

Metropolitan Mosquito Control District  
2020 *Ixodes scapularis* distribution study report

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**Metropolitan Mosquito Control District**  
***IXODES SCAPULARIS* DISTRIBUTION STUDY**  
**2020**

**Abstract**

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A black legged tick (*Ixodes scapularis*) distribution study designed to detect any changes in *Is* 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. Except for 2011, each year since 2007 we have collected *Is* from at least one site in all seven counties that comprise our service area. As in 2018 (64) and 2019 (63), we tabulated a seemingly low number of positive sites in 2020 (64), but totals in the 60's are higher than has been tabulated for most (22 of 31) years of this study, including all years from 1990-2009. In 2020 specifically we collected a total of 1,121 *Is* removed from 1,109 mammals for a season mean of 1.011 *Is* per mammal. Except for 2019's .737 average we have tabulated an overall yearly average > 1.0 *Is* per mammal since 2014. The highest 1990-2020 overall county season mean was calculated for Anoka County (1.219) and was followed by Washington County (1.046). We collected a record proportion of *Is* in our overall tick collections in 2020, as *Is* comprised 89% of all ticks collected (69% were from sites north of the Mississippi River). Our Anoka County sites accounted for the majority (36%) and Washington County accounted for another 30% of *Is* collections. Small mammal (Table 2) species diversity and collection success level in 2020 is comparable to past years; *Peromyscus leucopus* was the predominant mammal species collected. The immature tick species diversity continues to be comparable to past years, but the yearly collection percentages of *Is* and *Dermacentor variabilis* do show changes over time. *Is* has now comprised  $\geq 50\%$  of our overall collections 16 times, compared to the 17 times (the last being in 2011) that *Dv* has comprised the majority. In 2020 we collected an exceptionally low number of *Dv*. While *Dv* in Minnesota only rarely transmit disease and our focus remains on *Is* and its disease potential, we attempted to clarify what may be happening with *Is* and *Dv* by calculating the yearly total percentages of small mammals with at least one *Is* (then one *Dv*) of overall small mammals collected, and by compiling a yearly overall average for *Dv* and a yearly average number of *Is* (then *Dv*) per mammal for only mammals with at least one *Is* (then *Dv*). Percentages of small mammals with *Is* have risen while percentages of small mammals with *Dv*, are more variable, yet stable overall; in the single digits only since 2017 (interpretation possibly complicated by spring snows in 2018, 2019, and 2020). The overall average number of *Dv* per mammal totals have been roughly half or more lower than the *Is* overall averages since 2012, leading to a possible conclusion that *Is* is outcompeting them as our sites are in prime *Is*, not *Dv*, habitat. However, when comparing the yearly *Is* and *Dv* averages from only mammals with at least one *Is* or one *Dv*, the *Is* averages trend slightly upwards while the *Dv* averages seem split into two periods (generally >4 through 2009 and generally < 4 since 2010) and the *Dv* yearly averages are higher than the *Is* averages for 2011, 2012 and 2014. These calculations seem to lead to the conclusion that the *Dv* in our sampling sites are not so much being outcompeted by *Is*, but are being impacted in some other way, while *Is* are just continuing to build and become more prevalent. They also make our record proportion of 89% *Is* in our overall tick collections seem less important; the 2020 *Is* average for only mammals with at least one *Is* is not all that much higher than 2019's, and is lower than averages compiled for some other years. As of July 1, 2020, (due to all epidemiology staff being diverted to the SARS-CoV-2 pandemic) the MN Department of Health (MDH) did not have 2019 or 2020 tick-borne disease case totals prepared but there had been 950 Lyme and 496 human anaplasmosis cases in 2018. While it will take future sampling to determine whether our overall *Is* results will show a continuing upwards trend in the metro *Is* population, the risk of metro *Is* tick encounters remains higher than it used to be throughout our service area as we continue to collect *Is* ticks from a broader geographic area, and in higher numbers, now than in years past. While we are as yet unsure as to where our various *Is* results will land in the next few years, our collections over the longer term should provide us with some more solid answers.

## 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* 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 flagging (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 *Ixodes* 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 *Ixodes* 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 changes in *Ixodes* 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 to track areas that have shown potential *Ixodes* range expansion.

Periodically, additional sites have been sampled:

From 1995-1997 two additional sites were sampled; section 7 of New Market Township in Scott County (where a single adult *Ixodes* 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 *Ixodes* had been collected in either location in the three-year period.

From 2007-2009 several park sites were sampled and results compared to our 1990 results. Although we are still sampling a limited number of parks today, in 1990 a larger number of our sites had been selected inside metropolitan parks to provide a primitive assessment of park user risk to potential *Ixodes* encounters. Included were Joy Park in North Saint Paul (62-08-01) and a location near Pigs Eye Lake in St Paul (62-13-02). In 1990 *Ixodes* had not been collected at either park in three rounds of sampling. We re-sampled both parks, for two rounds only, as extra sites in 2007 and 2008. The 2007-08 Pigs Eye site was moved over one section, to section 3 while the 2007-08 Joy Park site was in the same (square mile) section, but east of our 1990 location. Unlike 1990, we detected *Ixodes* in both parks in both years. In 2009, Joy Park and a previously unsampled Ramsey County location (Priory Preserve (62-04-24)), were both sampled for three rounds. *Ixodes* was found again at Joy Park. Zero mammals were collected at Priory Preserve.

In 2010 Joy Park and Priory Reserve were sampled for two rounds and a new site, section 18 of Laketown Township in Carver County (a single adult *Ixodes* had been collected in late July 2009), was sampled for all three rounds. *Ixodes* was not found at Joy Park in 2010 but was detected at both Priory Reserve and Laketown Township.

## 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 27, 2020 and ended on October 29, 2020. Small mammal trapping was 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. <http://www.earth-pics.com/gallery/10most/the-most-amazing-ice-formations>

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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### ➤ 2020 Study (Repeat Sites):

Except for 2011, since 2007 and again in 2020 we collected *Ixodes* from at least one site in all seven counties that comprise our service area. Specifically, we found at least one *Ixodes* at 64 of our 100 sampling sites, with 40 of these positive sites located north of the Mississippi River in Anoka (21 sites positive of 28 sites sampled), Washington (17 sites positive of 25 sites sampled), and Ramsey (2 sites positive

of 3 sites sampled) counties. Twenty-four additional positive sites were detected south of the river in Dakota (9), Hennepin (7), Scott (6), and Carver (2) counties (Figure 5A).

Overall, 1109 mammals (Figure 1 and 2020 results in Table 2) were inspected: 584 from north of the Mississippi River and 525 from south of the river. A total of 1,121 *Is* (Figure 2 and 2020 results in Table 3) were collected from them. In all, 69% of our 2020 *Is* collections were obtained from our sites north of the Mississippi River. Our Anoka County sites accounted for the majority (36%) of our 2020 collections, with the highest numbers collected in Coon Rapids (121L; 39N) township. Washington County accounted for another 30% of our total *Is* collections, with the highest numbers collected in May township (153L: 7N).

