# Metropolitan Mosquito Control District
# *IXODES SCAPULARIS* DISTRIBUTION STUDY
# 2006


## 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 locations that have all been sampled since 1990 or 1991. The number of positive sites, sites where at least one *I. scapularis* was collected, was tabulated in the 50's for the 2nd consecutive year (total of 52 in 2006) and for only the 4th time (all since 2000) since the inception of this study. We also continued to tabulate higher than typical positive sites from counties south of the Mississippi River (9 Dakota, 2 Hennepin, and 1 Scott) in 2006. A total of 791 *I. scapularis* were removed from 1241 mammals for an overall season mean of .637 *I. scapularis* per mammal. This average is lower than our elevated averages (all ≥ .806) of 2000 – 2002, 2004 and 2005, but is higher than the averages compiled for the period 1990 – 1999 (range .089 - .406) as well as for 2003 (.389). The Anoka County sites accounted for 66% of the total 2006 *I. scapularis* collections (485L; 35N), and *I. scapularis* were primarily collected from two townships (184L; 8N Coon Rapids, 101L Saint Francis). Our Washington County sites accounted for 18% of the total (137L; 6N) - similar to the overall total (109L; 15N) and percentage (16%) from south of the Mississippi River. The highest county average number of *I. scapularis* per mammal (1.383) was calculated for Anoka County and was followed by Washington (.540) and Dakota (.468) counties. Townships maintaining the highest (all ≥ 1.0) *I. scapularis* per mammal averages included Coon Rapids, Saint Francis, Oak Grove, Blaine, Andover, and East Bethel of Anoka County (range 1.0 - 4.923), Grant (3.737) of Washington County, and Ravenna (1.273) and Vermillion (1.091) of Dakota County. Townships averaging ≥ .500 *I. scapularis* per mammal included Linwood (Anoka County), May (Washington County), Rosemount, and Inver Grove Heights (both Dakota County). Anoka County maintained the highest 1990-2006 overall season mean (.863), followed by Washington County (.732). Our compiled 1990-2006 *I. scapularis* per mammal township averages (all > 1.0) include May, New Scandia, Hugo, and Grant of Washington County and Blaine, Coon Rapids, Saint Francis, and East Bethel of Anoka County. South of the Mississippi River, the highest 1991-2006 averages (> .500 *I. scapularis* per mammal) occurred in Inver Grove Heights and Vermillion townships of Dakota County. Both small mammal and immature tick species diversity in 2006 appeared comparable to past years although for the 3rd consecutive year we tabulated a record percentage of *I. scapularis* in our overall collections (58% equals the record of 2005). This is only the 4th time (all since 2002) that *I. scapularis* has comprised ≥ 50% of our overall collections. As in past years, *Peromyscus leucopus* was the predominant mammal species collected, and the 2006 average number of mammals collected per site (12.41) appears to represent a typical yearly small mammal collection level. Examining human data, the MN Dept Health recorded high Lyme disease case totals (914) and human anaplasmosis case totals (177) in 2006, similar to the record-setting totals from 2005 [Lyme (918-2nd highest); HGA (186-highest recorded total in their database)]. The Twin Cities metro case totals have also risen over time but not as dramatically as the recent elevated state-wide totals. We evaluated several hypotheses that could have caused or contributed to our lower 2006 tick collection success compared to recent years but were unsuccessful in supporting our theories. The decrease in our 2006 *I. scapularis* tick collection success compared to 2005 could be simply general year-to-year variability or due to some other unconsidered factor rather than the weather-related variables that we considered. Overall, our 2006 results seem to indicate that the metro *I. scapularis* population remains elevated, despite the drop in our *I. scapularis* per mammal average in 2006.


## 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 each used as secondary collection methods in the past.

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 may 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 24, 2006 and ended on October 26, 2006 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

### Ø 2006 Study (Repeat Sites):

We found at least one *I. scapularis* at 52 of 100 sampling sites, with 40 of these positive sites located north of the Mississippi River in Anoka (22 sites positive/28 sites sampled), Washington (16 sites positive/25 sites sampled), and Ramsey (2 sites positive/3 sites sampled) counties. Twelve additional positive sites were detected south of the river in Dakota (9), Hennepin (2), and Scott (1) counties. Zero *I. scapularis* were collected in Carver County in 2006.

Overall, 1241 mammals (Figure 1 and 2006 results in Table 2) were inspected: 677 from north of the Mississippi River and 564 from south of the river and a total of 731 *I. scapularis* (Figure 2 and 2006 results in Table 3) were collected from them. The Anoka County sites accounted for 66% of the total *I. scapularis* collections (485 larvae; 35 nymphs), with over half of the *I. scapularis* collected from two townships ( Coon Rapids (184L; 8N) and Saint Francis (101L; 0N)). Only an additional 18% of the total (137L; 6N) were collected from our Washington County sites, with the highest collections occurring in Grant Township (68L; 3N). Our sites located south of the Mississippi River accounted for another 16% (109L; 15N) of our overall *I. scapularis* collections with all but 6 larvae and 1 nymph collected in Dakota County.

The overall season mean number of *I. scapularis* collected per mammal in 2006 was .637 (larvae: .591, nymphs: .047). The mean increases to 1.091 (larvae: 1.018, nymphs: .081) when all sites negative for *I. scapularis* are excluded (see 2006 results in Figure 6). The highest average number of *I. scapularis* per mammal was calculated for Anoka County, which had a season mean of 1.383 compared with Washington (.540) and Dakota (.468) county's season means (see 2006 results in Figure 3).

Townships in Anoka County averaging ≥ 1.0 *I. scapularis* per mammal in 2006 included Coon Rapids (4.923), Saint Francis (3.741), Oak Grove (1.243), Blaine (1.242), Andover (1.233), and East Bethel (1.0), with Linwood Township (.625) averaging ≥ .500 *I. scapularis* per mammal. Grant (3.737) and May (.796) townships of Washington County maintained averages ≥ .500 *I. scapularis* per mammal (Figure 4), as did Ravenna (1.273), Vermillion (1.091), Rosemount (.833), and Inver Grove Heights (.500) townships of Dakota County, south[1] of the Mississippi River (no figure).

