of the Mississippi River in Anoka (22 sites positive/28 sites sampled), Washington (21 sites positive/25 sites sampled), and Ramsey (1 site positive/3 sites sampled) counties. Twelve additional positive sites were detected south of the river; eight were located in Dakota County, three in Hennepin County, and one in Scott County. Zero *I. scapularis* were collected in Carver County.

Overall, 1236 mammals (Figure 1 and 2002 results in Table 2) were inspected: 576 from north of the Mississippi River and 660 from south of the river, and a total of 1099 *I. scapularis* (Figure 2 and 2002 results in Table 3) were collected from them. The Anoka County sampling locations accounted for 66% (607 larvae; 113 nymphs) of the total, with 331 larvae and 65 nymphs collected from just one Coon Rapids township site. Washington County collections accounted for an additional 30% (227 larvae; 57 nymphs) of the total, with the majority of collections occurring in May (172 larvae; 20 nymphs) and Afton (45 larvae; 19 nymphs) townships.

The overall season mean number of *I. scapularis* collected per mammal in 2002 was .889 (larvae: .746, nymphs: .143). The mean increases to 1.556 (larvae: 1.305, nymphs: .251) when all sites negative for *I. scapularis* are excluded (see 2002 results in Figure 6). The highest average number of *I. scapularis* per mammal was calculated for Anoka County, which had a season mean of 2.215 compared with Washington (1.445) and Ramsey (1.083) counties season means (see 2002 results in Figure 3). Townships in Anoka County averaging ≥ 1.0 *I. scapularis* per mammal in 2002 were Coon Rapids (6.348), Ham Lake (3.824), Blaine (2.846), East Bethel (1.850), and Oak Grove (1.278) with Andover (.804), Saint Francis (.714), Linwood (.607), and Ramsey (.583) all averaging $\geq .500$ *I. scapularis* per mammal. In Washington County, townships averaging ≥ 1.0 *I. scapularis* per mammal in 2002 were May (3.840), Afton (2.207), Lakeland (1.0), and Hugo (1.0), while Grant (.647), Cottage Grove (.645), and Forest Lake (.500) all averaged $\geq .500$ *I. scapularis* per mammal (Figure 4).

➢ **Compiled 1990-2002 Results (Repeat Sites):**

The 1990-2002 mean number of *I. scapularis* collected per mammal is .361, with the highest averages continuing to occur north of the Mississippi River. The yearly season mean for Anoka County was the highest of any county for the fifth consecutive year, and was followed by Washington County. The Ramsey County average was > 1.0 *I. scapularis* per mammal for the first time in 2002 (Figure 3). The 1990-2002 township averages for Hugo, New Scandia, May (Washington County), East Bethel, Coon Rapids and Blaine (Anoka County) townships were > 1.0 *I. scapularis* per mammal, while the averages for Linwood, Ham Lake, and Saint Francis of Anoka County, as well as Afton, Grant, and Lakeland townships of Washington County were > .500 *I. scapularis* per mammal (Figures 4A and B—inserts on Figure 4).

I. scapularis status at the 100 repeat sampling locations is shown on Figure 5. The status has changed at 69 of the sites since 1990 or 1991 (see 2002 results in Table 1). While the number of sites where *I. scapularis* is detected every year has seemed to stabilize, 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 - 2002

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
No. sites changing status	26	34	38	40	47	53	58	59	61	66	69
Ticks found:											
all years	21	19	17	16	11	6	5	5	5	5	4
most years	5	15	15	15	19	27	27	31	31	34	35
least	21	19	23	25	28	26	31	28	30	32	34
(not found)	53	47	45	44	42	41	37	36	34	29	27

Our positive sites have been primarily located north of the Mississippi River, where all but one site are located within Anoka and Washington counties. In comparison, south of the river we typically tabulate 3-4 positive sites each season. Except for 1991 when several *I. scapularis* were also collected at one site each in Scott and Carver counties, positive sites from south of the river were located only in Dakota County from 1990 through 1997. In 1998 we detected *I. scapularis* in Hennepin and Scott counties[1]. In 2000 we tabulated a total of seven sites (6 Dakota; 1 Hennepin) south of the river. Our tabulation for 2001 increased to ten (7 Dakota; 2 Hennepin; 1 Scott) with an increase up to 12 in 2002 (8 Dakota; 3 Hennepin; 1 Scott).

