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Metropolitan Mosquito Control District
***Ixodes scapularis* Distribution Study Report**

Janet Jarnefeld
Tick Vector Services

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Metropolitan Mosquito Control District
***IXODES SCAPULARIS* DISTRIBUTION STUDY**
2001

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 49 of these sites during 2001, which is the second-highest tabulated total since 1990 and a decrease from 2000's highest tabulated number of 55 positive sites. Thirty-nine of these sites are located north of the Mississippi River where most of our positive sites are typically located. South of the river, however, our number of positive sites increased to 10, up from 7 in 2000 (in a typical season we detect 3 to 4 positive sites). These 10 sites are distributed through the counties of Dakota (7 sites; 2 newly positive), Hennepin (1 new Eden Prairie site and 1 in Dayton township at Elm Creek Park Reserve- *I. scapularis* had been previously detected in this park in past collaborative study efforts), and Scott (1 new site-a small isolated brushy tree line in Cedar Creek Township). Although human cases have been recorded from all seven metro counties in the past, detecting *I. scapularis* within at least a few of these 5 newly positive locations from south of the river could be looked at as somewhat unexpected. A total of 741 *I. scapularis* (compared with 945 in 2000) were removed from 897 mammals for an overall season mean of .826 *I. scapularis* per mammal; the highest mean compiled to date, but comparable with the 2000 average of .806. The majority of *I. scapularis* were collected in Anoka County (54% of the total (372 larvae; 25 nymphs)), with Washington County collections accounting for an additional 39% (272 larvae; 16 nymphs) of the total. The highest average number of *I. scapularis* per mammal was calculated for Anoka County; a season mean of 1.640 compared with Washington County's season mean of 1.440 overall. Townships averaging > 1.0 *I. scapularis* per mammal in 2001 were Blaine (6.484), Ham Lake (2.810), Coon Rapids (1.879) (of Anoka County), May (2.679), Lakeland (2.438), Afton (2.414), and Hugo (1.500) (of Washington County). Townships maintaining averages \geq .500 *I. scapularis* per mammal in 2001 were Grant (.778) and New Scandia (.500) townships of Washington County, and Burns (.667), Linwood (.639), Ramsey (.636), Lino Lakes (.550), and Saint Francis (.500) townships of Anoka County. Our 1990-2001 *I. scapularis* per mammal township averages (all > 1.0) include Hugo, New Scandia, May (Washington County), and East Bethel (Anoka County), while the 1990-2001 averages for Blaine, Linwood, Ham Lake, Saint Francis, (Anoka County), Afton, Grant, and Lakeland (Washington County) townships were > .500 *I. scapularis* per mammal. *P. leucopus* consistently has been the predominant yearly mammal species collected, with yearly variability in the total percentages collected, and no major shifts in the diversity of our small mammal or immature tick collections seems to have occurred in 2001. The 2001 average number of mammals collected per site (8.97) appears to represent a lower than average yearly small mammal collection level. Although our total collections of *I. scapularis* nymphs decreased in 2001 from the elevated 2000 collection level (44 versus 257 in 2000), the numbers of collected *I. scapularis* larvae have continued to increase in each of the last four years, although the increase between 2000 (688 larvae) and 2001 (697 larvae) was extremely slight. Examining human case totals provided by the Minnesota Department of Health, the 2001 totals were comparable to the 2000 levels (Lyme 461 vs. 465 and ehrlichiosis 93 vs. 77 cases respectively). Perhaps correspondingly, our results appear to show that we have collected an elevated number of *I. scapularis* in the last several years compared with a typical year. Because of this apparent elevated number, we again conclude that *I. scapularis* range expansion has not been detected because we do not yet feel that we have seen a significant permanent change in where our tick collections are occurring.

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 23, 2001 and ended on October 25, 2001 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

➤ 2001 Study (Repeat Sites):

We found at least one *I. scapularis* at 49 of 100 sampling sites, with 39 of these positive sites located north of the Mississippi River in Anoka (21 sites positive/28 sites sampled), Washington (17 sites positive/25 sites sampled), and Ramsey (1 site positive/3 sites sampled) counties. Ten additional positive sites were detected south of the river; seven were located in Dakota County, two in Hennepin County, and one in Scott County. Zero *I. scapularis* were collected in Carver County.