Ø **Compiled Results (Repeat Sites) from 1990 - 2006 or 1991 - 2006:**

The 1990-2006 mean number of *I. scapularis* collected per mammal is .440, with the highest averages continuing to occur north of the Mississippi River. Washington County maintained the highest yearly county season means from 1990-1997 and Anoka County has maintained the highest yearly county season means since 1998 (Figure 3). The highest compiled 1990-2006 overall season mean was tabulated for Anoka County (.863), followed closely by Washington County (.732). The 1990-2006 township averages (all > 1.0) include May, New Scandia, Hugo, and Grant of Washington County and Blaine, Coon Rapids, Saint Francis, and East Bethel of Anoka County, while the averages for Ham Lake, Linwood, and Andover of Anoka County and Afton and Lakeland townships of Washington County are > .500 *I. scapularis* per mammal (Figures 4A and B—inserts on Figure 4). In compiled results from south of the Mississippi River, both Inver Grove Heights (.779) and Vermillion (.599) townships of Dakota County maintained 1991-2006 averages > .500 *I. scapularis* per mammal[2] (no figure).

*I. scapularis* status at the 100 repeat sampling locations is shown on Figure 5. The status has changed at 78 of the sites since 1990 or 1991 (see 2006 results in Table 1). While the number of sites where *I. scapularis* is detected every year has decreased since 1992, 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 | 1994 | 1996 | 1998 | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **No. sites changing status** | 26 | 38 | 47 | 58 | 61 | 66 | 69 | 72 | 75 | 76 | 78 |
| **Ticks found:** | | | | | | | | | | | |
| **all years** | 21 | 17 | 11 | 5 | 5 | 5 | 4 | 3 | 1 | 1 | 1 |
| **most years** | 5 | 15 | 19 | 27 | 31 | 34 | 35 | 37 | 38 | 41 | 41 |
| **least** | 21 | 23 | 28 | 31 | 30 | 32 | 34 | 35 | 37 | 35 | 37 |
| **(not found)** | 53 | 45 | 42 | 37 | 34 | 29 | 27 | 25 | 24 | 23 | 21 |

Our positive sites have been primarily located north of the Mississippi River in Anoka and Washington counties, with one consistently positive Ramsey County site (northern Shoreview Township). In 2003 we tabulated two positive Ramsey County sites (both of our Shoreview Township sites) for the first time. The second Shoreview Township site was positive for *I. scapularis* again in 2005 and 2006. South of the river from 1990 – 1999 it was typical to tabulate a maximum total of 3-4 positive sites each season. Except for 1991 when several *I. scapularis* were collected at one site each in Scott and Carver counties, positive sites were located only in Dakota County from 1990 through 1997. In 1998 we first detected *I. scapularis* in Hennepin and Scott counties[3] and in 2000 we began to tabulate

[1] Prior to 2005, township averages south of the river were not tabulated. See footnote 1 (and the report text) in the 2005 report for detailed yearly averages for positive townships south of the Mississippi River through 2005. In brief, Inver Grove Heights Township first averaged > .500 in 1998 while Vermillion Township first averaged > .500 in 1991. 2005 was the first year that Hassan Township (Hennepin County) had an average ≥ .500.

[2] Inver Grove Heights Township has maintained a compiled 1991-current year average of > .500 *I. scapularis* per mammal since 1999 while Vermillion's first compiled 1991-current year average > .500 *I. scapularis* per mammal occurred in 2004.

[3] *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 there in a 3 year sampling effort. Staff or the public have continued to occasionally turn in adult *I. scapularis* from Scott County, especially from New Market Township, since 1995.

more sites south of the river (7 total (6 Dakota; 1 Hennepin)). Our tabulation increased to ten in 2001 (7 Dakota; 2 Hennepin; 1 Scott) and then to twelve in 2002 (8 Dakota; 3 Hennepin; 1 Scott) before decreasing back down to six in 2003 (all in Dakota County). In 2004 we tabulated nine sites (8 Dakota; 1 Scott), and in 2005 we tabulated ten sites (7 Dakota; 1 Hennepin; and 2 Scott). In 2006 our total increased back up to twelve (9 Dakota; 2 Hennepin; 1 Scott), with the Scott County positive site located in yet another new township (Louisville).

Comparing our 2006 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 the 2006 tabulation of 58% *I. scapularis* in our overall tick collections equals the 2005 tabulation and is the highest percentage tabulated since the inception of this study. Including 2006, *I. scapularis* has comprised $\geq$ 50% of our overall collections only four times since 1990; all of which have occurred since 2002 (Table 3). While our overall 2006 season mean of .637 *I. scapularis* per mammal is lower than our recent elevated averages (all $\geq$ .806) of 2000 – 2002, 2004, and 2005, it is still a higher average than was tabulated for 2003 or any other year prior to 2000 (Figures 3 and 6). *P. leucopus* consistently has been the predominant mammal species collected each year with some variability in the total percentages collected[4] (Figure 1 and Table 2). The 2006 average number of mammals collected per site (12.41) appears to represent a typical yearly small mammal collection level (Table 2). Our compiled average small mammal collection success level per site for 1990 through 2006 is 13.52 (1991-2006 average of 12.83 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.