Comparing our 2002 small mammal and immature *I. scapularis* collection results with past study efforts, both small mammal (Table 2) and immature tick (Table 3) species diversity appears comparable to past years, although we collected a lower percentage of *Dermacentor variabilis* (49%) than *I. scapularis* (50%) for the first time. Our overall season mean of .889 is comparable to the previous highest yearly mean of .826 *I. scapularis* per mammal which was calculated for 2001 (Figure 3). *P. leucopus* consistently has been the predominant mammal species collected each year with some variability in the total percentages collected[2]. The 2002 average number of mammals collected per site (12.36) appears to represent an average yearly collection level. Our compiled average small mammal collection success level per site for 1990 through 2001 is 13.53 (1991-2001 average of 13.29 for 100 repeat sites only), with results ranging from the low of 7.28 mammals collected per site in 1997 to the high of 20.61 (23.54 at the 100 repeat sites only) in 1991.

[1] *I. scapularis* was collected previously in Hennepin County in a collaborative study with Dr. R. Johnson of the University of Minnesota and in very small numbers in Scott and Carver counties (one site each) in our 1991 study effort. In 1995 District staff performing pest mosquito activities inadvertently found a single adult tick in Scott County's New Market township, but no additional *I. scapularis* were detected in a 3 year sampling effort.

[2] 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, 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[3].

While we have never claimed that our study methodology enables us to detect every *I. scapularis* in any given location at any point in time, our collection data as a whole appears to provide evidence of an elevated local tick population in recent years[4]. Figure 3 seems to illustrate how our *I. scapularis* collections have been on the rise since 1998 and seemingly elevated since 2000 compared to our earlier studies. Our 2002 data compilations resulted in the highest total number of tabulated positive sites (56) and the highest overall season mean (.889) *I. scapularis* per mammal compiled since 1990, although both are comparable to their respective 2000 and 2001 totals. Examining Figure 3 also shows that Ramsey county maintained a season mean >1.0 *I. scapularis* per mammal (1.083) for the first time in 2002, which seems noteworthy despite the small number of sampling sites in the county. Also, we collected a higher percentage of *I. scapularis* (50%) than *Dermacentor variabilis* (49%) for the first time (see Table 3). Additionally, we found it interesting that we collected more *I. scapularis* (331 larvae; 65 nymphs) at just one Coon Rapids township site (brushy understory with a scattered oak canopy, located in a county park) than we did in all of our Washington County sites (227 larvae; 57 nymphs). South of the Mississippi River, where historically the majority of our sites have been negative for *I. scapularis*, we have tabulated an increase in our positive site totals since 2000 as well as a spread outward from Dakota County starting in 1998[5] (see Table 1 and Figure 5).

Examining human case totals provided by the Minnesota Department of Health, it appears that human tick-borne disease case totals have also been on the rise in recent years. The 2002 totals (Lyme 867 and ehrlichiosis 152) are the highest recorded tabulations in their databases and represent an 84% increase over 2001 (Lyme 461; ehrlichiosis 93). The 2000 (Lyme 465; ehrlichiosis 77) and 2001 totals had previously been the highest recorded case numbers in their databases. Additionally, several metro residents contracted ehrlichiosis in 2002 - one case each in Anoka and Washington counties[6].

Unlike the striking upward increase noted between the 2002 and previous human case totals, we did not detect a similar upward spike in our *I. scapularis* collections in 2002. Based on our results over the years, *I scapularis* populations seem to have maintained the same basic elevated levels since 2000.

[3]Yearly metro human exposure case totals vary from 1 case per year occurring sporadically in Scott and Carver counties to double-digit amounts (typically teens to twenties) for both Anoka and Washington counties (personal communication MN Dept Health).

[4]Concepts in this paragraph were presented in the discussion sections of the 1998 - 2001 *I. scapularis* distribution study reports.

[5]*I. scapularis* had been previously detected in Hennepin and Scott counties outside the scope of this study and the MDH has recorded human cases from all seven metropolitan area counties in the past.

[6]Typical state case totals had been in the range of 15 HGE cases per year, with no metro area exposures. Past Lyme totals had been in the range of 250.

ADDITIONAL UPDATES/RESEARCH:

CONTINUING STUDIES FOR 2003.

- ***Ixodes scapularis* distribution study** (sites unchanged from 1993).

