

# Metropolitan Mosquito Control District

## *Ixodes scapularis* DISTRIBUTION STUDY

### 2004

#### Abstract

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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. The number of positive sites, sites where at least one *I. scapularis* was collected, increased to 46 from 39 in 2003, and we continued to tabulate higher than typical positive site numbers south of the Mississippi River (8 from Dakota County and 1 from Scott County). A total of 976 *I. scapularis* were removed from 1152 mammals for an overall season mean of .847 *I. scapularis* per mammal, higher than our 2003 average of .389 and more comparable with our elevated 2000 - 2002 averages (all  $\geq$  .806). The Anoka County sites accounted for 60% of the total *I. scapularis* collections (540 larvae; 48 nymphs), with 302 larvae and 10 nymphs collected from just one Blaine Township site. We collected an additional 28% of the total (249 larvae; 22 nymphs) from our Washington County sites. The highest county average number of *I. scapularis* per mammal (2.333) was calculated for Anoka County and was followed by Washington County (.964). Townships maintaining the highest (all  $\geq$  1.0) *I. scapularis* per mammal averages were Saint Francis (6.444), Blaine (6.407), Coon Rapids (1.667), Oak Grove (1.500), Andover (1.481), Ramsey (1.400), East Bethel (1.333) and Lino Lakes (1.216) of Anoka County and Grant (3.647), May (2.123) and Hugo (1.0) townships of Washington County, while averaging  $\geq$  .500 *I. scapularis* per mammal were Burns of Anoka County and New Scandia, Denmark, and Cottage Grove townships of Washington County. Anoka County maintained the highest 1990-2004 overall season mean (.740), surpassing Washington County (.698) for the first time. Our compiled 1990-2004 *I. scapularis* per mammal township averages (all  $>$  1.0) include May, New Scandia, and Hugo of Washington County and Blaine, Coon Rapids, and East Bethel of Anoka County. Both small mammal and immature tick species diversity in 2004 appeared comparable to past years, although *I. scapularis* comprised  $\geq$  50% of our overall collections for only the 2<sup>nd</sup> time (the 2004 tabulation of 55% is the highest percentage of *I. scapularis* in our overall yearly collections since the inception of this study). As in past years, *Peromyscus leucopus* was the predominant mammal species collected, and the 2004 average number of mammals collected per site (11.52) appears to be within low normal parameters for yearly collection levels. Examining human tick-borne disease case numbers, the Minnesota Department of Health recorded an all-time high of Lyme disease cases (1023) and their 2<sup>nd</sup> highest human anaplasmosis case totals (139) in 2004. Although our 2004 results do seem to provide evidence of an elevated *I. scapularis* population, we did not detect unusually high numbers of *I. scapularis* compared with past years. However, even in 2003 when our overall average was lower, we concluded that *I. scapularis* populations remained higher than levels we had detected prior to 1998. Based on these results over the years, we maintain that *I. scapularis* have shown signs of an elevated population level since 2000.

#### Introduction

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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

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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 26, 2004 and ended on October 28, 2004 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

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### Ø 2004 Study (Repeat Sites):

We found at least one *I. scapularis* at 46 of 100 sampling sites, with 37 of these positive sites located north of the Mississippi River in Anoka (17 sites positive/28 sites sampled), Washington (19 sites positive/25 sites sampled), and Ramsey (1 site positive/3 sites sampled) counties. Nine additional positive sites were detected south of the river in Dakota County (8) and Scott County (1). Zero *I. scapularis* were collected in Hennepin or Carver counties in 2004.

Overall, 1152 mammals (Figure 1 and 2004 results in Table 2) were inspected: 564 from north of the Mississippi River and 588 from south of the river and a total of 976 *I. scapularis* (Figure 2 and 2004 results in Table 3) were collected from them. The Anoka County sampling locations accounted for 60% (540 larvae; 48 nymphs) of the total, with 302 larvae and 10 nymphs collected from just one Blaine Township sampling site. We collected an additional 28% of the total (249 larvae; 22 nymphs) from Washington County, with most of the collections occurring in May (134 larvae; 4 nymphs), and Grant (53 larvae; 9 nymphs) townships.