## 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[5].

Overall, our 2006 results seem to indicate that the metro *I. scapularis* population remains elevated. Despite tabulating a lower 2006 season mean compared with our elevated averages (all $\geq$ .806) of 2000 – 2002, 2004 and 2005, the 2006 average is higher than the averages compiled for any other year (Figures 3 and 6). *I. scapularis* also comprised $\geq$ 50% of our overall tick collections (58% in 2006). This is important as it ties the record of 58% that was first set in 2005 (Table 3), and also, other than 2002 (50%), 2004 (55%), and 2005 (58%), the majority of ticks collected each year have actually been *Dermacentor variabilis* rather than *I. scapularis.* Additionally, not only did we compile a high overall positive site total, our 2006 positive site total of twelve from south of the Mississippi River equals the 2002 record total and is only the 4$^{th}$ time (all since 2001) that we have tabulated a double digit positive site total from our sites located south of the Mississippi River. We believe that these higher compiled totals from south of the Mississippi River seem to be indicating an increase in the ability to detect low population levels or perhaps geographic spread of the *I. scapularis* population into new areas.

While there have always been fluctuations both up and down in our year-to-year tick collections, both *I. scapularis* larval and nymphal as well as *D. variabilis* larval collections in 2006 were down

[4] see the discussion sections in the 1993 (*I. scapularis* population estimates) and 1994 (graph handout-mammal density equality across sites) *I. scapularis* distribution study reports.

[5] 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).

approximately one third compared with 2005. As already noted, Table 2 appears to illustrate a typical yearly small mammal collection level in 2006. We hypothesized that perhaps higher than typical 2005-2006 overwintering mortality rates in both species occurred, resulting in our lower tick collections of 2006 as had occurred with *I. scapularis* in 2003 (Figures 3 and 6). However, unlike the winter of 2002-2003 when single-digit snowfall accumulation and deep soil frost depths were recorded[6], no obvious atypical environmental factors were found to have occurred during the winter of 2005-2006, although January and the spring of 2006 as well as the entire July 2005 – June 2006 seasonal heating degree days period were cooler than the MN State Climatology Office's historical averages (Table 4, below). Further, *D. variabilis* nymphal collections remained similar to the total number of nymphs collected in most years of this study (Table 3). Since nymphal *D. variabilis* are derived from the same season larval *D. variabilis* co-hort this is somewhat perplexing, and led to the development of another hypothesis, that somehow our tick collection success was impeded during the spring of 2006.

Table 4: Temperatures: 2006 vs MN DNR State Climatology Office Historical Average

Twin Cities Monthly and Seasonal Heating Degree Days (Base:65F)
1891 – 2006

| Years | July | Aug | Sept | Oct | Nov | Dec | Jan | Feb | March | April | May | June | season |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2005-2006 | 0 | 3 | 61 | 416 | 845 | 1403 | 1123 | 1253 | 967 | 334 | 187 | 19 | 6611 |
| 1891-2006 | 7 | 20 | 164 | 476 | 951 | 1403 | 1588 | 1326 | 1065 | 561 | 243 | 51 | 7854 |

http://www.climate.umn.edu/text/historical/mspheatdd.txt

In addition to or combined with cool weather, precipitation levels[7] could have impacted tick collection success by delaying tick questing activity or possibly causing higher than normal desiccation rates, especially in the *I. scapularis* population. As shown in Table 5, however, April and May precipitation amounts were roughly normal. Although the months of June and especially July 2006 were lower than historical averages, they were not excessively low, especially as compared with the August 2003 monthly total (Table 5).

Table 5: May – Sept. Precipitation Totals: MMCD vs MN DNR State Climatology Office Historical Average

| | District 2006 | climatology 1891-2006 | District 2003 |
|---|---|---|---|
| *April | *2.89 | 2.21 | 2.55 |
| *May | *3.90 | 3.43 | 5.66 |
| June | 3.65 | 4.22 | 5.45 |
| July | 1.44 | 3.62 | 2.50 |
| August | 5.95 | 3.43 | 0.75 |
| Sept | 3.71 | 2.91 | 2.43 |

***NOTE: May 2006 rainfall averages are inflated due to weekend rainfall of April 30**

To be thorough, however, we examined the average number of *D. variabilis* and *I. scapularis* collected per mammal by round between 2002 – 2006 in an attempt to detect any potential massive die offs or unusually high collection numbers[8] in any particular round.

[6] see the discussion section in the 2003 *I. scapularis* distribution study report for concepts expressed throughout the Discussion section.

[7] as expressed by higher or lower than normal monthly rain gauge readings compiled from MMCD's precipitation network

[8] reflected as a considerably reduced or inflated average

As shown in Table 6 (below), we collected the majority of *D. variabilis* in Round A, lower numbers in Round B, and very low numbers in Round C in 2006; similar to our collection success by round in the other years examined. Table 7 illustrates that as in the other years examined, we collected the majority of *I. scapularis* in Rounds A and B. We did note that the 2006 *I. scapularis* averages for Rounds A and B were lower than years other than 2003, while the Round C average was higher than all years except 2005. Although an argument could be made that the lower averages for Rounds A and B in 2006 could be indicative of higher *I. scapularis* desiccation rates in 2006 or due to higher than normal 2005-2006 overwintering mortality, the results don't seem compelling enough to firmly make either of these claims. Likewise, perhaps some of the Round C upswing in our *I. scapularis* collections could be attributed to some larval *I. scapularis* having waited for more favorable questing conditions or even some adult females delaying egg laying in 2006, but we did not collect most of our *I. scapularis* in Round C either, so our data does not strongly support those theories. Although portions of spring and summer 2006 were a bit drier than the historical average, an analysis of previous distribution study results (at the time) expressed in the discussion section of our 2003 report had determined that we had actually collected more larvae in the fall of 2003 than some fall periods in prior studies, despite the extreme dry spell of 2003. The decrease in our 2006 tick collection success compared to 2005 could be general year-to-year variability in our tick collection success or due to some other unconsidered factor rather than the weather-related variables that we considered. Although the July 2005 – June 2006 seasonal heating degree days period was cooler than historical averages, we assume that *I. scapularis* as well as any other native tick species have evolved to handle normal variances in at least short term climatic conditions.