Overall, 897 mammals (Figure 1 and 2001 results in Table 2) were inspected: 466 from north of the Mississippi River and 431 from south of the river, and a total of 741 *I. scapularis* (Figure 2 and 2001 results in Table 3) were collected from them. The Anoka County sampling locations accounted for 54% (372 larvae; 25 nymphs) of the total, with the greatest number of *I. scapularis* obtained from Blaine (192 larvae; 9 nymphs), Coon Rapids (62 larvae), and Ham Lake (56 larvae; 3 nymphs) townships. Collections from Washington County accounted for an additional 39% (272 larvae; 16 nymphs) of the total, with May (139 larvae; 11 nymphs), Afton (68 larvae; 2 nymphs), and Lakeland (37 larvae; 2 nymphs) township collections the highest. The majority of the remaining 741 *I. scapularis* collected were obtained from Dakota (29 larvae; 3 nymphs) and Ramsey (19 larvae) counties.

The overall season mean number of *I. scapularis* collected per mammal in 2001 was .826 (larvae: .777, nymphs: .049). The mean increases to 1.563 (larvae: 1.470, nymphs: .093) when all sites negative for *I. scapularis* are excluded (see 2001 results in Figure 6). The highest average number of *I. scapularis* per mammal was calculated for Anoka County, which had a season mean of 1.640, compared with Washington County's season mean of 1.440 overall (see 2001 results in Figure 3). Townships in Anoka County averaging > 1.0 *I. scapularis* per mammal in 2001 were Blaine (6.484), Ham Lake (2.810), and Coon Rapids (1.879), with Burns (.667), Linwood (.639), Ramsey (.636), and Lino Lakes (.550) all averaging > .500 *I. scapularis* per mammal. The Saint Francis township average was .500. In Washington County, townships averaging > 1.0 *I. scapularis* per mammal in 2001 were May (2.679), Lakeland (2.438), Afton (2.414), and Hugo (1.500). Grant Township maintained an average of .778 *I. scapularis* per mammal, while New Scandia Township maintained an average of .500 *I. scapularis* per mammal (Figure 4).

➤ Compiled 1990-2001 Results (Repeat Sites):

The 1990-2001 mean number of *I. scapularis* collected per mammal was .321, 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 fourth consecutive year in 2001, and was 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 1990-2001 township averages for Hugo, New Scandia, May (Washington County), and East Bethel (Anoka County) townships were > 1.0 *I. scapularis* per mammal, while the averages for Blaine, 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 Fig. 4).

I. scapularis status at the 100 repeat sampling locations is shown on Figure 5. The status has changed at 66 of the sites since 1990 or 1991 (see 2001 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 - 2001

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

Comparing our 2001 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 our *I. scapularis* nymph collections decreased from the elevated 2000 total (44 versus 257 in 2000). Our overall season mean of .826 is comparable to the previous highest yearly mean of .806 *I. scapularis* per mammal calculated for 2000 (Figure 3). *P. leucopus* consistently has been the predominant mammal species collected each year with some variability in the total percentages collected¹. The 2001 average number of mammals collected per site (8.97) appears to represent a lower than average yearly collection level. Our compiled average small mammal collection success level per site for 1990 through 2001 is 13.62 (1991-2001 average of 13.37 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.

¹see 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 the total number of 49 tabulated positive sites in 2001 is lower compared with the 2000 tabulation of 55, it is still a high total when compared to past results, as shown in the text boxes on Figure 3. Additionally, although Table 1 illustrates that we have consistently detected *I. scapularis* at several new sampling locations each year, we believe that detecting *I. scapularis* within at least a few of the five 2001 newly positive sampling locations could be looked at as somewhat unexpected, although not completely out of the scope of reasonable; we are aware that human cases have been recorded from all seven metropolitan area counties in the past² and we do not claim that our study methodology enables us to detect every *I. scapularis* in any given location at any point in time. Furthermore, based on what seems to be our elevated overall collections of *I. scapularis* over the last several years, we do not exclude the possibility that a temporary tick population level increase has occurred, or that we simply detected transient introductions of *I. scapularis* into these areas³.