The overall season mean number of *I. scapularis* collected per mammal in 2004 was .847 (larvae: .782, nymphs: .065). The mean increases to 1.554 (larvae: 1.435, nymphs: .119) when all sites negative for *I. scapularis* are excluded (see 2004 results in Figure 6). The highest average number of *I. scapularis* per mammal was calculated for Anoka County, which had a season mean of 2.333 compared with Washington County's season mean of .964 (see 2004 results in Figure 3). Townships in Anoka County averaging  $\geq 1.0$  *I. scapularis* per mammal in 2004 were Saint Francis (6.444), Blaine (6.407), Coon Rapids (1.667), Oak Grove (1.500), Andover (1.481), Ramsey (1.400), East Bethel (1.333) and Lino Lakes (1.216), with Burns (.529) averaging  $\geq .500$  *I. scapularis* per mammal. In Washington County, Grant (3.647), May (2.123) and Hugo (1.0) townships averaged  $\geq 1.0$  *I. scapularis* per mammal in 2004 while New Scandia (.889), Denmark (.622), and Cottage Grove (.541) townships maintained an average  $\geq .500$  *I. scapularis* per mammal (Figure 4).

### Ø Compiled 1990-2004 Results (Repeat Sites):

The 1990-2004 mean number of *I. scapularis* collected per mammal is .392, 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 1990-2004 overall season mean was tabulated for Anoka County (.740), surpassing Washington County (.698) for the first time (no figure). The 1990-2004 township averages for Blaine, Coon Rapids, East Bethel (Anoka County), May, Hugo, and New Scandia (Washington County) townships are > 1.0 *I. scapularis* per mammal, while the averages for Saint Francis, Linwood, and Ham Lake of Anoka County, as well as Grant, Afton, and Lakeland townships of Washington County are > .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 75 of the sites since 1990 or 1991 (see 2004 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
<b>No. sites changing status</b>	26	38	47	58	61	66	69	72	75
<b>Ticks found:</b>									
<b>all years</b>	21	17	11	5	5	5	4	3	1
<b>most years</b>	5	15	19	27	31	34	35	37	38
<b>least</b>	21	23	28	31	30	32	34	35	37
<b>(not found)</b>	53	45	42	37	34	29	27	25	24

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, but in 2004 the second Shoreview Township site was again negative for *I. scapularis*. South of the river we typically tabulate 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 from south of the river were located only in Dakota County from 1990 through 1997. In 1998 we first detected *I. scapularis* in Hennepin and Scott counties<sup>1</sup> and in 2000 we tabulated a total of seven sites (6 Dakota; 1 Hennepin) south of the river. 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 Dakota County locations). In 2004 we tabulated nine sites (8 Dakota; 1 Scott), including one new Dakota County site located in Randolph Township.

Comparing our 2004 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 tabulated the highest percentage of *I. scapularis* (55%) since the inception of this study. This is only the 2<sup>nd</sup> time that *I. scapularis* has comprised ≥ 50% of our overall collections. Our overall season mean of .847 *I. scapularis* per mammal is comparable to our elevated averages of 2000 -2002 (all ≥ .806) and higher than our 2003 average of .389<sup>2</sup> (Figures 3 and 6). *P. leucopus* consistently has been the predominant mammal species collected each year with some

<sup>1</sup> *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.

<sup>2</sup> while we collected fewer *I. scapularis* larvae, our total 2003 *I. scapularis* nymph count was in the hundreds (140) for only the 3<sup>rd</sup> time.

variability in the total percentages collected<sup>3</sup> (Figure 1 and Table 2). The 2004 average number of mammals collected per site (11.52) appears to be within low normal parameters for yearly collection levels. Our compiled average small mammal collection success level per site for 1990 through 2004 is 13.78 (1991-2004 average of 13.09 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

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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<sup>4</sup>.

Our *I. scapularis* collections in 2004 seem to reflect the elevated population levels of 2000 – 2002<sup>5</sup> compared with our lower (but mixed) results in 2003<sup>6</sup>. In 2004 we collected fewer *I. scapularis* nymphs but many more *I. scapularis* larvae than in 2003 (Table 3). We also tabulated more positive sites (white boxes on Figure 3) in 2004 compared with 2003 and all years prior to 1999. Our overall season mean of .847 *I. scapularis* per mammal is higher than our 2003 average of .389 and similar to our elevated 2000 - 2002 averages (all  $\geq$  .806). We compiled the highest season mean number of *I. scapularis* collected per mammal for an individual county in 2004 (2.333 for Anoka County) as well as the highest average to date for Dakota County (Figure 3), but we had compiled similar results when Anoka County maintained comparable averages in 2000 (2.192) and 2002 (2.125). We did tabulate the highest percentage of *I. scapularis* (55%) in our overall collections since the inception of this study, which is important since other than 2002, when *I. scapularis* comprised 50% of our overall collections, the majority of ticks we have collected each year have actually been *Dermacentor variabilis* rather than *I. scapularis* (Table 3).