Table 6: Average *D. variabilis* per Mammal by Round, 2002 – 2006

| | Round A | Round B | Round C |
|---|---|---|---|
| 2002 | 3.399 | .388 | .013 |
| 2003 | 2.638 | .327 | .014 |
| 2004 | 2.270 | .396 | .006 |
| 2005 | 3.258 | .657 | .021 |
| 2006 | 1.484 | .324 | .055 |

Table 7: Average *I. scapularis* per Mammal, by Round, 2002 2006

| | Round A | Round B | Round C |
|---|---|---|---|
| 2002 | 1.681 | 1.170 | .243 |
| 2003 | .703 | .463 | .161 |
| 2004 | 2.146 | .691 | .216 |
| 2005 | 1.254 | 2.006 | .473 |
| 2006 | .895 | .910 | .302 |

We also examined factors to address the noticeable dip in our 2006 Washington county *I. scapularis* collections. Factors considered included a possible site(s)-specific issue, lower than average Washington County small mammal collections in 2006, or the impact of even more localized low precipitation in Washington County than the District as a whole causing greater mortality in Washington County than elsewhere in one or more sampling rounds. None of these scenarios were supported by the data (no figure). We did find that we had collected similar percentages of *I. scapularis* from our Washington County (29%) and Dakota county (25%) sites once before, in 1996, when both our small mammal and tick collections were lower than typical (Tables 2 and 3).

Examining human tick-borne disease case numbers, the Minnesota Department of Health (MDH) has been consistently tabulating record-setting tick-borne disease statewide case totals since 2000. Their 2006 statewide Lyme disease case total is 914, similar to 2005's 2$^{nd}$ highest statewide Lyme case total of 918. Their all-time high statewide Lyme disease tabulation occurred in 2004 (1023 cases) with the Lyme case totals of 2000 (463 cases), 2001 (465 cases), and 2003 (473 cases) being comparable. They had recorded 867 Lyme cases for 2002. Human (granulocytic) anaplasmosis (HGA) case totals have increased in recent years also. The MDH 2006 statewide HGA case total as of June 19, 2007 was 177. They had recorded an all-time high HGA case total of 186 in 2005, with cases ranging from 78 to 152 from 2000 – 2004. The MDH compiled an average of roughly 15 HGA cases per year through 1999. Babesiosis case totals have typically been in the single digits, but of note, MDH tabulated 18 statewide

babesiosis cases in 2006. In Twin Cities by-county exposure data, the Twin Cities metro tick-borne disease case totals have also risen over time, but not as dramatically as the statewide totals. The MDH's metro-exposed case totals for 2006 were 48 Lyme, 4 HGA, and zero locally transmitted babesiosis cases. Historically, the range for metro-exposed Lyme cases for all seven counties combined was 15 to 43 from 1991 – 1999 and 40 to 69 from 2000 – 2005. Although HGA was detected in metro-collected small mammals beginning in 1995[9] in MMCD collaborative research, locally acquired human HGA cases were not documented by MDH until 2000. Since 2000 however, MDH has typically tabulated a few metro-exposed HGA cases (range 0-7) each year.

Although we developed and evaluated several hypotheses that could have caused or contributed to our lower 2006 *I. scapularis* collection success compared to recent years, we do not feel our data supported our theories. We can only say that our 2006 *I. scapularis* collections were lower than what we have been consistently tabulating since 2000 with the exception of our even lower *I. scapularis* collection success of 2003. Despite our lower *I. scapularis* collection success in 2006, we did continue to collect more *I. scapularis* than we had during the period from 1990 – 1999 and in 2003. Based on that fact and our detection of other indicators like continued high numbers of positive sites overall and from south of the Mississippi River, as well as the high percentage of *I. scapularis* in our overall tick collections (*I. scapularis* comprising $\geq$ 50% of our overall collections for only the 4$^{th}$ time; all since 2002), our 2006 results seem to indicate that the metro *I. scapularis* population remains elevated, despite the detected drop in our *I. scapularis* per mammal average in 2006.

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[9]Several serology studies have been performed since 1995 using both distribution-study collected small mammals and small mammals collected at different sites. A map showing the results of our 1995 and 1997 efforts is available on our website (http://www.mmcd.org/tick_links.html). The 1995 work has been published--Walls, J. J., B. Greig, et al. (1997). "Natural Infection of Small Mammal Species in Minnesota with the Agent of Human Granulocytic Ehrlichiosis." Journal of Clinical Microbiology **35**(4): 853-855. Additional unpublished studies have been performed in collaboration with Dr. Russell Johnson, UM Microbiologist. Serology results of the later distribution study serology efforts are similar overall to the 1995 and 1997 work shown on the website map.

# ADDITIONAL UPDATES/RESEARCH:

## CONTINUING STUDIES FOR 2007.

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

## RESULTS FROM 2006 COLLABORATIVE WORK.

- **Cooperative studies with David Neitzel and Melissa Kemperman (MN Dept Health).**

MMCD collected questing *I. scapularis* in one Anoka and one Washington County site (five 100-meter transects at each site) via dragging with drag cloths of a "finger drag" design (design and manufacturing instructions had been graciously provided to MMCD by Dr. Uriel Kitron and Roberto Cortinas of the University of Illinois in 2001. MMCD later provided MDH a sample finished product and the manufacturing instructions). The *I. scapularis* collected from the drag or the human samplers were stored for later testing to determine the infection rate status for Lyme disease, HGA, and babesiosis. A total of four sampling dates were conducted with a start date of May 9 and end date of June 26, 2006. MDH began this study in northern Minnesota in 2005 with a goal of obtaining one-year samples from across the entire state of Minnesota over time. MDH collected ticks from additional locations outside the Twin Cities metropolitan area in 2006. (In 2007 MDH planned to collect at least a few years of longitudinal data at several central and northern Minnesota locations using this same general design. MMCD was not asked to collect ticks from any metro locations in 2007.)