Due to budget constraints and in anticipation of increased workload for mosquito vector activities, the District declined to participate in additional studies in 2003.

DISCONTINUATIONS FOR 2003.

- **Discontinued: Risk Assessment of the Expanding Distribution of Lyme Disease in the North – Central US:**

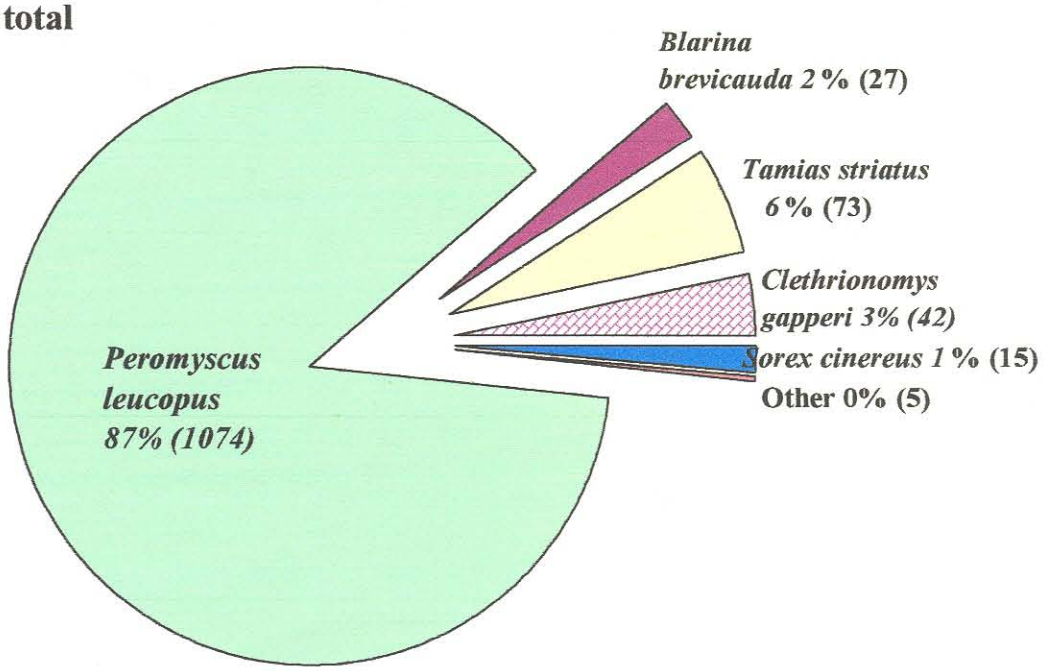
The goal of this effort is to expand the known risk model and maps developed for Illinois and Wisconsin to include the rest of the north-central U.S. and areas south as far as Tennessee using digitized data bases available from the USGS, GAP programs, etc. Known negative and positive sites from Michigan, Indiana, Minnesota, Ohio and Tennessee will be overlaid on the risk maps.

Co-investigators: Uriel Kitron, Ph.D. University of Illinois-Urbana Champaign
Edward D. Walker, Ph.D. Michigan State University
Mark L. Wilson, SC.D. University of Michigan-Ann Arbor

Questions on this project, as well as results of the sampling effort should be directed to Dr. M. Roberto Cortinas (cortinas@uiuc.edu) or any of the co-investigators.