Examining human tick-borne disease case numbers, the Minnesota Department of Health (MDH) recorded another all-time high of Lyme disease cases (1023) as well as their 2<sup>nd</sup> highest human anaplasmosis case totals (139) in 2004<sup>7</sup>. Since 2000 the MDH has been consistently tabulating record-setting tick-borne disease case totals. Their previous all-time high statewide tabulations occurred in 2002 (Lyme 867 and human anaplasmosis 152), with the Lyme case totals of 2000, 2001, and 2003 being comparable (all  $\geq$  463). In the same period, human anaplasmosis cases have ranged from 78 to 152 compared with an average of roughly 15 cases per year through 1999.

Although our 2004 results do seem to provide evidence of an elevated *I. scapularis* population, we did not detect unusually high numbers of *I. scapularis* compared with past years. However, even in 2003 when our overall average was lower, we concluded that *I. scapularis* populations remained higher than levels we had detected prior to 1998. Based on these results over the years, we maintain that *I. scapularis* have shown signs of an elevated population level since 2000.

<sup>3</sup> 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.

<sup>4</sup> 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).

<sup>5</sup> Concepts in this and following paragraphs were presented in the discussion sections of the 1998 - 2003 *I. scapularis* distribution study reports.

<sup>6</sup> Evidence of a continued high level of *I. scapularis* included a high total nymph count, *I. scapularis* collected for the first time near the city of Roseville in Ramsey County (a wooded corridor that connects to a residential park), still higher than typical number of sites (6) tabulated south of the Mississippi River. Evidence of a lowering population included fewer larvae collected, tabulating fewer positive sites (white boxes on Figure 3) overall, and, south of the Mississippi River, from a more restricted geographic area (Dakota County only) when compared to 2000 - 2002.

<sup>7</sup> Human anaplasmosis cases for 2004 are artificially low due to incomplete blood work (56 potential cases not counted in 2004 vs teens in a typical year). Metro 2004 Lyme case totals were 40 (444 total residents diagnosed), with 1 HGE infection (33 total residents diagnosed) pers. comm. MDH.

## ADDITIONAL UPDATES/RESEARCH:

### CONTINUING STUDIES FOR 2005.

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

### DISCONTINUATION FOR 2005.

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Ø **Cooperative studies with Dr. Russell Johnson (University of Minnesota-Mpls).**

A cooperative study regarding the distribution and prevalence of *Borrelia burgdorferi* and the HGE agent in the metropolitan area had resumed in 2004 after a several year break. Sampling was completed in October 2004 but results are not yet available. This was intended as a single year project and is discontinued for 2005.

### **Re-sampling North Oaks (Ramsey County-2 sites) and Elm Creek Park Reserve (Hennepin County-1 site).**

#### **Background:**

#### **North Oaks**

is a residential community in Ramsey county that was extensively examined by the District and Dr. Russell Johnson (UM-Mpls) from 1992 – 1997 and again in 2000. It is parceled into larger acreage lots; those located on the eastern half of the community consisting generally of woody-stemmed vegetation (trees and bushes), with the western side tending towards a more open vegetative environment. Past research results found a *B. burgdorferi* small mammal infection rate ranging overall from 4.5% - 15% (rates seemingly site specific and localized). Most of the *I. scapularis* collections as well as higher *B. burgdorferi* infection rates were found on the eastern side of North Oaks. Surveys regarding Lyme disease in North Oaks residents performed by the Minnesota Department of Health also seemed to establish a pattern of higher risk in the eastern side of the community.