To outline what we mean by expected versus unexpected results, we provide the following comparisons. As in past results, our tabulated positive sites for 2001 are primarily located north of the Mississippi River, and, more specifically, are located within Anoka and Washington counties. In comparison, south of the river we typically tabulate 3-4 positive sites each season, located primarily in Dakota County. In 2000 we tabulated a total of seven sites, and our tabulation for 2001 increased to ten positive sites. We had detected *I. scapularis* in five of these ten locations in previous years. An examination of the remaining five newly positive site locations for 2001 seemed to bring a combination of expected and unexpected results. For instance, in Dakota County we have previously detected *I. scapularis* at nine of the county's fifteen sampling locations, so detecting *I. scapularis* in two additional locations in 2001 would seem to fit as somewhat expected. Also somewhat expected was the collection of two *I. scapularis* larvae at Elm Creek Park Reserve (Dayton township in Hennepin County) as *I. scapularis* had been previously detected in a past collaborative study at a different location in this large park. Although we sporadically collected 1-2 *I. scapularis* in Scott county locations in the past, we have not typically tabulated positive sites in our Scott County sampling sites. In our view, an expected positive Scott County result would have been the collection of one or more *I. scapularis* in one of the larger wooded sampling sites that are located in the county. What we consider to be an unexpected Scott County result occurred in Cedar Creek Township, where two larvae were collected in a small isolated brushy tree line. Although the possibility of a tick dropping off from birds, deer, or other temporary hosts could occur at any location, the idea of an egg hatch occurring at that particular small, isolated site in a county without a number of *I. scapularis* positive sites nearby was mildly surprising. The other unexpected *I. scapularis* detection (1 larva) is located in Eden Prairie Township in southern Hennepin County. Although we have collected small numbers of *I. scapularis* on several occasions in other portions of Hennepin County, *I. scapularis* had not been detected previously from our southern Hennepin County sites. The Minnesota Department of Health, however, has recorded a limited number of human cases in Hennepin County over the years, including some recordings of southern Hennepin County exposures⁴.

² & ⁴ personal communication with the MN Dept Health--yearly 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.

³ see the discussion section in the 1998 and 2000 *I. scapularis* distribution study reports for particulars.

Although our total collections of *I. scapularis* nymphs decreased in 2001 from the elevated 2000 collection level, collections of *I. scapularis* larvae have increased in each of the last four years, although only extremely slightly between 2000 (688 larvae) and 2001 (697 larvae). And, while a decrease from 2000 was seen, our total *I. scapularis* collections still appear to be elevated, with a calculated overall season mean of .826 *I. scapularis* per mammal that is comparable with the 2000 average of .806. The Minnesota Department of Health's 2001 tabulated number of human Lyme (461) and ehrlichiosis (93) case totals⁵ were also generally comparable to the 2000 levels (465 and 77 cases respectively). Their 2000 case totals had been the highest recorded tabulations in their databases, and perhaps correspondingly, our results appear to show an elevated number of *I. scapularis* collected over the last several years. Although we have examined several theories in past reports to explain the increases that we have seen since the 1998 season, we are not satisfied that our theories hold up well under scrutiny. We believe it is likely that additional factors or variables that we have not considered are influencing our *I. scapularis* collection results and corresponding tabulated positive site totals. Because our *I. scapularis* collections seemed elevated again in 2001, we are not convinced that we have seen a significant permanent change in where our tick collections occurred. Therefore, we again conclude that *I. scapularis* range expansion has not been detected.

⁵personal communication with MN Dept Health

ADDITIONAL UPDATES/RESEARCH:

CONTINUING STUDIES FOR 2002.

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

Dr. M. Roberto Cortinas and several crew from the University of Illinois came to Minnesota during the week of June 10, 2002. They chose a total of 7 sites (2 Anoka, 2 Hennepin, and 3 Scott county locations) for sampling. Large Sherman traps were used to collect small mammals, which were anesthetized, examined for ticks, and released back into the site. Results of this effort are not yet available. Questions on this project, as well as results of the sampling effort should be directed to Dr. Cortinas or any of the co-investigators.