The overall season mean number of *Is* collected per mammal in 2020 was 1.011 (larvae: .967, nymphs: .044). The mean increases to 1.393 (larvae: .967, nymphs: .044) when all sites negative for *Is* are excluded (see 2020 results in Figure 6). The highest average number of *Is* per mammal was calculated for Anoka (1.428) and Washington (1.264) counties (see 2020 results in Figure 3). North of the Mississippi River, townships in Washington County averaging  $\geq 1.0$  *Is* per mammal in 2020 were May (2.352), Stillwater (2.142), Cottage Grove (1.844), Hugo (1.154), and Afton (1.026), in Anoka County, Coon Rapids (4.500), Ham Lake (3.0), Blaine (2.882), East Bethel (2.812), Linwood (1.292), and Lino Lakes (1.120), and in Ramsey County, Shoreview (1.409). Averaging  $\geq .500$  *Is* per mammal north of the Mississippi River in 2020 was Grant (.875), New Scandia (.769), and Denmark (.667) of Washington County, and Andover (.889) of Anoka County. South<sup>1</sup> of the Mississippi River (no figure), townships maintaining averages  $\geq .500$  *Is* per mammal were, in Dakota, Burnsville (5.0) and Inver Grove Heights (1.611) townships, in Hennepin, Dayton (3.0), Bloomington (1.923), and Brooklyn Park (1.0) townships, and in Scott County, Blakeley (1.136) and Saint Lawrence (1.0) townships (Figure 4).

#### ➤ **Compiled Results (Repeat Sites) from 1990 – 2020 or 1991 - 2020:**

Except for 2019's .737 average, we have tabulated an overall yearly average  $> 1.0$  *Is* per mammal since 2014. Comparatively, prior to 2014 we had only tabulated an overall average  $> 1.0$  once, in 2005 (Figures 3 and 6). As shown in our 2020 results above, yearly averages in some townships south of the Mississippi River are now comparable with many townships from north of the river.

The 1990-2020 mean number of *Is* collected per mammal is .684. The highest yearly season means by county have fluctuated primarily between Washington and Anoka counties. Washington County maintained the highest yearly county season means from 1990-1997 while Anoka County maintained the highest yearly county season means from 1998-2009. Since then, Washington County's mean was highest in 2010, 2012 and 2019, while Anoka's was highest in 2011, 2014-2018 and again in 2020. Ramsey County had the highest county season mean (.842) in 2013 (Figure 3). Anoka County's compiled 1990-2020 overall season mean is 1.219 and is followed by Washington County (1.046). The 1990-2020 township averages (all  $> 1.0$ ), north of the Mississippi River include May, Hugo, Afton, Grant, and New Scandia of Washington County and Coon Rapids, Blaine, Ham Lake, Saint Francis, East Bethel, and Linwood of Anoka County, while the averages for Oak Grove, Andover, and Lino Lakes of Anoka County and Lakeland, Cottage Grove, and Lake Elmo townships of Washington County are  $> .500$  *Is* per mammal (Figures 4A and B—inserts on Figure 4). Shoreview of Ramsey County maintained a compiled 1990-2020 average of 1.066. In compiled results from south of the Mississippi River (1991 – 2020), Burnsville (2.680), Inver Grove Heights (1.050), Vermillion (.862) and Hastings (.628) townships of Dakota County, and Bloomington township (.673) of Hennepin County maintained 1991-2020 averages  $> .500$  *Is* per mammal<sup>2</sup> (no figure).

<sup>1</sup> 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  $\geq .500$ .

<sup>2</sup> Inver Grove Heights Township has maintained a compiled 1991-current year average of  $> .500$  *Is* per mammal since 1999 while Vermillion's first compiled 1991-current year average  $> .500$  *Is* per mammal occurred in 2004.

*Is* status at the 100 repeat sampling locations is shown on Figure 5. While the number of sites where *Is* is detected every year has decreased since 1992, we continued to detect *Is* at an increasing number of sites over time and we have now detected *Is* at all but three of our sampling locations. Since 2016 we have tabulated the three negative sites and some fluctuation between least to most at some sites where we tend to find *Is* roughly half of the time (Table 1).

Our positive sites were initially primarily located north of the Mississippi River in Anoka and Washington counties, with one consistently positive Ramsey County site (northern Shoreview Township). We tabulated two positive Ramsey County sites (both of our Shoreview Township sites) for the first time in 2003, and they were positive for *Is* again in 2005, 2006, 2008, 2010, and 2013-2017. Our Roseville site has been positive since 2013.

South of the river, except for 1991 when several *Is* were collected at one site each in Scott and Carver counties, positive sites were located only in Dakota County from 1990 through 1997. Additionally, from 1990 – 1999 we had tabulated a maximum total of 3-4 positive sites each season. In 1998 we first detected *Is* in Hennepin and Scott counties<sup>3</sup> and in 2000 we began to tabulate more sites south of the river than in past years. In 2014 we first tabulated 30 positive sites south of the river and we tabulated similar totals in 2015 (30), 2016 (29), and 2017 (30). In 2020 we tabulated 24 positive sites south of the river (Table 1A).

The total number of ticks collected in 2020 (*Dv*, *Is*, and *Ixodes muris* combined) was 1,264, which is lower than the 1993-2020 average of 1588 ticks collected. However, we did collect more ticks than in seven other years of this study (Table 3). As Figures 3 and 6 show, most of our yearly *Is* averages have been  $\geq .806$  since 2000.

Small mammal (Table 2) species diversity and collection success level in 2020 is comparable to past years. *P. leucopus* consistently has been the predominant mammal species collected each year, with some variability in the total percentages collected<sup>4</sup> (Figure 1 and Table 2). Our compiled average small mammal collection success level per site for 1990 through 2020 is 12.33 (1991-2020 average of 11.76 for 100 repeat sites only), with results ranging from 2013's low of 5.96 mammals collected per site to the high of 20.61 (23.54 at the 100 repeat sites only) in 1991. Therefore, 2020's average number of mammals collected per site (11.09) is a typical yearly small mammal collection total (Table 2).