Small Mammals Collected
2002: 1236 total

Figure 1



Ticks, by Species and Stage, Removed from Small Mammals
2002: 2185 total

Figure 2

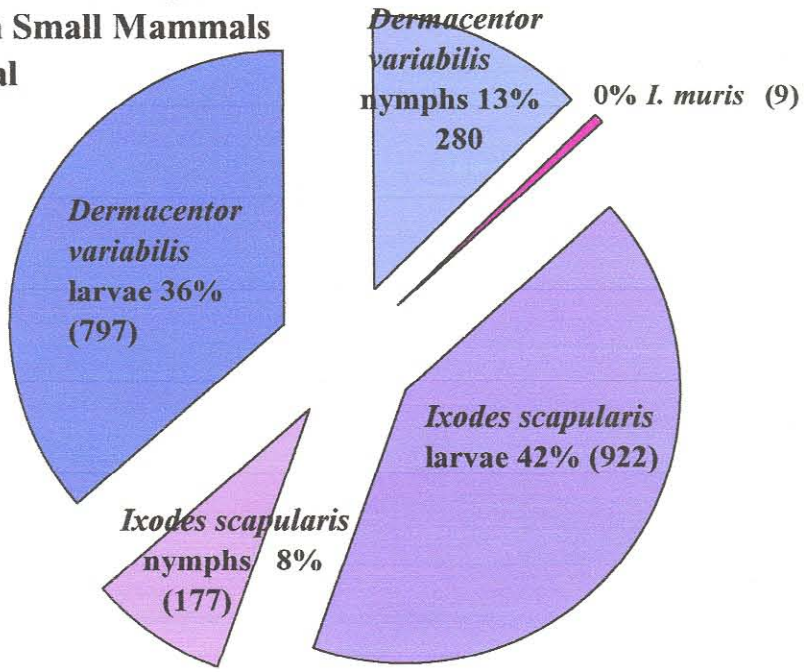
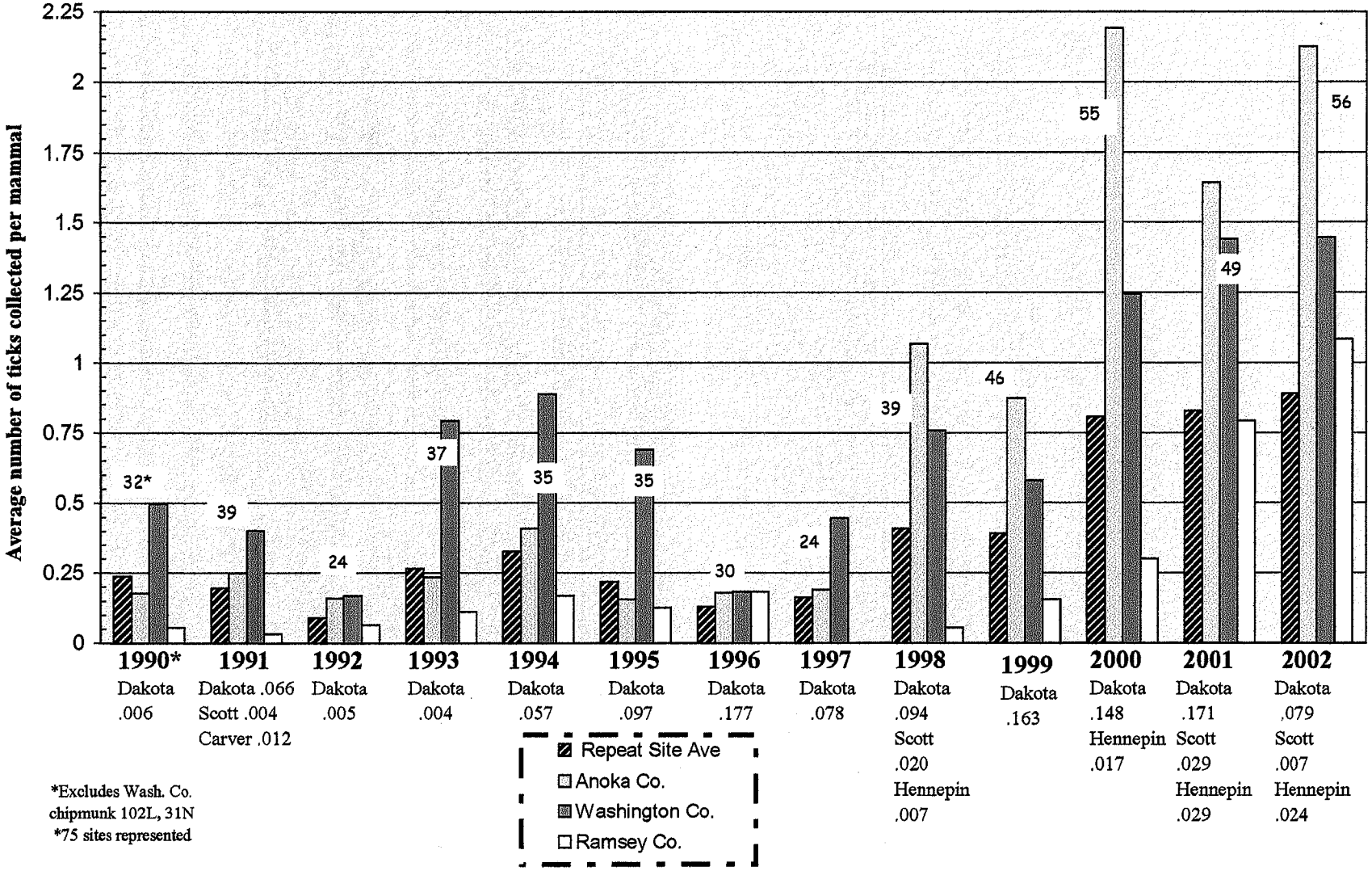