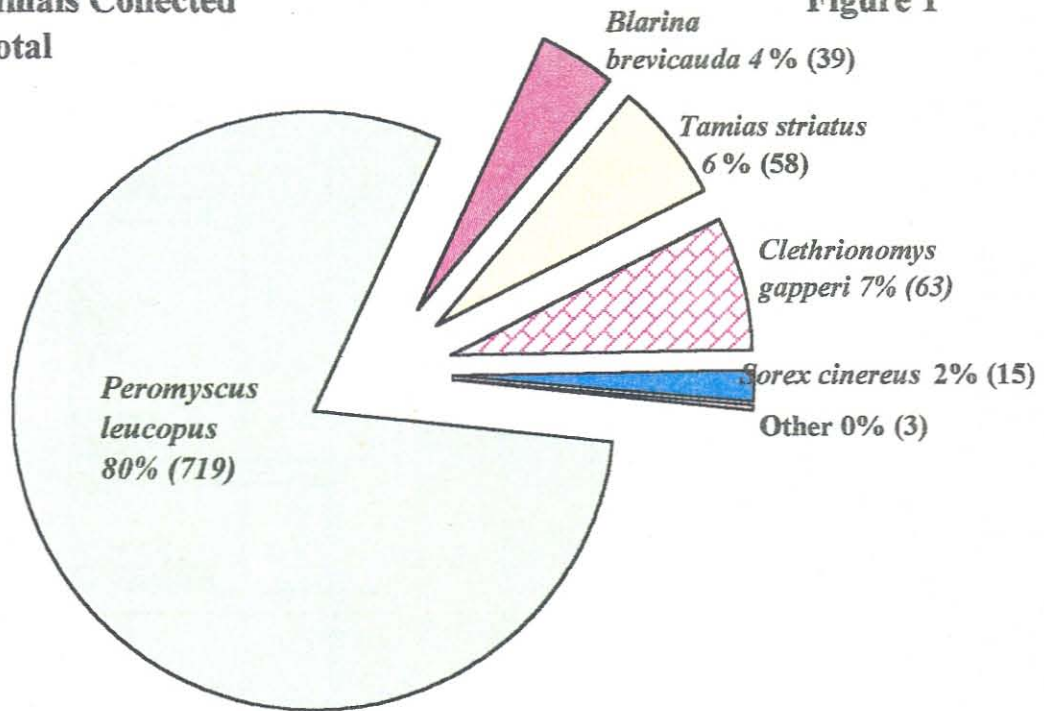
DISCONTINUATIONS FOR 2002.

- **Discontinued: Cooperative studies with Dr. Russell Johnson (UM-Mpls) and Marty Skoglund and Jay Brezinka (Dept of Military Affairs, Little Falls, MN):**

The University of Minnesota and the Department of Military Affairs continued this study in 2002 using a more limited approach than had been utilized in 2000 and 2001. Samples are being collected in Little Falls only from April through July and dragging for questing ticks has been discontinued. Due to budget constraints and in anticipation of increased workload for mosquito vector activities, the District declined to participate in 2002.

**Small Mammals Collected
2001: 897 total**

Figure 1



**Ticks, by Species and Stage,
Removed from Small Mammals
2001: 1957 total**

Figure 2

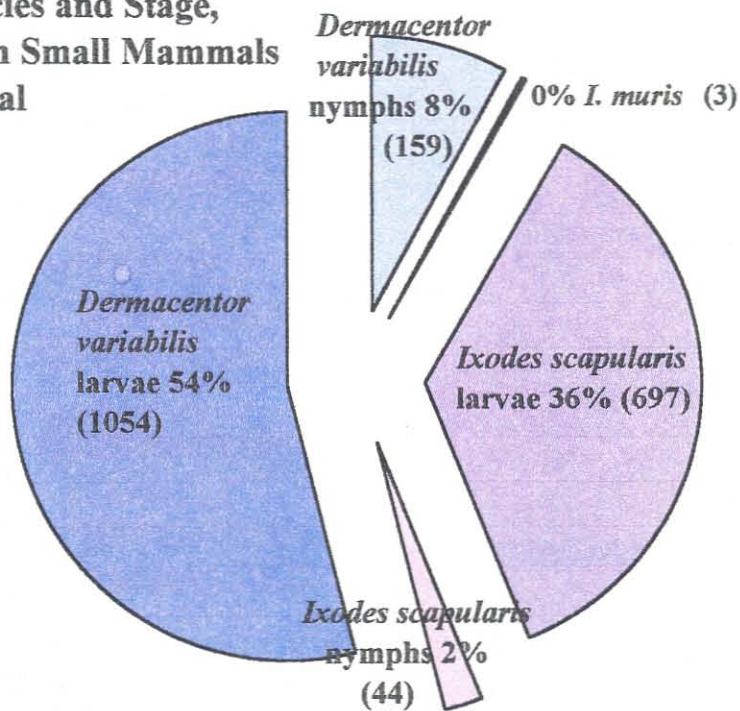


Figure 3

Average number of *I. scapularis* collected per mammal at 100* sampling locations in Anoka, Washington, and Ramsey counties: 1990 - 2001
(white box shows the total number of sites where at least one *I. scapularis* was found: by year)