While the immature tick species diversity appears comparable to past years, the yearly collection percentages of *Is* and *Dv* in Table 3 do show changes over time. Starting in 2002 and including 2020, *Is* has comprised  $\geq 50\%$  of our overall collections 16 times, compared to the 17 times (including for the first 12 years of this study) that *Dv* has comprised the majority. The last time *Dv* was the majority of our overall collections was in 2011. In 2020 *Is* comprised 89% of our overall collections, a new record. To date there have been only eight years with *Is* percentages  $\geq 70\%$ , including 2020. The percentages of *Dv* collected yearly trends downward over time. In fact, excluding 1990-1992 which had more sampling sites and more sites in then known *Dv* habitat, the average percentage of *Dv* in our overall collections has been reducing at a more than 10% rate in roughly five year increments (1993-1997 an average of 74% of overall collections; 1998-2003, 58% of overall collections; 2004-2009, 49% of overall collections; 2010-2014, 34% of overall collections; 2015-2019, 22% of overall collections). In 2020 we collected an exceptionally low number of *Dv* in our overall collections (11%).

<sup>3</sup>*Is* 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 *Is* adult tick in Scott County's New Market Township but no additional *Is* were detected there in a 3 year sampling effort. Staff or the public have continued to occasionally turn in adult *Is* from Scott County, especially from New Market Township, since 1995.

<sup>4</sup>see the discussion sections in the 1993 (*Is* population estimates) and 1994 (graph handout-mammal density equality across sites) *Is* study report.

## Discussion

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*Is* populations are now established throughout our seven-county service area. While in earlier years Lyme disease risk and cases tabulated by the MDH were higher in the northern metropolitan area, greater *Is* exposure opportunities and therefore higher tick-borne disease risk now occurs in all seven counties that comprise our service area. South of the Mississippi River especially, however, risk level varies, as some areas do not contain the wooded or brushy *Is* habitat needed to sustain *Is*.

As Figure's 3 and 6 show, our 2020 overall season mean of 1.011 *Is* per mammal has bumped back up from its 2019 average of .737 and is back to the averages we have come to expect since 2000 (most season means have been  $\geq$  .806), and, except for 2019, more in line with the averages we have been tabulating since 2014 (range 1.011-1.679). We did not see an increase in the number of positive sites we tabulated in 2020, though. As in 2018 (64) and 2019 (63), we tabulated a seemingly low number of positive sites in 2020 (64). Our yearly positive site totals have been lower than 64 only three times in the last 11 years (2019 (63), 2011 (55) and 2013 (43). However, as shown in Figure 3, yearly positive site totals in the 60's are a still higher total than was tabulated for 22 of the 31 years of this study, and are higher than any yearly positive site total through 2009 (range 24 – 57). Our first positive site total in the 50's occurred in 2000, then skipped the 60's and went straight to a total in the 70's in 2010. Our first positive site total in the 80's was in 2015. As we had said in our 2019 report, a few more years of data collection should clarify as to whether 2014 (75 positive sites), 2015 (81), and 2016 (82) are simply outliers or a pre cursor of an eventual continuing documented build up in the *Is* population.

Minnesota human tick-borne disease statewide case data for 2019 and 2020 as provided by the Minnesota Department of Health (MDH) is not yet available (as of June 17, 2020) but in 2018 there had been 950 Lyme and 496 human anaplasmosis (HA) cases. Overall, tick-borne disease cases as tabulated by the MDH began to rise in 2000. The median number of Lyme cases from 2000 to 2008 was 913 (range 463 - 1,239) and from 2009 - 2017 was 1,203 (range 896 - 1,431), while the median number of human anaplasmosis cases from 2000 - 2009 was 163 (range 76-322) and from 2010-2017 was 633 (range 448-788). Comparatively, statewide Lyme case totals from 1992-1999 had been roughly 250 Lyme cases per year, and statewide HA cases from 1997 to 1999 had been roughly 15 HA cases per year.

For a time the MDH had consistently documented that metro residents comprised roughly half of the Minnesota Lyme cases tallied<sup>5</sup>, both in their state-wide and metro-wide data. And, although HA had been detected in MMCD collaborative research in metro-collected small mammals beginning in 1995<sup>6</sup>, locally acquired human HA cases were not documented by MDH until 2000. From 2000 – 2007 the MDH had typically tabulated a few metro-exposed HA cases each year (range 0-9).

As *Dv* in Minnesota only rarely transmit disease (0-2 Rocky Mountain spotted fever cases per year in the state, 0-3 tularemia cases; not all via tick bite, and no known tick paralysis cases) and our focus remains on *Is* and its disease potential, we did and do find it interesting that not only do the percentages of *Dv* collected yearly in Table 3 trend downward over time but that we collected so few *Dv* in 2020. As in 2019 we were not sure what to make of either of these observations. We know that we are not sampling in prime *Dv* habitat but in prime *Is* habitat, which we have thought *Is* to be taking full advantage of and seemingly outcompeting *Dv* there.

<sup>5</sup>Slide 37 [www.health.state.mn.us/divs/idepc/diseases/lyme/lymeslide.ppt](http://www.health.state.mn.us/divs/idepc/diseases/lyme/lymeslide.ppt)

<sup>6</sup>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](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.

In an attempt to clarify what may be happening with *Is* and *Dv*, we decided to compile our data in a couple of different ways. First, for each year of this study (except 1990 as the data file is unreadable), we sorted then counted the number of small mammals with at least one *Is* tick by year and divided it by the total number of small mammals collected that year to arrive at a percentage of small mammals in our overall small mammal collections with at least one *Is*. We did this same calculation for *Dv*. The result is shown in Table EXTRA (Table 2 with two added columns). Not surprisingly, the percentages of small mammals with *Is* have gone up, from single digits to low teens, to low twenties, and then, except for 2013, into the high twenties, with the highest percentage calculated for 2016 (35%), before receding back into the low twenties for 2019 and 2020. For the yearly percentages of small mammals with at least one *Dv*, it was kind of a surprise to not have seen the reverse. The percentages are more variable, yet stable overall, over time, through 2016, when compared with the *Is* mammal percentages. It has only been since 2017 that the yearly *Dv* mammal percentages have been in the single digits. To complicate (or un-complicate) that situation, our seven county Twin Cities service area experienced spring snowstorms in 2018, 2019, and 2020, which could have impacted the number of eggs laid, hatched, or adult or larval survivability. As *Is* adults are out questing generally a month earlier than *Dv* adults, perhaps that caused differences in the effects of the snow events between the two species, as perhaps *Dv* experienced the snow events in a more sensitive time/co-hort than *Is*.