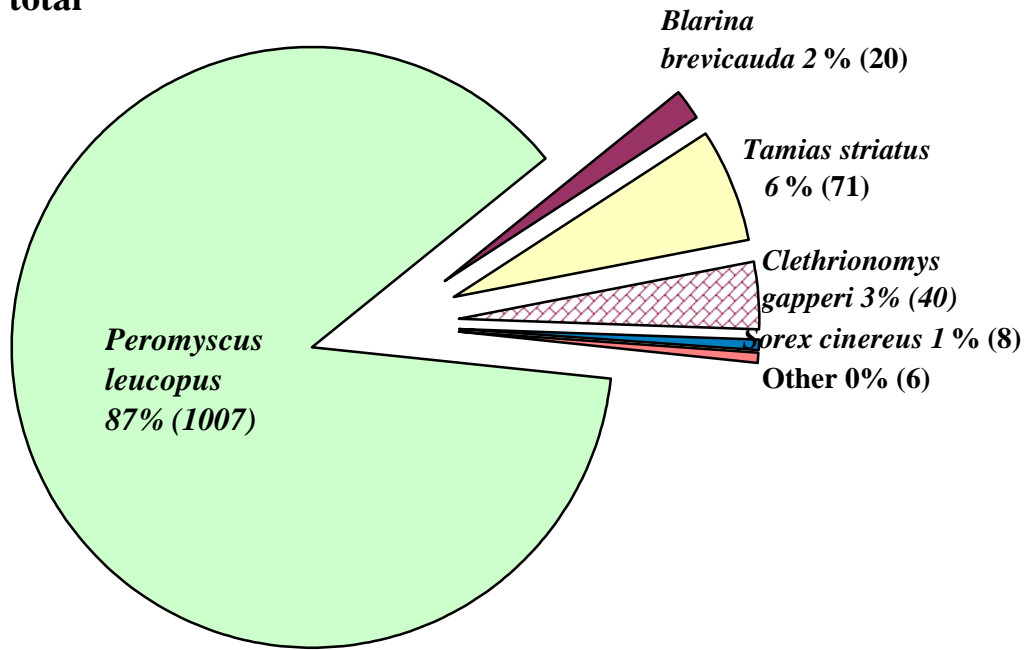
#### **Elm Creek Park Reserve**

is a large acreage nature park comprising of fragmented wooded and open habitats in Dayton, Maple Grove, and Champlin Townships of Hennepin County. A northwest area in Dayton Township was selected for sampling in 1992 as a representative non-endemic site as part of an overall study to demonstrate the presence of *B. burgdorferi* within the seven-county metropolitan area. The 1992 research results for Elm Creek indicated that a small percentage of small mammals were infected with *B. burgdorferi*, and *I. scapularis* were also found in limited numbers at this site.

Since Elm Creek Park Reserve was initially sampled over a decade ago and since the District's surveillance sampling in recent years has detected an elevated *I. scapularis* population, we wanted to re-sample Elm Creek to determine whether any increases in small mammal infection rates or numbers of ticks could be detected. North Oaks was chosen for comparative reasons. Sampling in North Oaks and at Elm Creek Park Reserve occurred from May 10, 2004 through October 14, 2004. Results are not yet available.

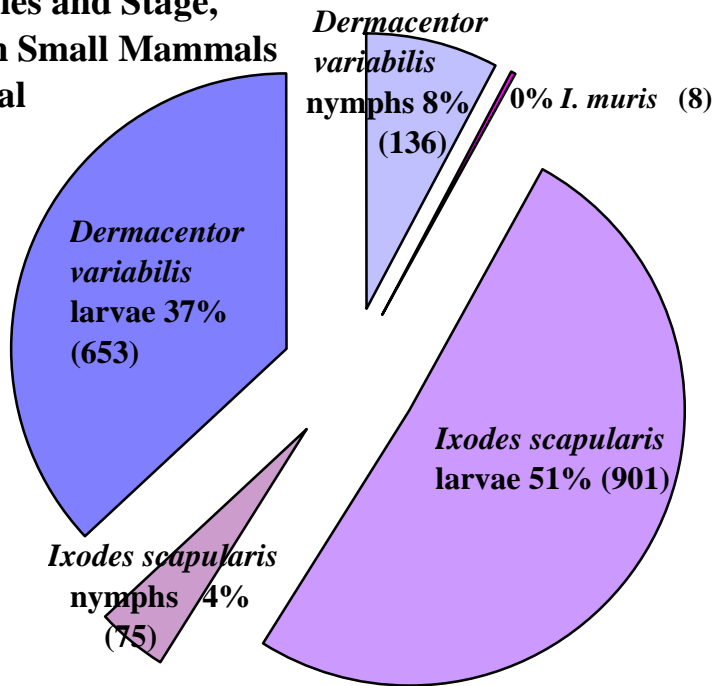
**Small Mammals Collected  
2004: 1152 total**

**Figure 1**



**Ticks, by Species and Stage,  
Removed from Small Mammals  
2004: 1773 total**

**Figure 2**



**Figure 3**

**Average number of *I. scapularis* collected per mammal at 100 sampling locations in Anoka, Washington, and Ramsey counties: 1990 - 2004**  
**(white box shows the total number of sites where at least one *I. scapularis* was found: by year)**