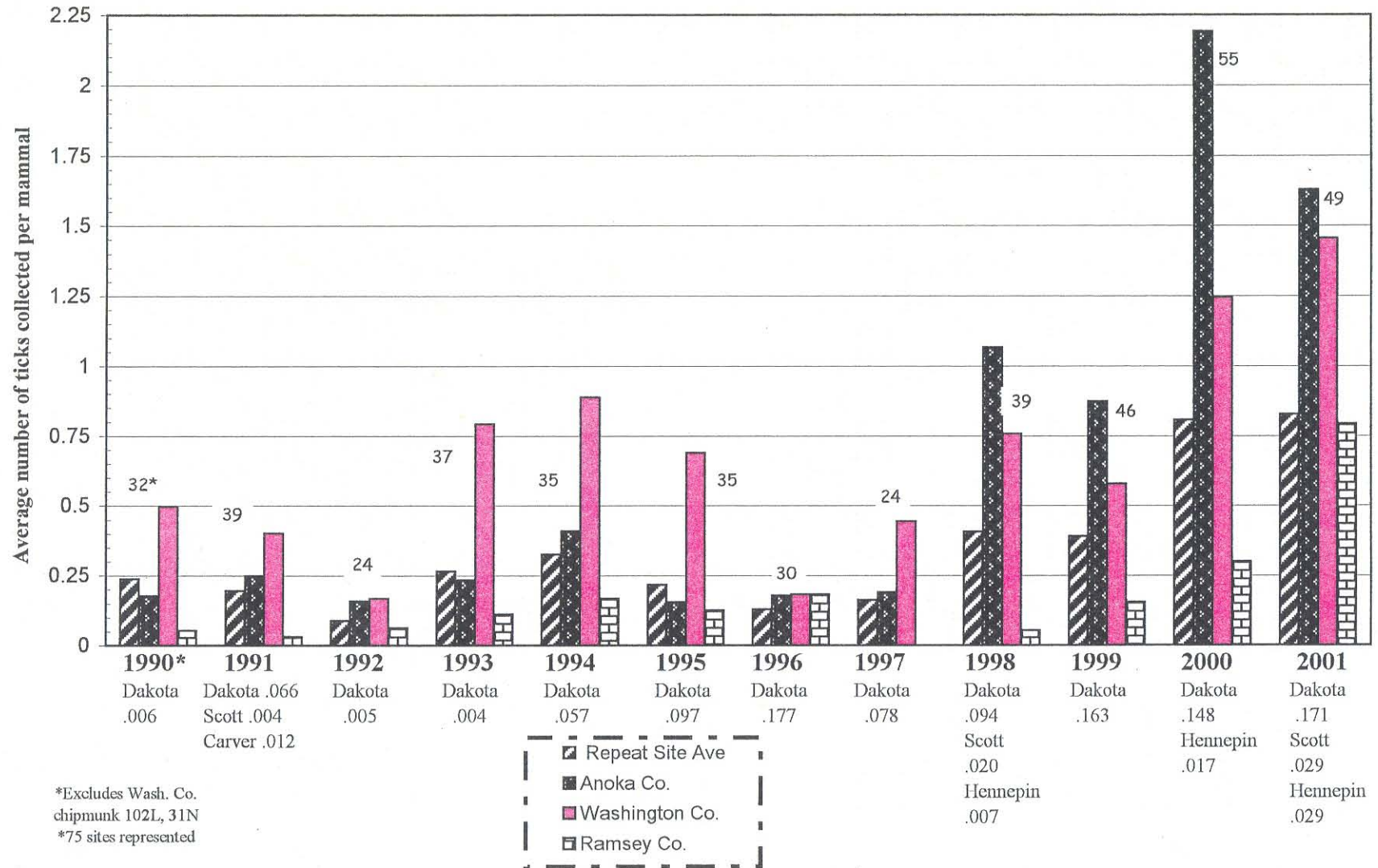
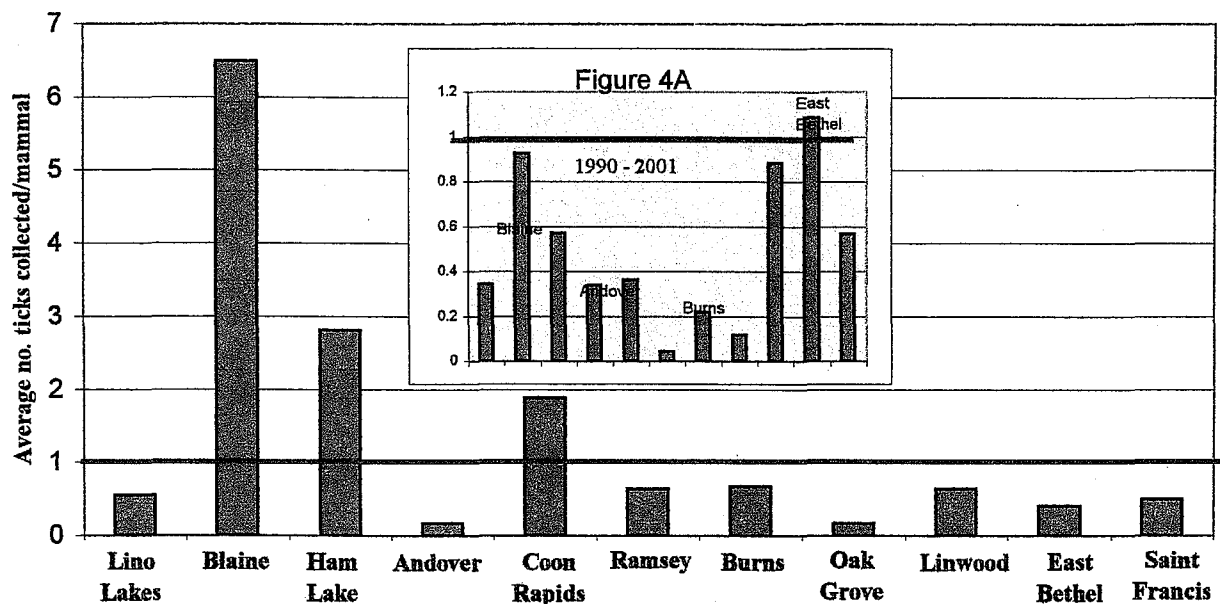