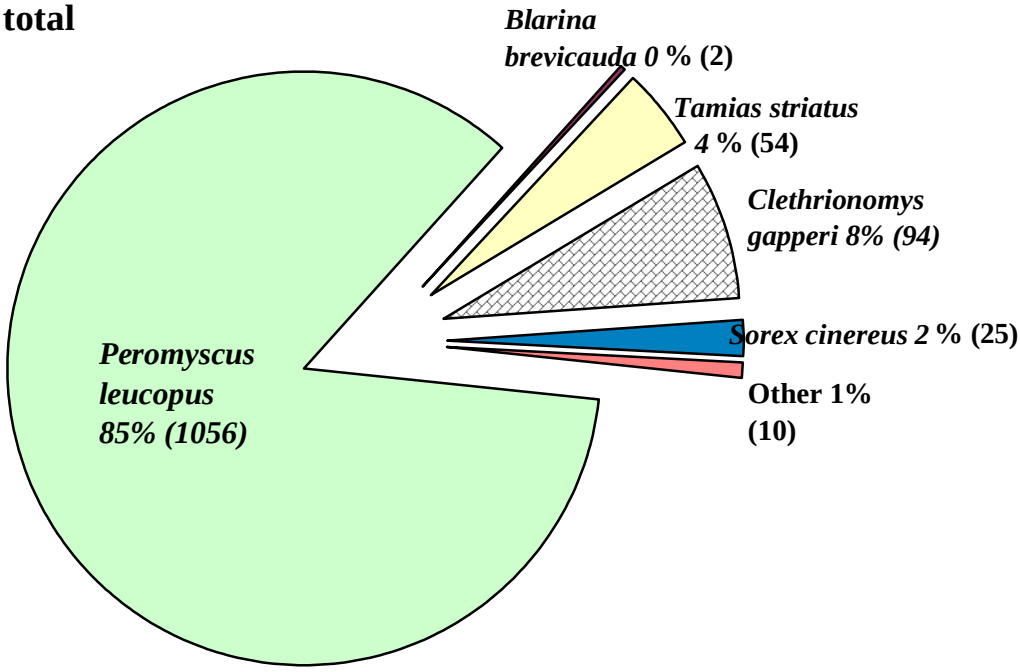
Metro deer tick infection rates:
The test results in the table below show the general tick infection rate status for Lyme disease, human granulocytic anaplasmosis (HGA), and babesiosis at one site each in Anoka (Carlos Avery) and Washington (St Croix Watershed) counties. Due to future publishing concerns by MDH, actual percentages are not being distributed.

2006 MMCD collaborative research with MN Dept Health
Tick infection rates

| | Lyme *Borrelia* | HGA *Anaplasma* | babesiosis *Babesia* |
|---|---|---|---|
| **Carlos Avery** | | | |
| adults | <20% | <5% | <5% |
| nymphs | 0.0% | 0.0% | 0.0% |
| **St Croix Watershed** | | | |
| adults | <30% | 5% | <10% |
| nymphs | <5% | <15% | 0.0% |

**Small Mammals Collected**
**2006: 1241 total**

**Figure 1**

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**Ticks, by Species and Stage, Removed from Small Mammals**
**2006: 1353 total**

**Figure 2**

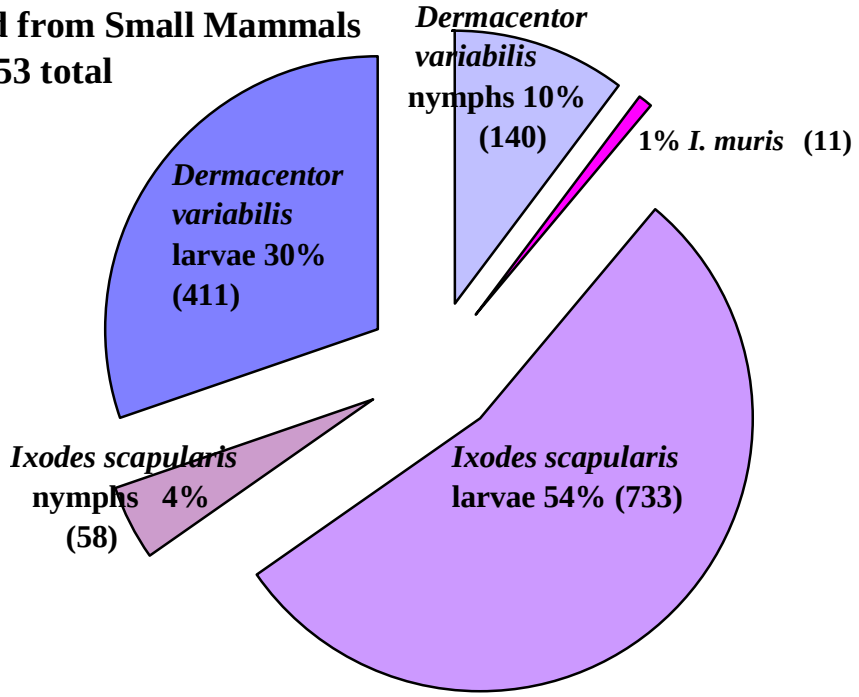


Figure 3

**Average number of *I. scapularis* collected per mammal at 100 sampling locations in Anoka, Washington, and Ramsey counties: 1990 - 2006**
**(white box shows the total number of sites where at least one *I. scapularis* was found: by year)**