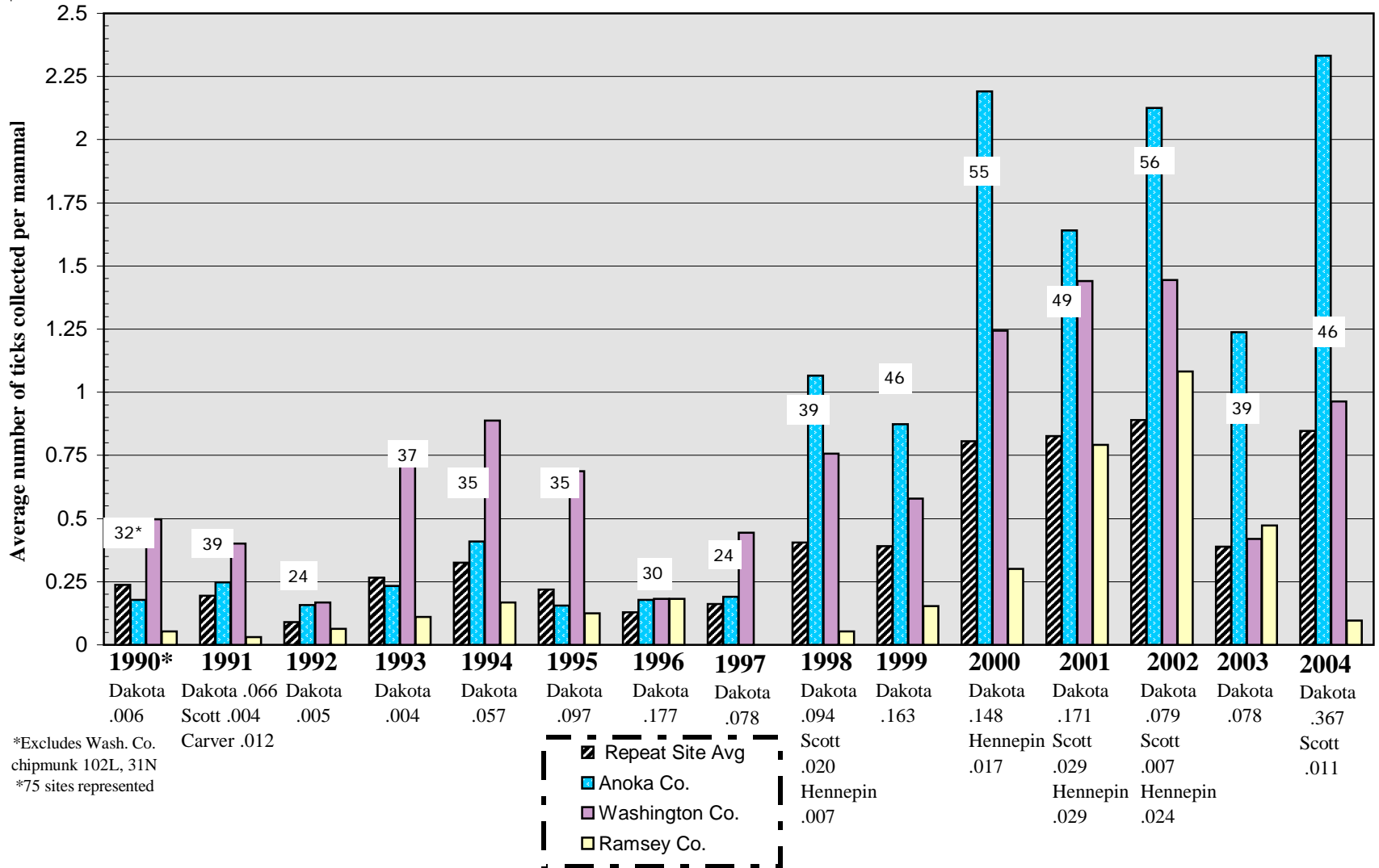
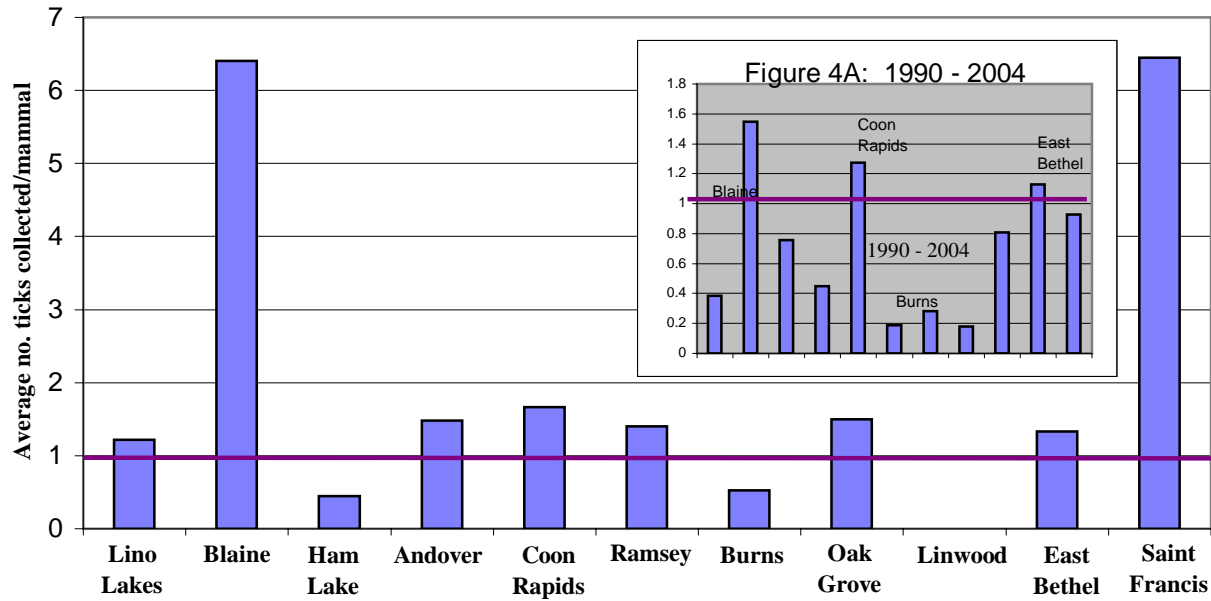