Figure 3

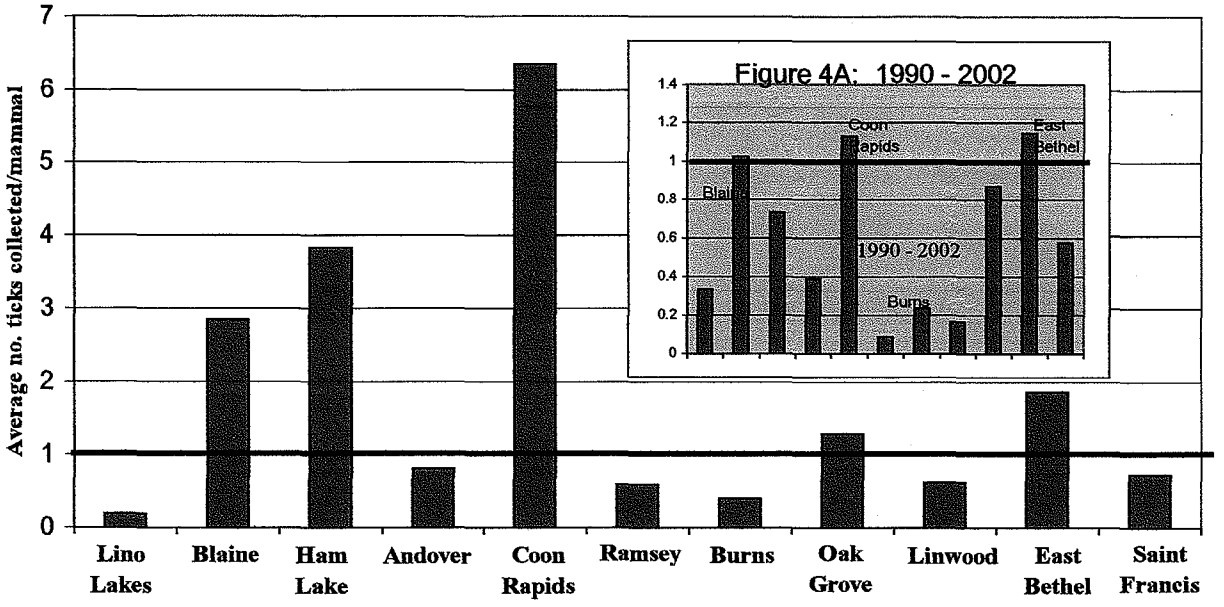
Average number of *I. scapularis* collected per mammal at 100* sampling locations in Anoka, Washington, and Ramsey counties: 1990 - 2002
(white box shows the total number of sites where at least one *I. scapularis* was found: by year)



*Excludes Wash. Co. chipmunk 102L, 31N
*75 sites represented

Figure 4

Average number of *I. scapularis* collected per mammal in Anoka county (by township): 2002 results



Average number of *I. scapularis* collected per mammal in Washington county (by township): 2002 results