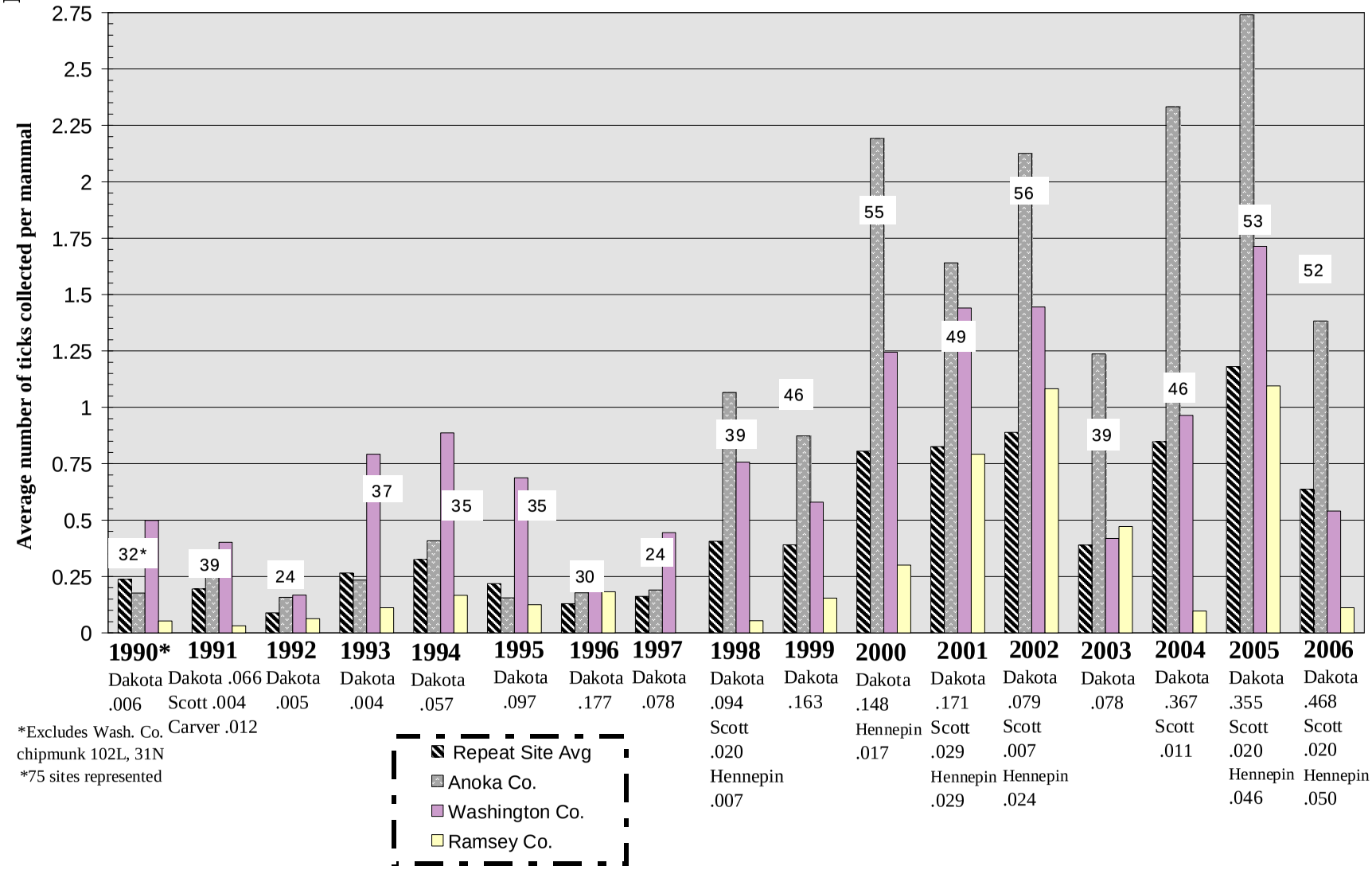
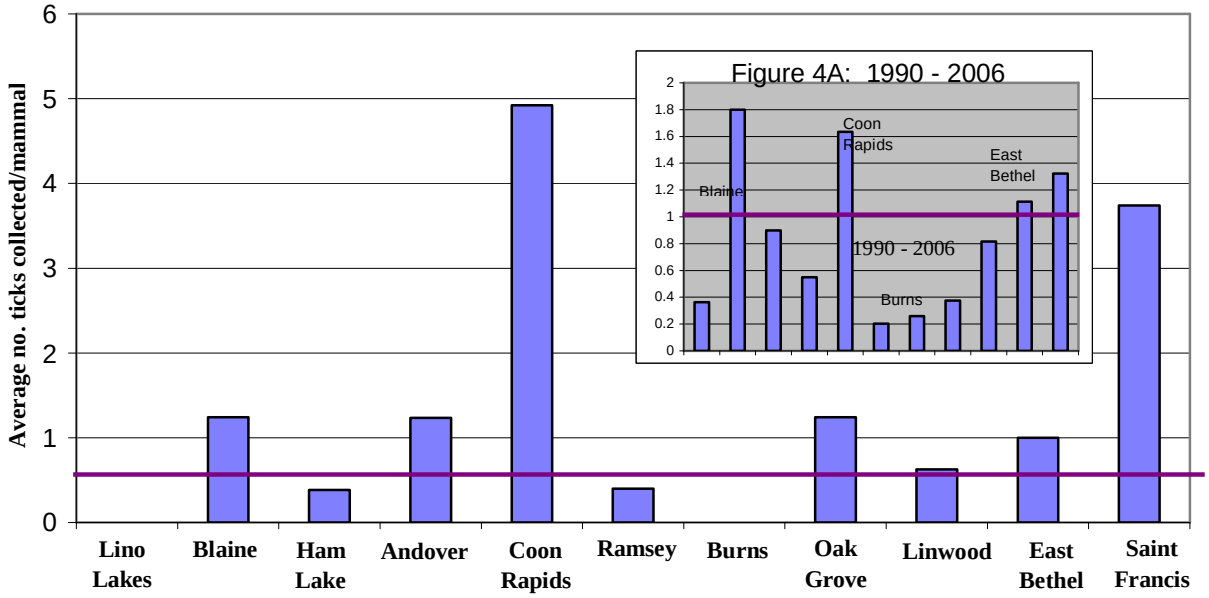