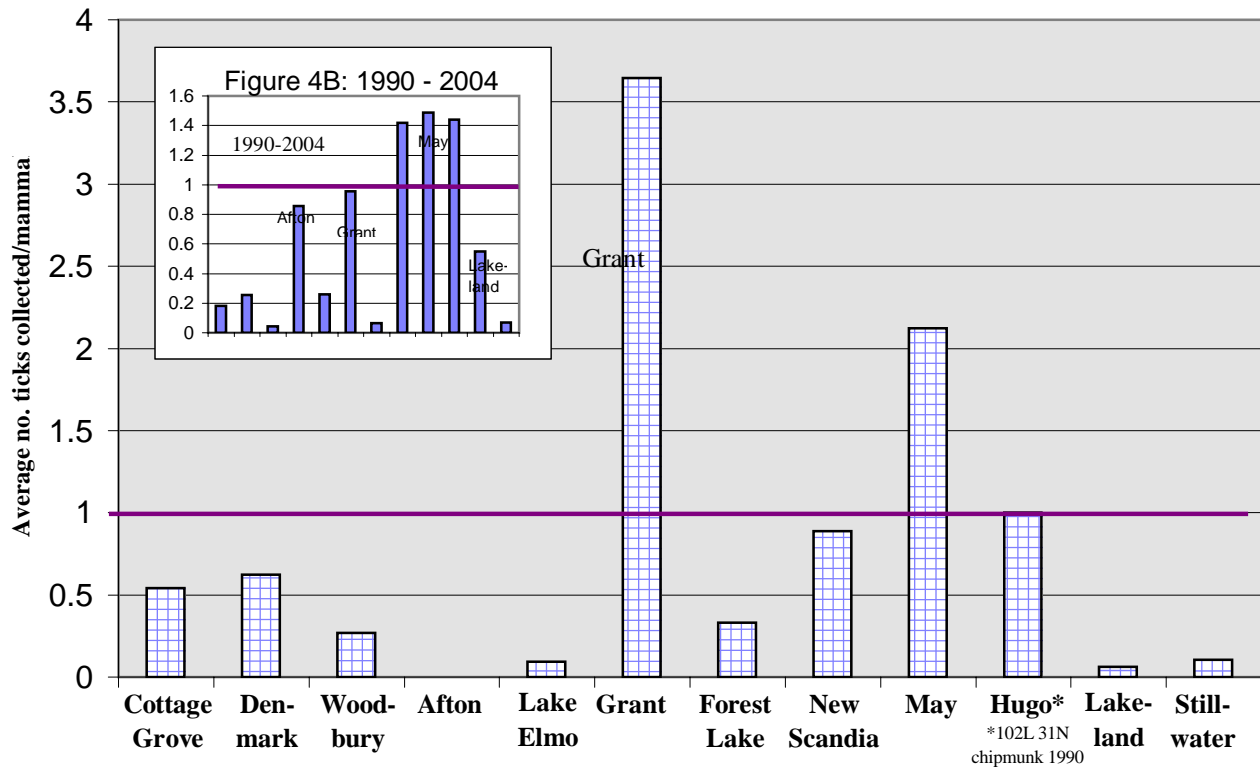