Figure 4

Average number of *I. scapularis* collected per mammal in
Anoka county (by township): 2001 results only



Average number of *I. scapularis* collected per mammal in
Washington county (by township): 2001 results only

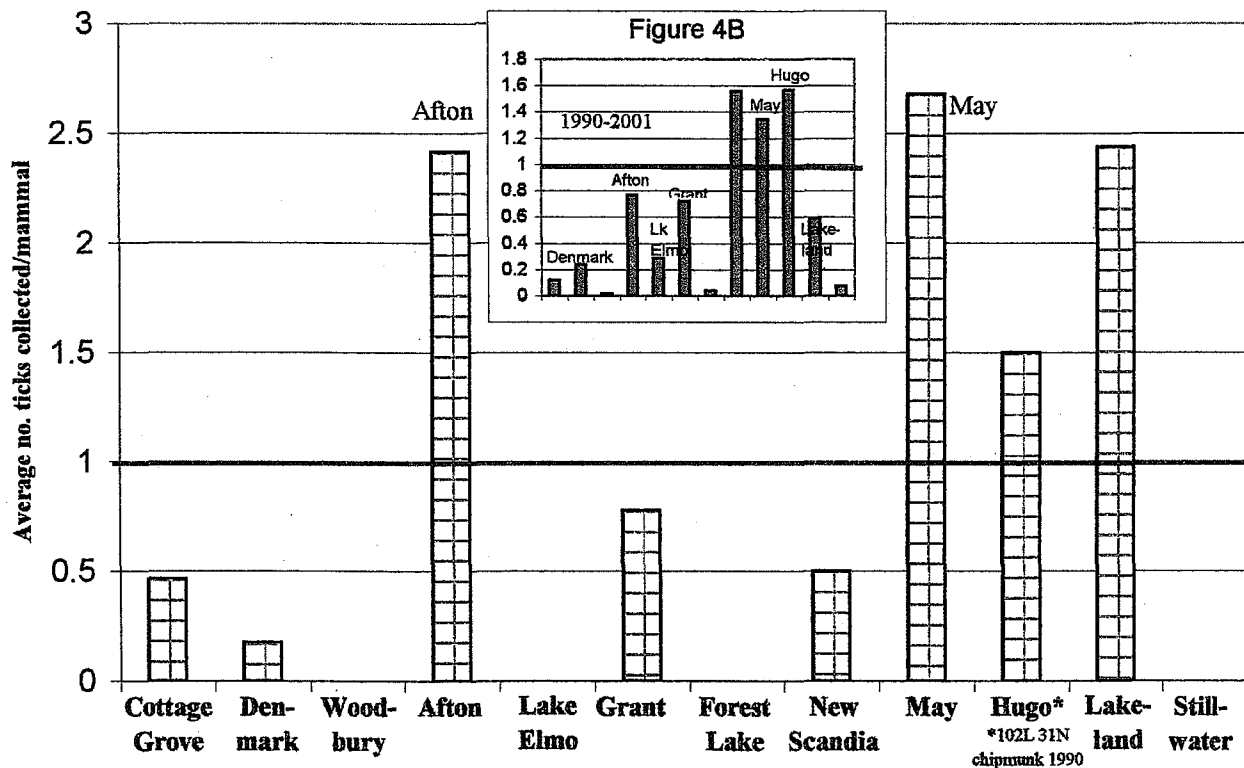
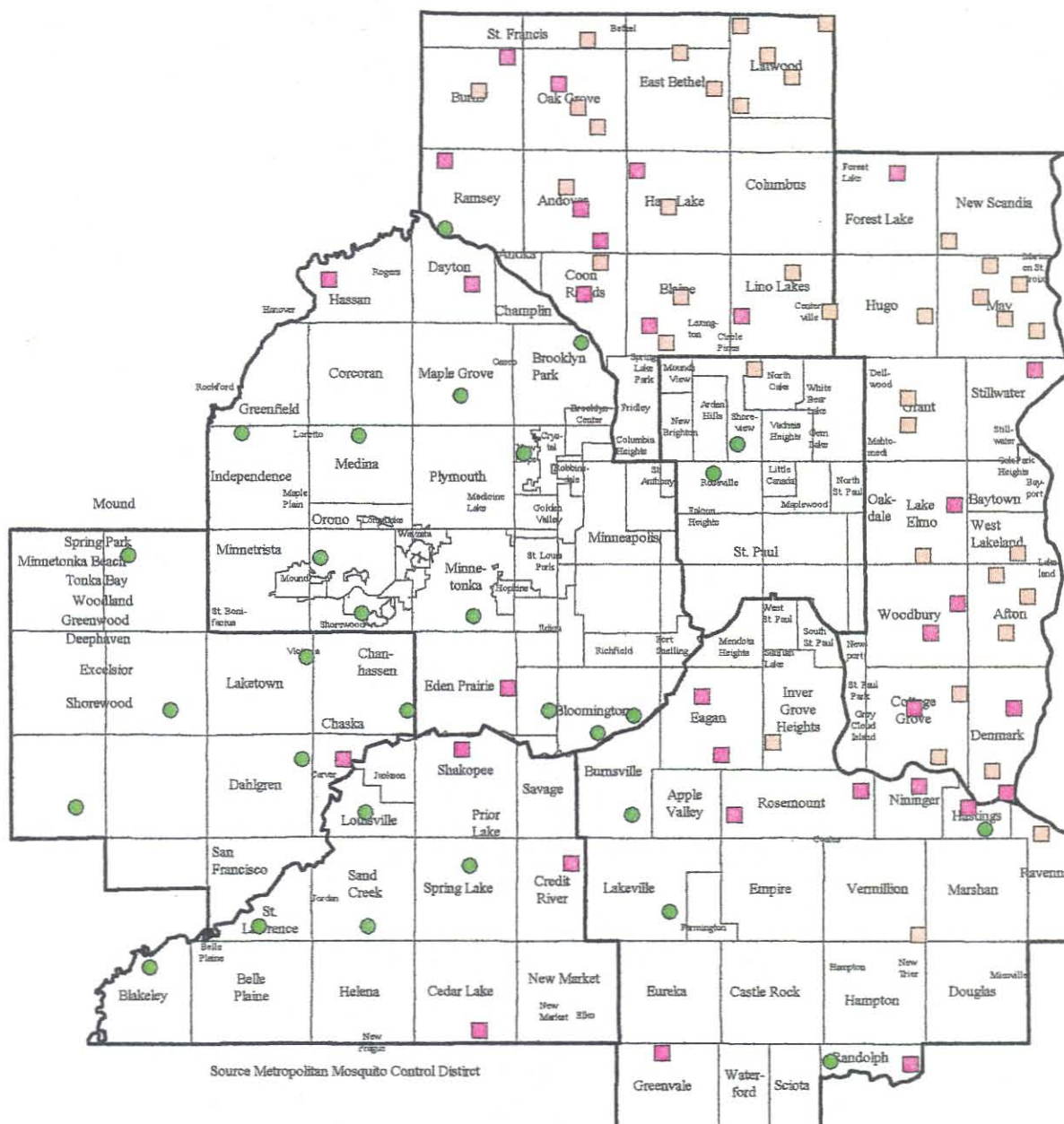


Figure 5

Ixodes scapularis Presence/Absence status: 1990 - 2001
(present if at least one *I. scapularis* is collected during a year)