**Figure 4**

**Average number of *I. scapularis* collected per mammal in Anoka county (by township): 2006 results**




**Average number of *I. scapularis* collected per mammal in Washington county (by township): 2006 results**

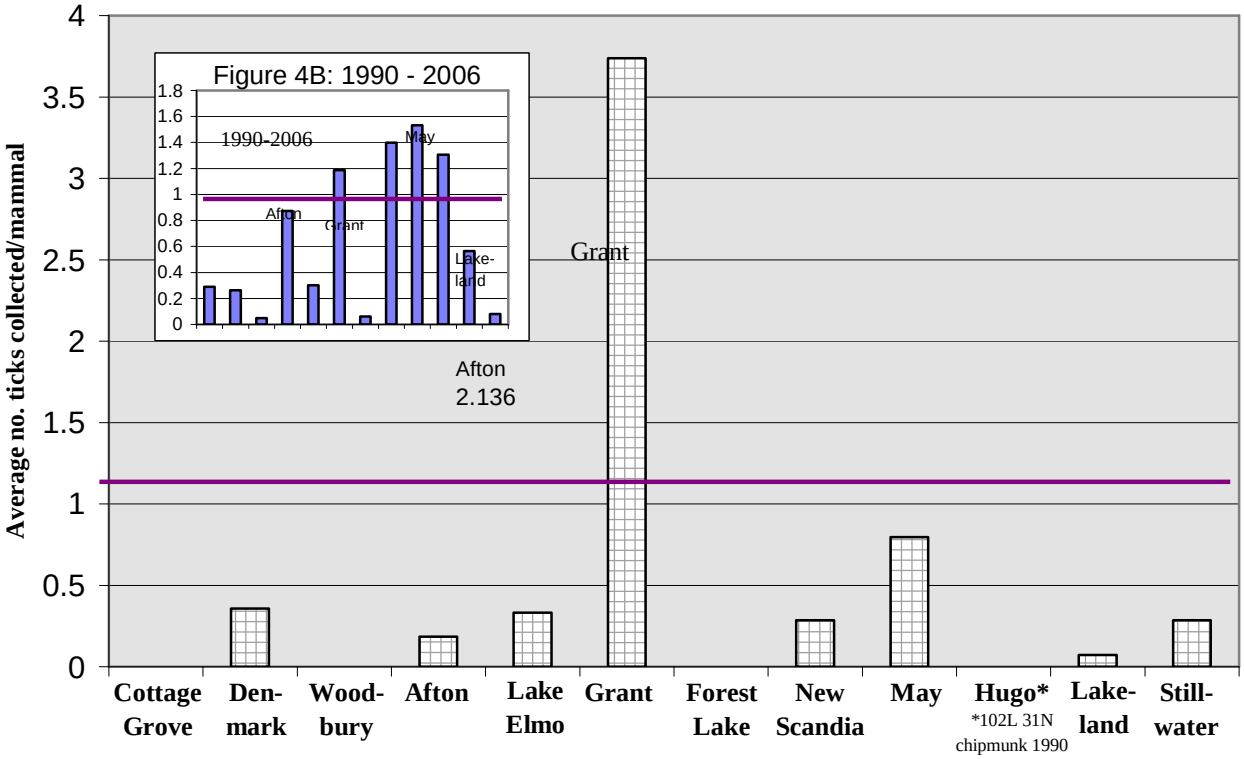
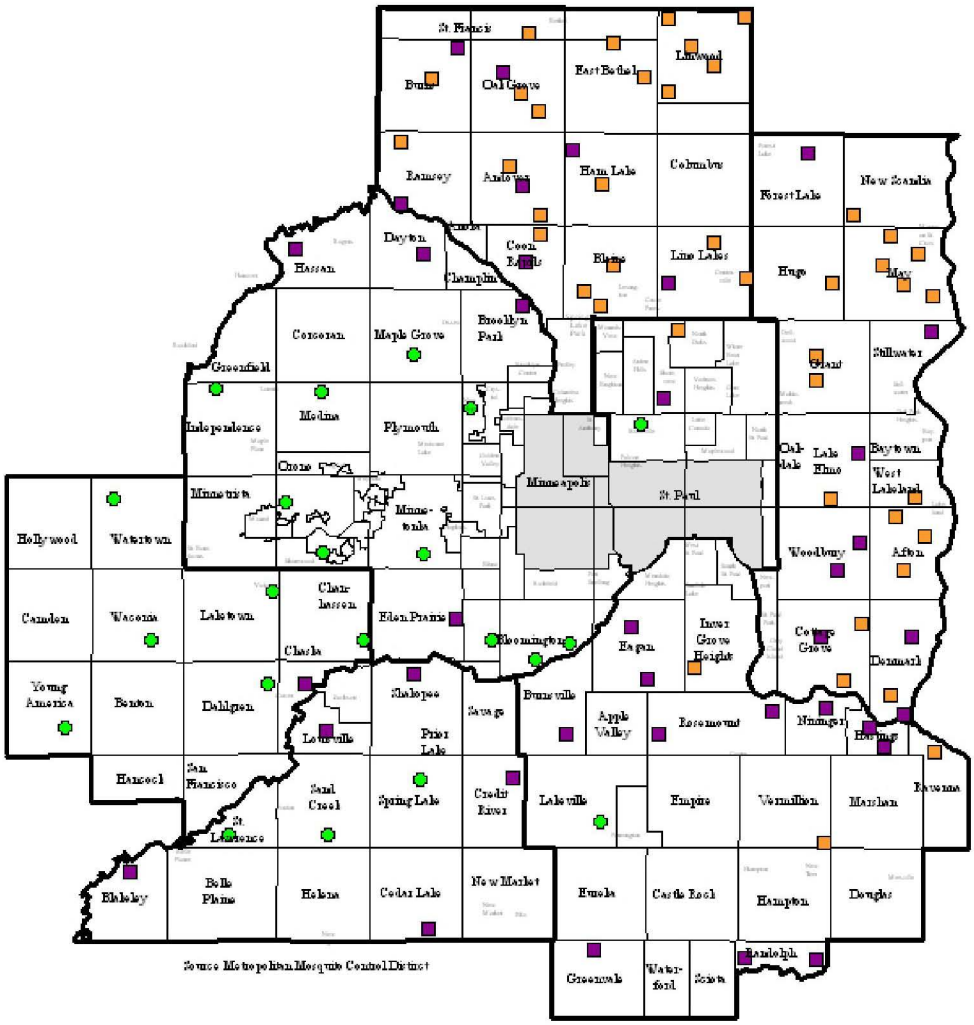