Figure 4

Average number of *I. scapularis* collected per mammal in Anoka county (by township): 2004 results



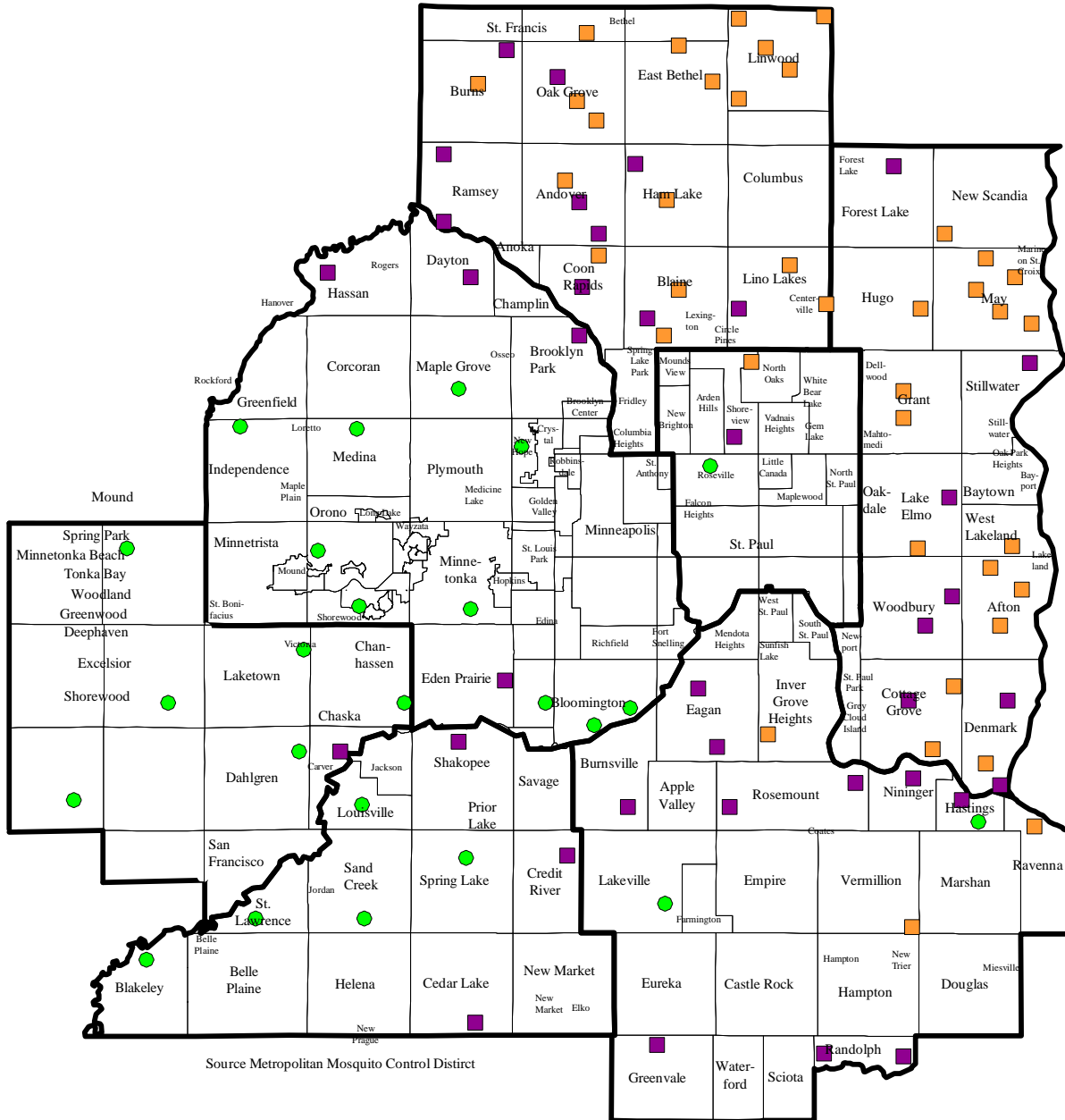
Average number of *I. scapularis* collected per mammal in Washington county (by township): 2004 results





**Figure 5**

*Ixodes scapularis* Presence/Absence status: 1990 - 2004  
 (present if at least one *I. scapularis* is collected during a year)