In our second method we sorted, then counted, the number of small mammals with at least one *Is* tick and divided it into the total number of *Is* collected to determine a yearly average *Is* per mammal for only those mammals with at least one *Is* tick. As before, we did the same for *Dv*. Looking at the overall averages for *Is* and *Dv* (the first two bars on Figure EXTRA), the *Dv* overall averages have been roughly half or more lower than the *Is* overall averages since 2012, while as our report already states, the overall *Is* averages have increased over time. However, when comparing not the overall, but the yearly, *Is* and *Dv* averages from only mammals with at least one *Is* or one *Dv* (the last two bars on Figure EXTRA), our record proportion of 89% *Is* of our overall tick collections seems less important as the 2020 *Is* average of 4.300 is not all that much higher than 2019's average of 3.738, and is actually lower than some averages compiled for other years. Looking across the years from 1990 forward, the *Is* averages trend upwards, but only slightly, while the *Dv* averages seem split into two periods (generally >4 through 2009 and generally < 4 since 2010). Our new calculations seem to lead to the conclusion that the *Dv* in our sampling sites are not so much being outcompeted by *Is*, but are being impacted in some other way, while *Is* are just continuing to build and become more prevalent; another interesting piece of information. It is always good to remind ourselves, and the reader, however, that we are not sampling in prime *Dv* habitat so these results may be different than if we were.

Regardless of what is occurring with *Dv*, the risk of *Is* tick encounters is higher than it used to be throughout our service area and is based both on our higher collections of *Is* in recent years compared to the early years as well as that we are collecting *Is* ticks from a broader geographic area now than in years past. While we are as yet unsure as to where our various *Is* results will land in the next few years, our collections over the longer term should provide us with some more solid answers.

#### ADDITIONAL UPDATES/RESEARCH:

#### STUDIES/PROJECT UPDATES AND PLANS FOR 2021.

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- ***Ixodes scapularis* distribution study** (sites unchanged from 1993).
  - **Publication in progress.** In 2014 MMCD had provided *I. scapularis* nymphs from 1990 - 2014 to Steve Bennett (UM-St Paul), for testing. Steve is preparing a paper for publication. His dissertation was titled "The Complex Eco-Epidemiology of Tick Borne Disease: Ticks, Hosts and Pathobiomes in an Urbanizing Environment".
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***AMBLYOMMA AMERICANUM*** (Note the increase in *Aa* collections in 2020, presumably due to an increase in walking locally due to stay at home orders caused by the SARS-CoV-2 pandemic.)

*Aa* (lone star tick) records are significant because these ticks vector human monocytic ehrlichiosis and red meat allergy, they are an aggressive human biter, and their range is known to be moving northward. Though found here since 1990 on a rare, sporadic basis, Minnesota is not within their historic range. In 2009 there were several *Aa* collections in one year (one adult, submitted to the MDH, one nymph, submitted to MMCD); an unusual event. However, since then either agency has continued to receive and identify *Aa* on a yearly basis, as shown in Table 4.

**Table 4. *Amblyomma americanum* collections by MMCD and the MN Dept Health, 2009 -2020.**

| Year  | Stage and sex   | Location  | Agency  |
|-------|---|---|---|
| 2009  | 1 female<br>1 nymph   | ?<br>?  | MDH<br>MMCD   |
| 2010  | 3 females   | Eagan, Mound,<br>Orono/Lk Mtka area   | MMCD  |
| 2011  | 3 females   | Shakopee, Lindstrom,<br>Hennepin Co.  | MDH   |
| 2012  | 3 females   | Eden Prairie or Burnsville,<br>Bloomington, Rice Co.  | MDH   |
| 2013  | 3 females   | Afton, Scandia, Western WI- sent to WDH   | MMCD  |
| 2014  | 1 female  | Zumbrota  | MDH   |
| 2015  | 1 male, 1 nymph<br>1 female   | Elk River area<br>? – collected by Jordan dog groomer   | MMCD  |
| 2016  | 2 nymphs<br>3 females (pictures)<br>2 females (reported)  | Florida travel history<br>Scott Co., Ramsey Co., on a dog – loc ?<br>Wabasha Co., Dakota Co.  | MMCD<br>MDH<br>MDH  |
| 2017  | 1 male (dragging) May 6<br>1 female (picture)<br>1 female (reported) June 27<br>1 female July 6<br>1 female July 7  | Cold Spring (Stearns Co.)<br>Ottertail Co. found on child<br>Chippewa Co<br>Stillwater, Washington Co.<br>Golden Valley, Hennepin Co.   | MDH   |
| 2018  | 1 adult (reported) before June 29<br>1 female (dragging) June 29  | Itasca State Park<br>Near same area as above tick, at Itasca State<br>Park  | MDH   |
| 2019  | 1 female July 12<br>1 female roughly July 16  | Shakopee (1 mi from PetSmart)<br>Lives in Wayzata, found right after Woodbury   | MMCD<br>MDH   |
| 2020  | 1 unknown April 11<br>1 female April 30<br>1 unknown unverified May 7<br>1 female May 18<br>1 male may 18 unverified<br>1 female May 28<br>1 female June 11<br>1 male June 22<br>1 female June 30<br>1 male July 2<br>1 Earlier this year | “imported”. Not from tc metro from Miss<br>Becker County<br>Northfield (fell off my garden glove)<br>Deephaven<br>Itasca St park<br>770 brookline ave st paul<br>Burnsville<br>Douglas County<br>Anoka County 7132 whipporwill ln<br>Nicollet Co N Mankato 519 W Wheeler A<br>N Mankato Belgrade twp 10 min n of this 1 | MDH<br>MDH<br>MMCD<br>MMCD<br>MDH<br>MDH<br>MMCD<br>MDH<br>MDH<br>MDH<br>MMCD |
| TOTAL | 32 female, 5 male, 4 nymph<br>4 unknown adult   | 45 <i>Amblyomma americanum</i> 2009-2020  |   |

## ***HAEMAPHYSALIS LONGICORNIS***

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The Asian longhorned tick (*H. longicornus*, also known as the bush tick/cattle tick) was first detected in New Jersey in the fall of 2017 and is now known to have been in the United States since at least 2010. It has been found mostly on the eastern seaboard but has been found in Arkansas, too. It has the potential to spread various diseases. Its principle host is cattle, and in the United States is known to have fed on domestic animals including cattle, sheep, goats, horses, and wildlife including raccoon, opossum, and deer. It has the potential to feed on humans as well. There are several ways this tick species can reproduce, and the type introduced into the U.S. is parthenogenetic. Therefore, an introduction of a single female tick into an area could potentially cause it to become established.

There is some question as to temperatures and survivability of this parthenogenetic form of tick in Minnesota. The lowest temperatures that the parthenogenetic version is known to be able to withstand is 14°F. Whether it can survive in lower temperatures is unknown. Higher temperatures ( $\geq 81$  °F – 86°F) are detrimental to egg development.

MMCD is in a good position to detect introductions of *HI*. While it seems that our tick surveillance is not as likely to pick up the immature stages, we have a lot of staff walking around in nature on a daily basis, and our staff turns in any unusual adult ticks for identification. We also have had our tick identification service in place for many years so we may receive one in the mail, and we will continue to utilize Facebook to keep the public informed and to enlist their help to turn in unusual ticks.