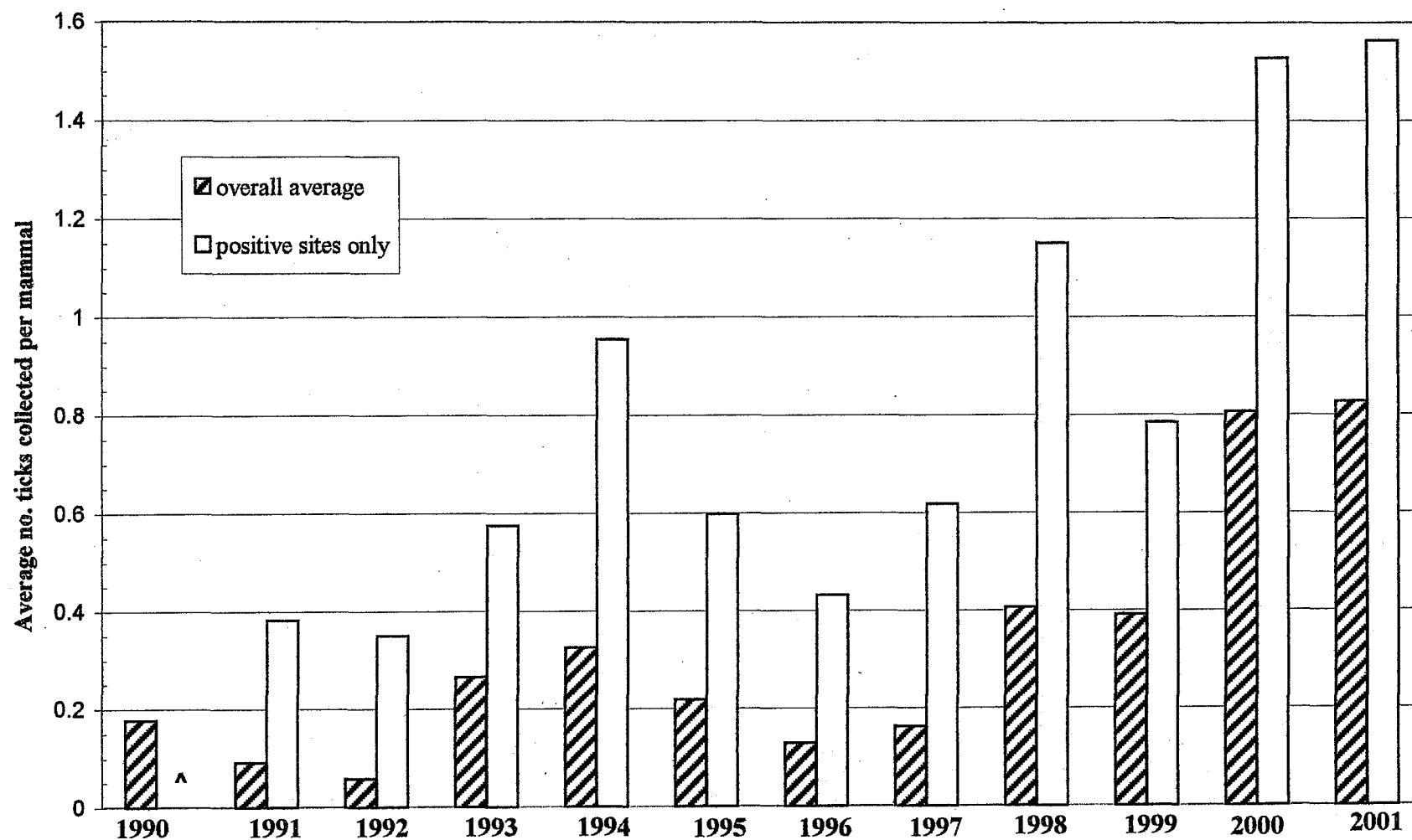
At least one tick found during:

- all/most years (39)
- at least one year (32)
- (not found) (29)

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Figure 6

Average number of *I. scapularis* collected per mammal at 100* repeat sampling locations 1990-2001: overall vs. sites where at least one *I. scapularis* was collected (positive sites)



*75 sites
^data unavailable

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]	<i>Peromyscus leucopus</i> percent (n)	<i>Tamias striatus</i> percent (n)	<i>Clethrionomys gapperi</i> percent (n)	<i>Blarina brevicauda</i> 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)

*Other includes *Microtus pennsylvanicus*, *Spermophilus tridecemlineatus*, *Zapus hudsonius*, *Mustela erminea*, *Tamiasciurus hudsonicus*, *Glaucomys volans*, *Sorex arcticus*, *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	<i>Dermacentor variabilis</i> L ² percent (n)	<i>Dermacentor variabilis</i> N ³ percent (n)	<i>Ixodes scapularis</i> L ² percent (n)	<i>Ixodes scapularis</i> 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)

¹ 1990 data excludes 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