**Figure 5**

*Ixodes scapularis* Presence/Absence status: 1990 - 2006

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




At least one tick found during:

- all/most years (42)
- at least one year (37)
- (not found) (21)

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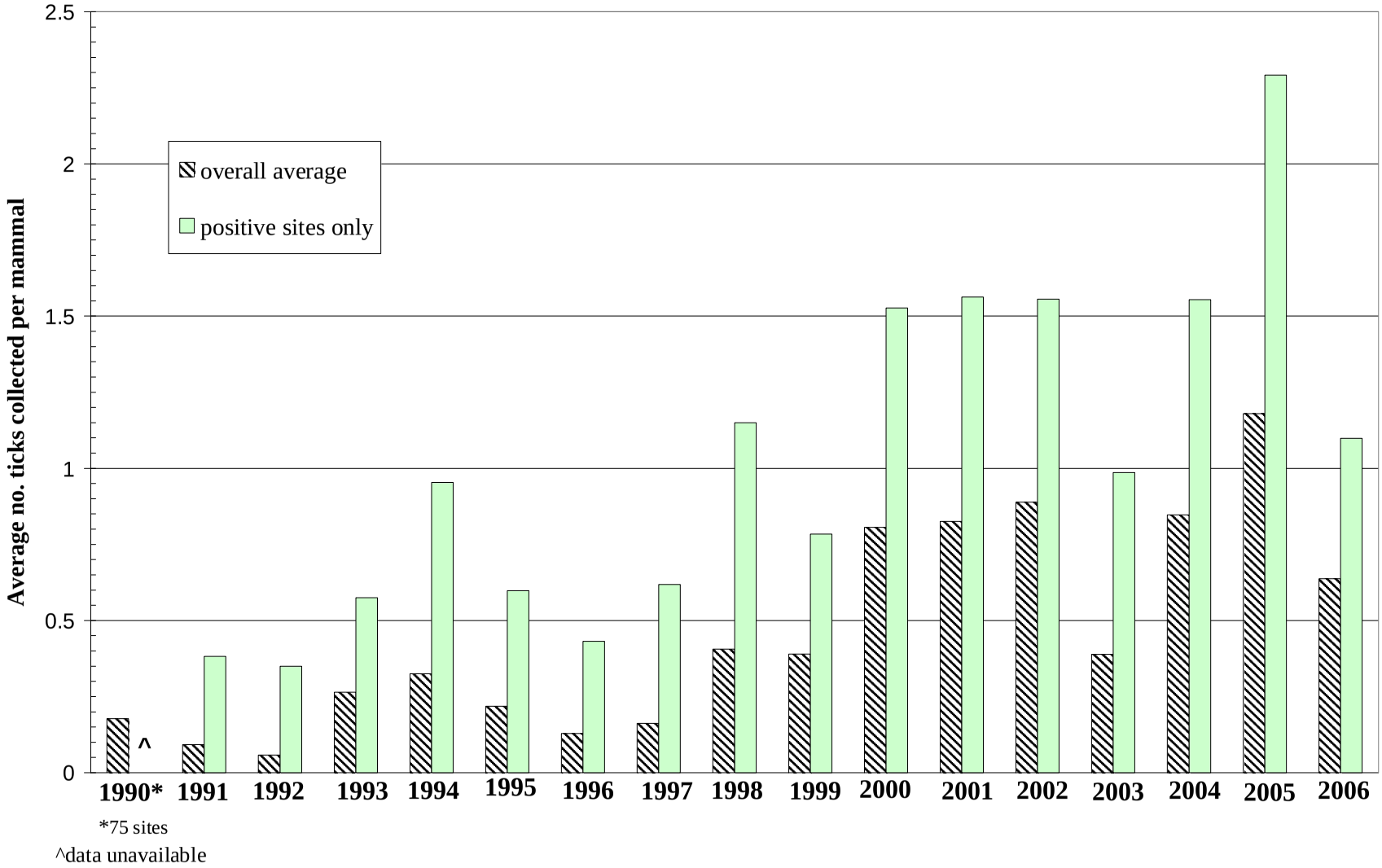
**Figure 6**

**Average number of *I. scapularis* collected per mammal at 100 repeat sampling locations 1990-2006: 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 | Avg 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) |
|---|---|---|---|---|---|---|---|---|
| [a] 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) |
| 2003 | 100 | 1226 | [12.26] | 88% (1081) | 6% (72) | 3% (36) | 1% (16) | 2% (21) |
| 2004 | 100 | 1152 | [11.52] | 87% (1007) | 6% (71) | 3% (40) | 2% (20) | 1% (14) |
| 2005 | 100 | 965 | [9.65] | 87% (841) | 6% (54) | 4% (37) | 2% (16) | 2% (17) |
| 2006 | 100 | 1241 | [12.41] | 85% (1056) | 4% (54) | 8% (94) | 0% (2) | 3% (35) |

*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[b] percent (n) | *Dermacentor variabilis* N[c] percent (n) | *Ixodes scapularis* L[b] percent (n) | *Ixodes scapularis* N[c] percent (n) | Other species[d] percent (n) |
|---|---|---|---|---|---|---|---|
| [a] 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) |
| 2003 | 100 | 1293 | 52% (676) | 11% (139) | 26% (337) | 11% (140) | 0% (1) |
| 2004 | 100 | 1773 | 37% (653) | 8% (136) | 51% (901) | 4% (75) | 0% (8) |
| 2005 | 100 | 1974 | 36% (708) | 6% (120) | 53% (1054) | 4% (85) | 0% (7) |
| 2006 | 100 | 1353 | 30% (411) | 10% (140) | 54% (733) | 4% (58) | 1% (11) |

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

[b] L = larvae

[c] N = nymphs

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