We are partnering with other Minnesota agencies, including the MDH. All agencies will keep each other informed of any *HI* found, and all ticks tentatively identified as *HI* will be sent to Dr. Ulrike Munderloh, UM – St Paul, for confirmation.

No *HI* are known to have been introduced into Minnesota since our statewide partnership began in the spring of 2018.

**POSTING AT DOG PARKS.** Suspended since 2020 due to the SARS-CoV-2 pandemic.

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Except for 2020 and into 2021, since the initial suggestion of the Technical Advisory Board (TAB) in 2010, we have visited dog parks and vet offices as part of our outreach. Signs have been posted in at least 21 parks with additional signs posted in active dog walking areas. In 2019 we had posted a total of 41 signs at over 36 locations throughout the metro with most signs removed in winter. Signs were re-posted in spring 2019.

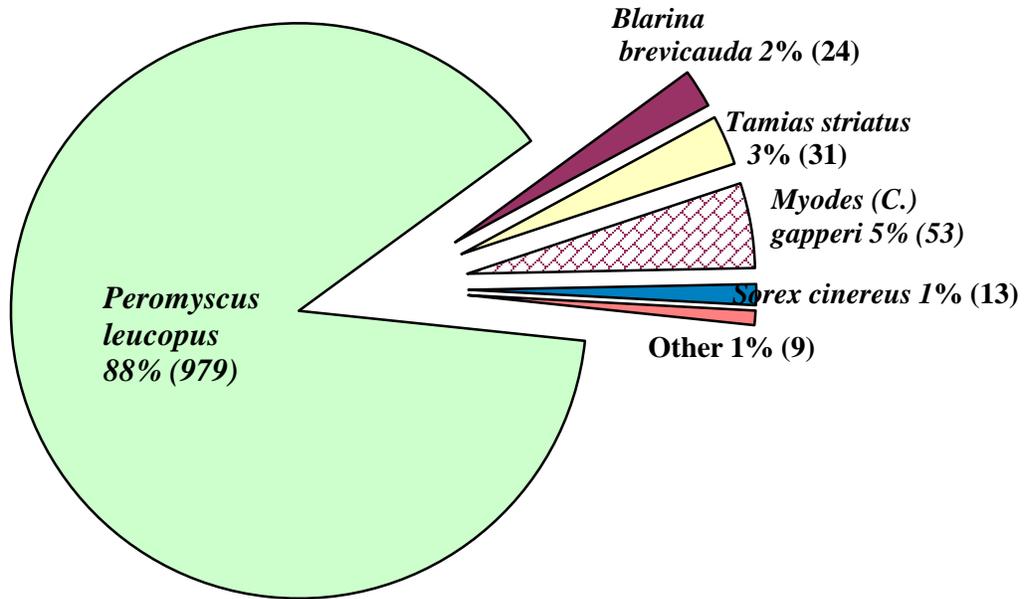
**DISTRIBUTING MATERIALS TO TARGETED AREAS.** Suspended since 2020 due to the SARS-CoV-2 pandemic.

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In 2019 distribution of brochures, tick cards, double-sided lone star/Asian longhorned tick cards, and/or posters were dropped at roughly 292 locations (city halls, libraries, schools, child care centers, retail establishments, vet clinics, parks) across the metro as well as distributed at fair booths and city events, with many more mailed upon request.

**Small Mammals Collected  
2020: 1109 total**

**Figure 1**



**Ticks, by Species and Stage,  
Removed from Small Mammals  
2020: 1,264 total**

**Figure 2**

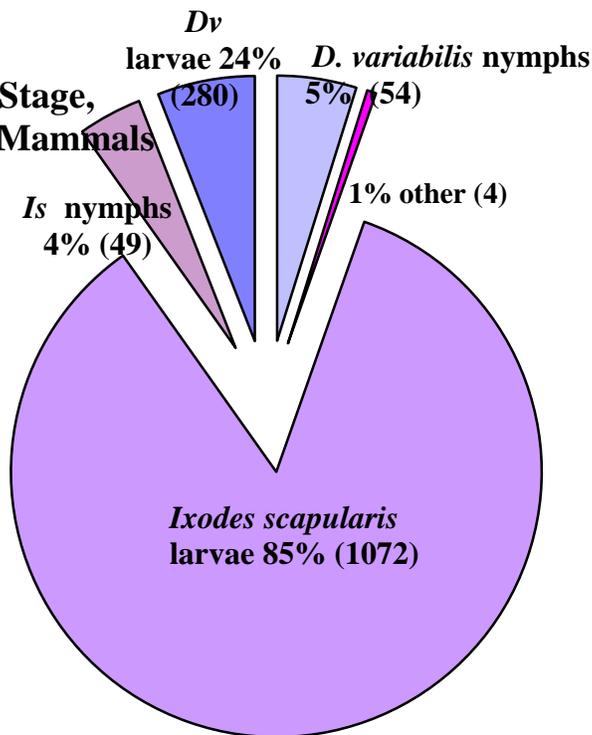


Figure 3

Average number of *I. scapularis* collected per mammal at 100 sampling locations in Anoka, Washington, and Ramsey counties: 1990 - 2020  
 (white box shows the total number of sites where at least one *I. scapularis* was found: by year)