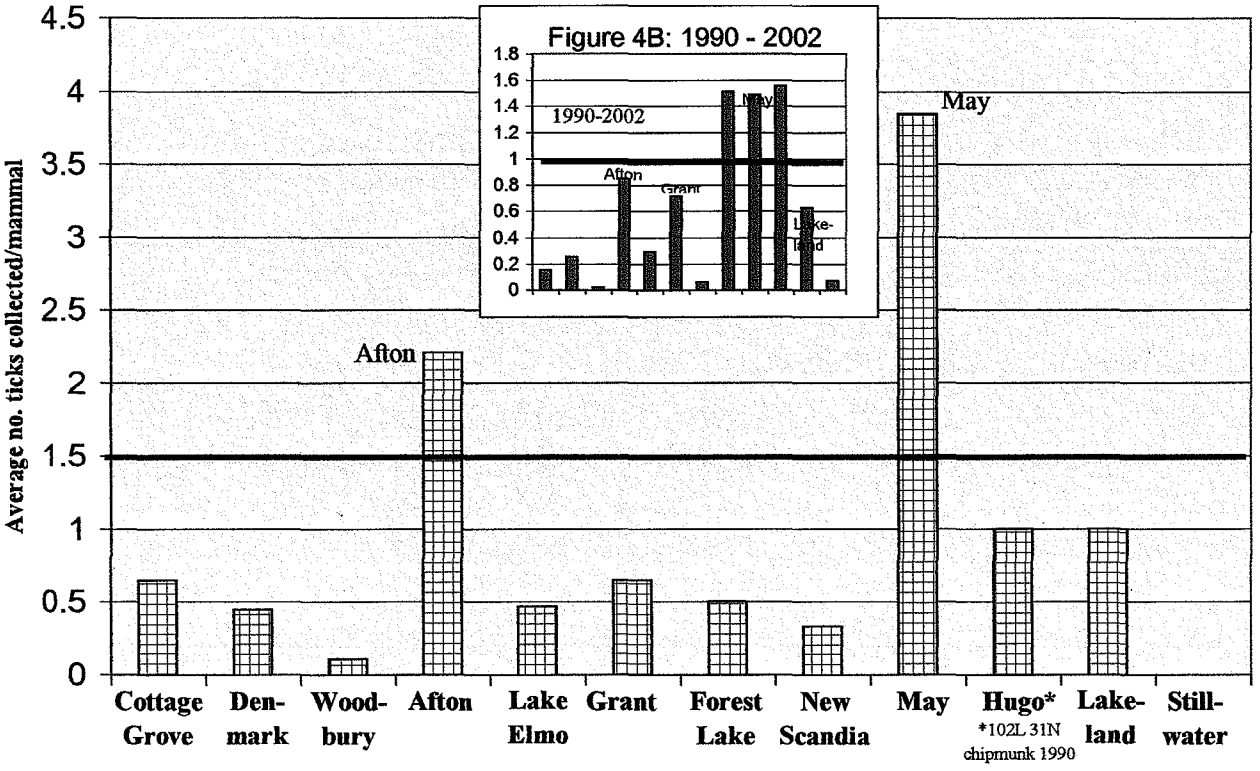
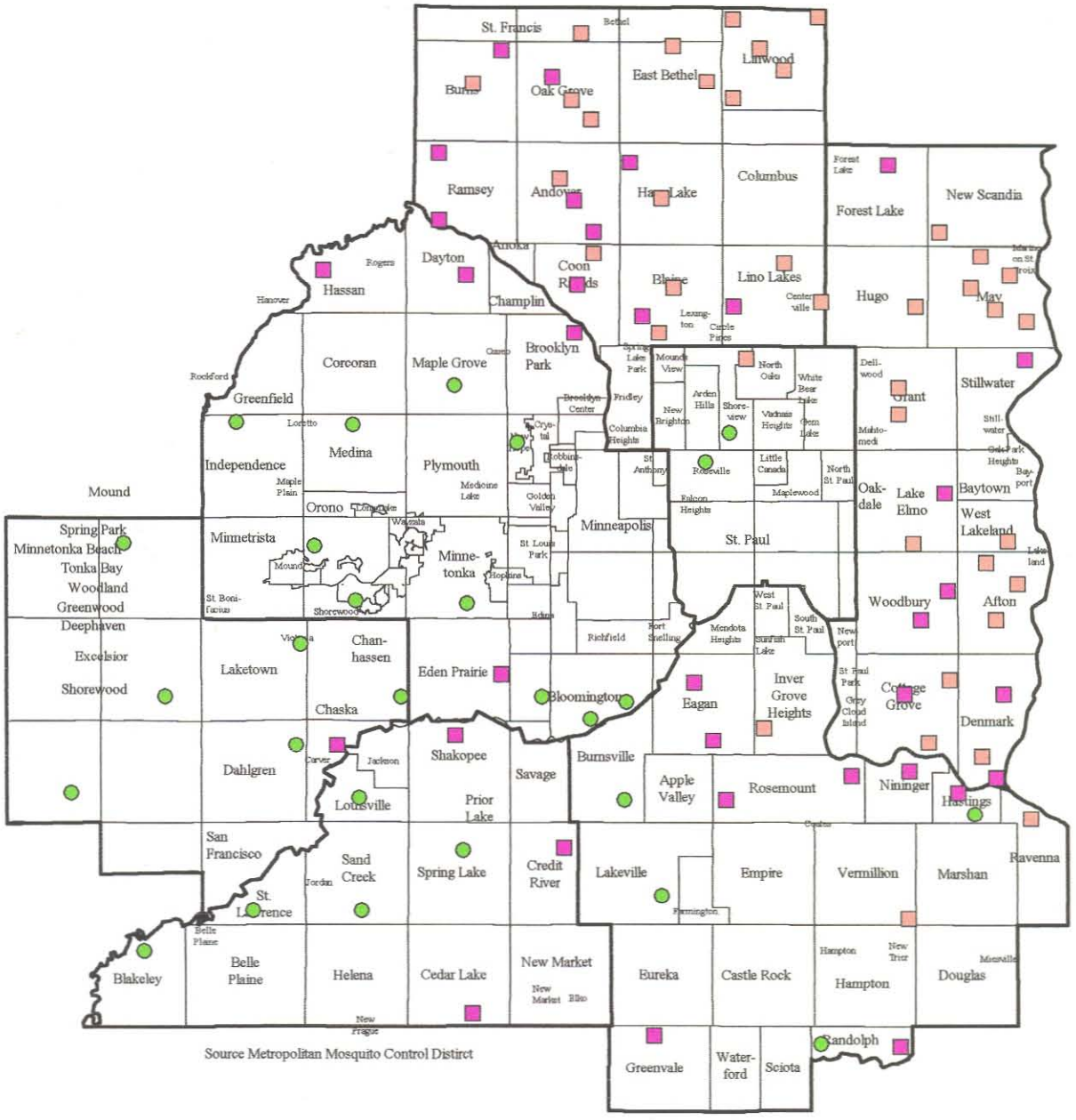