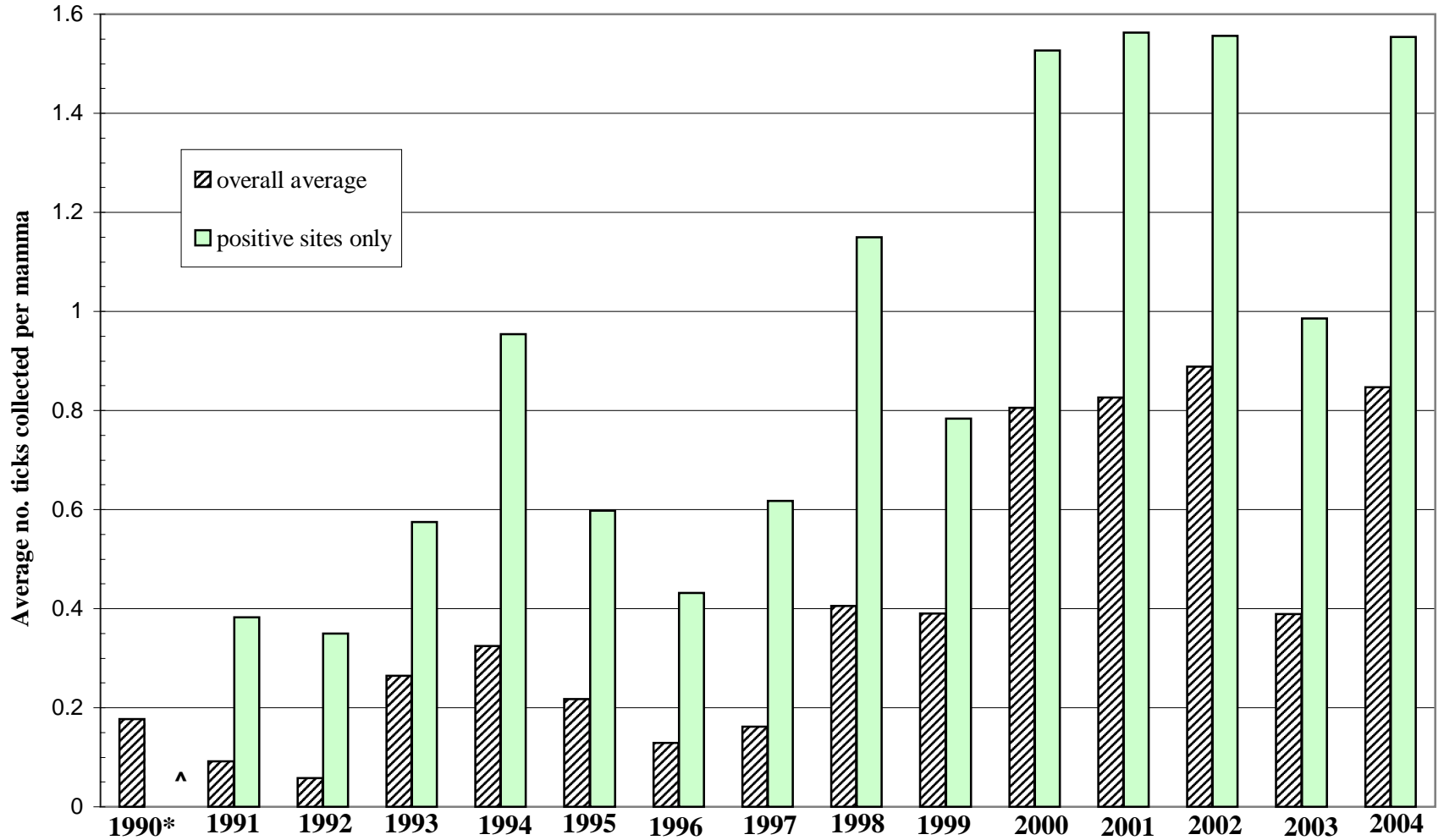


At least one tick found during:

- all/most years (39)
- at least one year (37)
- (not found) (24)

Figure 6

Average number of *I. scapularis* collected per mammal at 100 repeat sampling locations 1990-2004: 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]	<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)
<sup>a</sup> 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)

<sup>a</sup>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 <sup>b</sup> percent (n)	<i>Dermacentor variabilis</i> N <sup>c</sup> percent (n)	<i>Ixodes scapularis</i> L <sup>b</sup> percent (n)	<i>Ixodes scapularis</i> N <sup>c</sup> percent (n)	Other species <sup>d</sup> percent (n)
<sup>a</sup> 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)

<sup>a</sup> 1990 data excludes one *Tamias striatus* with 102 larval & 31 nymphal *I. scapularis*

<sup>b</sup> L = larvae

<sup>c</sup> N = nymphs

<sup>d</sup> Other species mostly *Ixodes muris* 1999-2nd adult *I. muris* collected