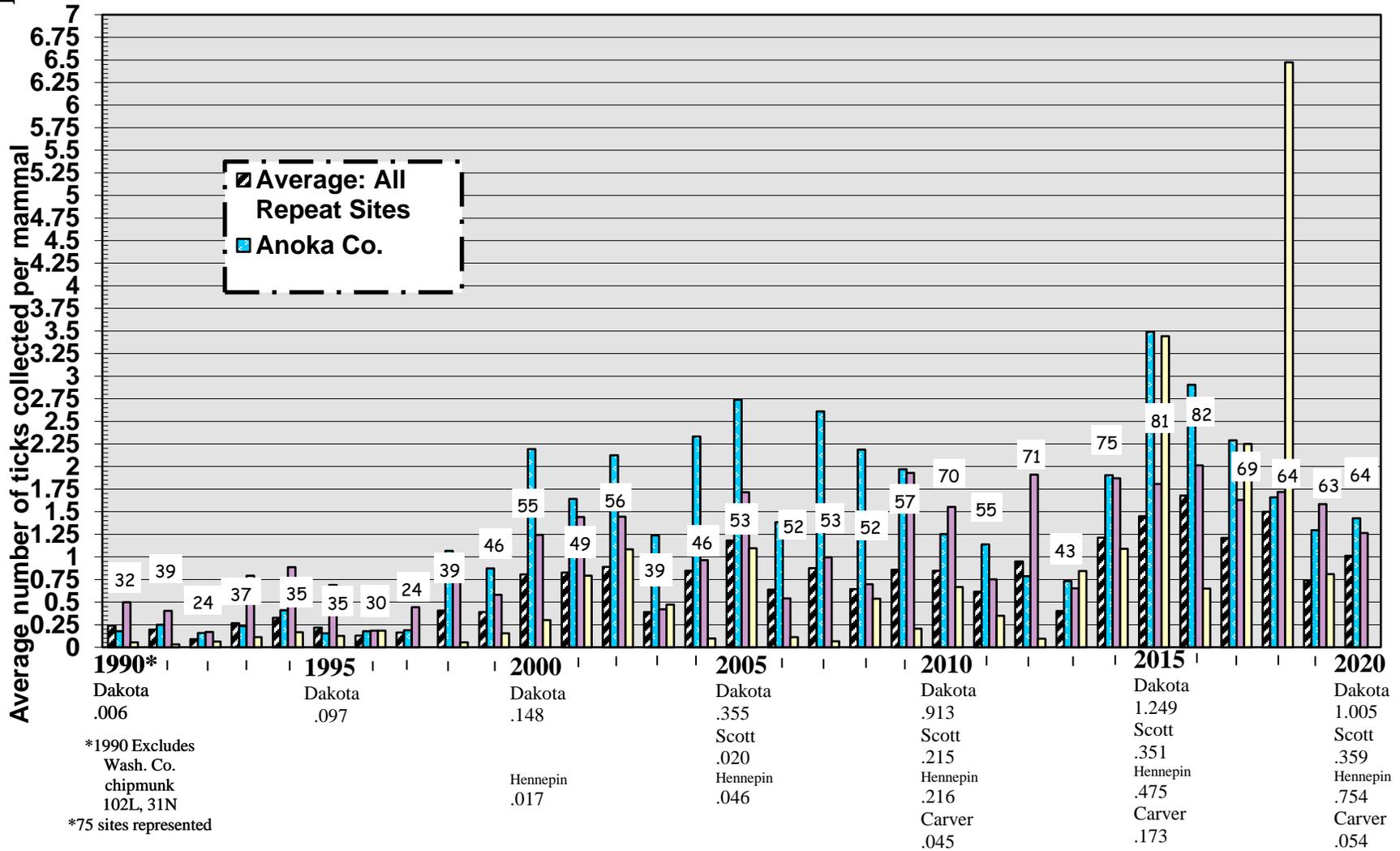
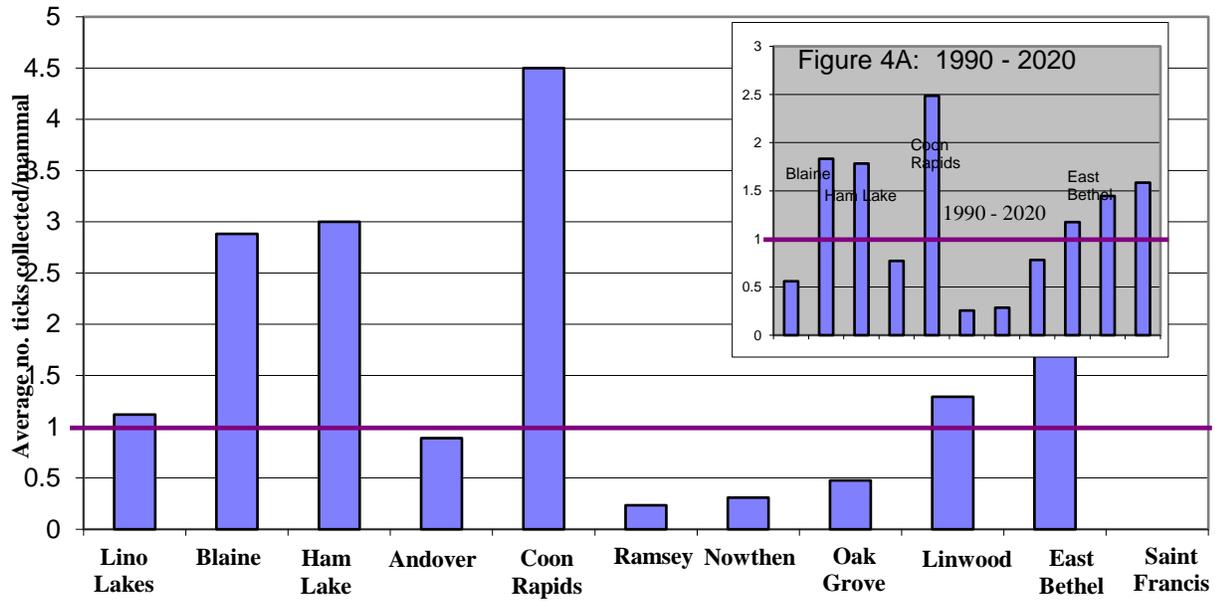


Figure 4

Average number of *I. scapularis* collected per mammal in Anoka county (by township): 2020 results



Average number of *I. scapularis* collected per mammal in Washington county (by township): 2020 results