Figure 5

Ixodes scapularis Presence/Absence status: 1990 - 2002

(present if at least one I. scapularis is collected during a year)



At least one tick found during:

- all/most years (39)
- at least one year (34)
- (not found) (27)

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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 [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]	81% (1243)	4% (69)	7% (101)	7% (107)	1% (23)
1994	100	1672	[16.72]	78% (1309)	10% (171)	5% (79)	5% (76)	2% (37)
1995	100	1406	[14.06]	79% (1115)	11% (156)	4% (55)	4% (61)	1% (19)
1996	100	791	[7.91]	79% (628)	11% (84)	3.5% (29)	3.5% (28)	3% (22)
1997	100	728	[7.28]	71% (515)	13% (98)	3% (24)	10% (71)	3% (20)
1998	100	1246	[12.46]	84% (1041)	4% (51)	3% (42)	6% (72)	3% (40)
1999	100	1627	[16.27]	85% (1376)	7% (108)	3% (46)	4% (63)	1% (9)
2000	100	1173	[11.73]	83% (968)	7% (86)	5% (55)	2% (28)	3% (36)
2001	100	897	[8.97]	80% (719)	6% (58)	7% (63)	4% (39)	2% (18)
2002	100	1236	[12.36]	87% (1074)	6% (73)	3% (42)	2% (27)	2% (19)

*Other includes *Microtus pennsylvanicus, Spermophilus tridecemlineatus, Zapus hudsonius, Mustela erminea, Tamiasciurus hudsonicus, Glaucomys volans, Sorex articus, Sorex cinereus*, 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[2] percent (n)	*Dermacentor variabilis* N[3] percent (n)	*Ixodes scapularis* L[2] percent (n)	*Ixodes scapularis* N[3] percent (n)	Other species[4] 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)	1% (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)	0% (3)
1998	100	1389	56% (779)	7% (100)	32% (439)	5% (67)	0% (4)
1999	100	1594	51% (820)	8% (128)	36% (570)	4% (64)	1% (12)
2000	100	2207	47% (1030)	10% (228)	31% (688)	12% (257)	0% (4)
2001	100	1957	54% (1054)	8% (159)	36% (697)	2% (44)	0% (3)
2002	100	2185	36% (797)	13% (280)	42% (922)	8% (177)	0% (9)

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

[2] L = larvae

[3] N = nymphs

[4] Other species mostly *Ixodes muris* 1999-2nd adult *I. muris* collected