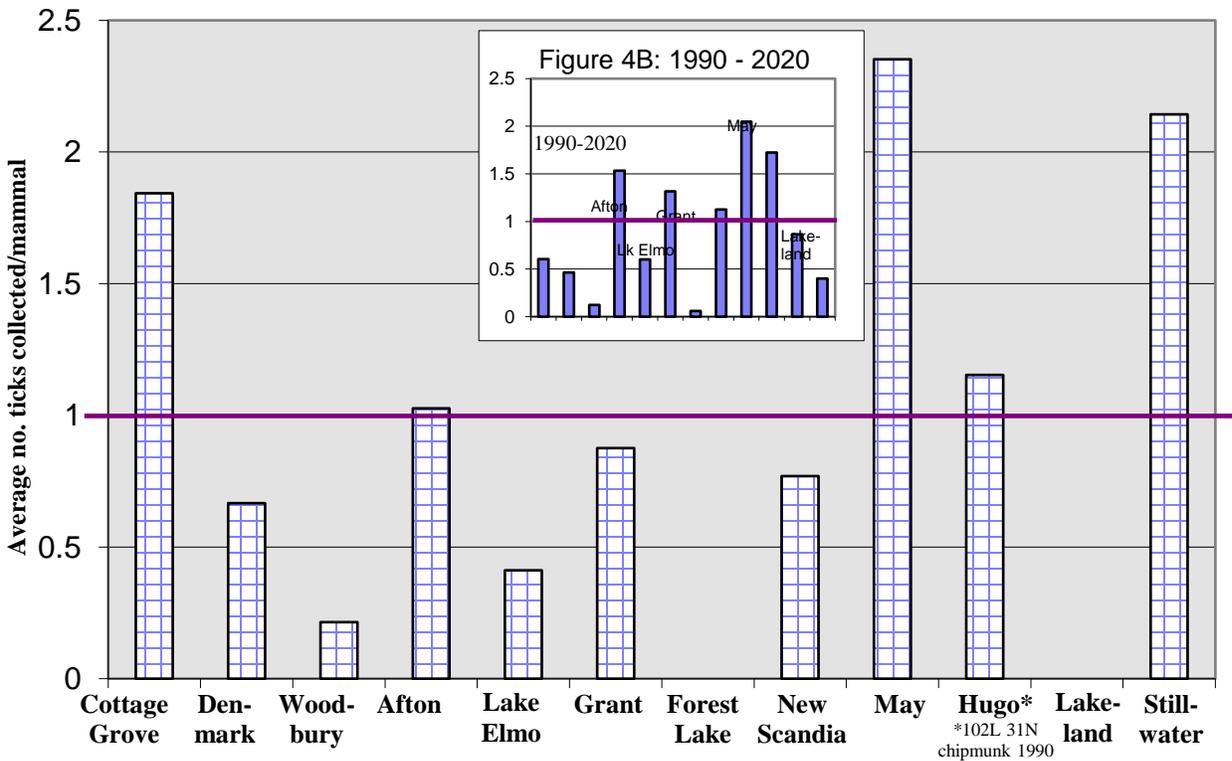
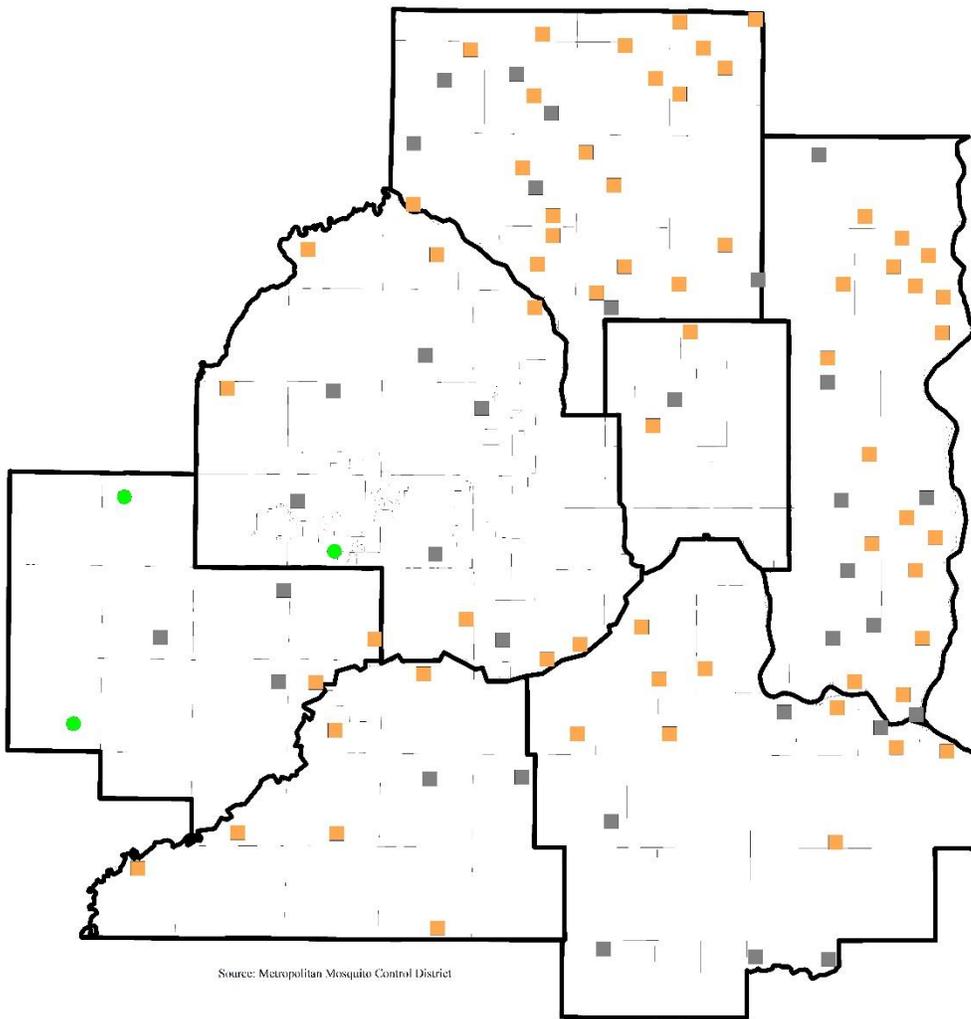


Figure 5A

*Ixodes scapularis* Presence/Absence status: 2020

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



| Status 2020        |      |
|--------------------|------|
| ■ present          | (64) |
| ■ absent this year | (33) |
| ● Not found        | (3)  |

2020 *Ixodes scapularis* distribution study report  
Metropolitan Mosquito Control District



Figure 6

Average number of *I. scapularis* collected per mammal at 100 repeat sampling locations 1990-2020 overall vs. sites where at least one *I. scapularis* was collected (positive sites)

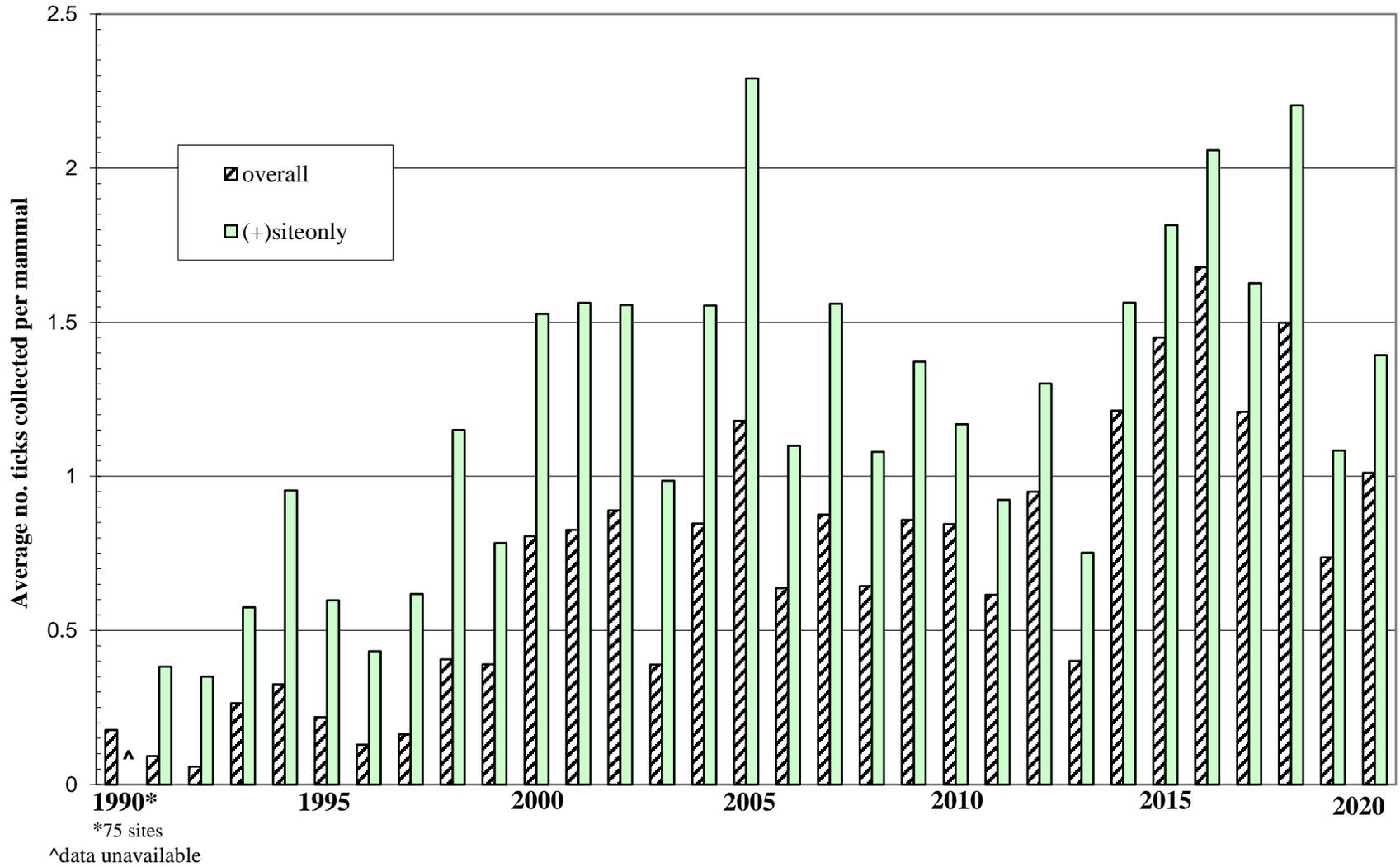


Table 1: Comparison of *I. scapularis* Presence/Absence Status at 100 Repeat Sampling Locations

|                                  | 1992 | 1994 | 1996 | 1998 | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2012 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|----------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| <b>No. sites changing status</b> | 26   | 38   | 47   | 58   | 61   | 69   | 75   | 78   | 81   | 88   | 91   | 94   | 95   | 96   | 96   | 96   | 96   | 96   |
| <b>Ticks found:</b>              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>all years</b>                 | 21   | 17   | 11   | 5    | 5    | 4    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| <b>most years</b>                | 5    | 15   | 19   | 27   | 31   | 35   | 38   | 41   | 42   | 44   | 45   | 45   | 48   | 45   | 51   | 50   | 53   | 54   |
| <b>least</b>                     | 21   | 23   | 28   | 31   | 30   | 34   | 37   | 37   | 39   | 44   | 46   | 49   | 47   | 51   | 45   | 46   | 43   | 42   |
| <b>(not found)</b>               | 53   | 45   | 42   | 37   | 34   | 27   | 24   | 21   | 18   | 11   | 8    | 5    | 4    | 3    | 3    | 3    | 3    | 3    |

Table 1A: Number of Sites South of the Mississippi River Positive for *I. scapularis*

|                                   | 1992 | 1994 | 1996 | 1998 | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2012 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|-----------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| <b>Total sites south of river</b> | *1   | 2    | 4    | 4    | 7    | 12   | 9    | 12   | 19   | 24   | 27   | 30   | 30   | 29   | 30   | 23   | 23   | 24   |
| <b>By county:</b>                 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Dakota</b>                     | *1   | 2    | 4    | 2    | 6    | 8    | 8    | 9    | 12   | 10   | 13   | 11   | 13   | 11   | 12   | 9    | 7    | 9    |
| <b>Hennepin</b>                   | *0   | 0    | 0    | 1    | 1    | 3    | 0    | 2    | 3    | 6    | 7    | 8    | 8    | 9    | 7    | 8    | 7    | 7    |
| <b>Scott</b>                      | *0   | 0    | 0    | 1    | 0    | 1    | 1    | 1    | 2    | 6    | 4    | 7    | 6    | 7    | 8    | 5    | 6    | 6    |
| <b>Carver</b>                     | *0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 2    | 2    | 3    | 4    | 3    | 2    | 3    | 1    | 3    | 2    |

\*This count includes only our current site network. However, despite our intensive 1992 effort, the overall total was only 2 (both Dakota County).

**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>Myodes (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% (1114)                             | 11% (156)                          | 4% (56)   | 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)                               | 2% (34)            |
| 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% (20)            |
| 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)            |
| 2007              | 100       | 849                     | [8.49]   | 85% (721)                              | 8% (71)                            | 5% (42)   | 1% (5)                                | 1% (10)            |
| 2008              | 100       | 702                     | [7.02]   | 80% (560)                              | 8% (53)                            | 6% (45)   | 4% (29)                               | 2% (15)            |
| 2009              | 100       | 941                     | [9.41]   | 86% (809)                              | 4% (40)                            | 5% (47)   | 1% (14)                               | 3% (31)            |
| 2010              | 100       | 1320                    | [13.20]  | 82% (1084)                             | 4% (55)                            | 6% (78)   | 5% (70)                               | 3% (33)            |
| 2011              | 100       | 756                     | [7.56]   | 73% (549)                              | 8% (62)                            | 11% (81)  | 6% (43)                               | 3% (21)            |
| 2012              | 100       | 1537                    | [15.37]  | 86% (1322)                             | 3% (49)                            | 7% (103)  | 2% (31)                               | 2% (32)            |
| 2013              | 100       | 596                     | [5.96]   | 80% (474)                              | 5% (31)                            | 9% (56)   | 3% (18)                               | 3% (17)            |
| 2014              | 100       | 1396                    | [13.96]  | 85% (1192)                             | 5% (69)                            | 7% (101)  | 2% (23)                               | 1% (11)            |
| 2015              | 100       | 1195                    | [11.95]  | 84% (1006)                             | 5% (62)                            | 7% (83)   | 2% (22)                               | 2% (22)            |
| 2016              | 100       | 1374                    | [13.74]  | 84% (1149)                             | 5% (67)                            | 6% (86)   | 3% (46)                               | 2% (26)            |
| 2017              | 100       | 1079                    | [10.79]  | 83% (894)                              | 5% (56)                            | 8% (88)   | 2% (25)                               | 1% (16)            |
| 2018              | 100       | 765                     | [7.65]   | 83% (637)                              | 3% (26)                            | 9% (69)   | 3% (23)                               | 1% (10)            |
| 2019              | 100       | 1121                    | [11.21]  | 88% (984)                              | 4% (42)                            | 6% (73)   | 1% (14)                               | 1% (8)             |
| 2020              | 100       | 1109                    | [11.09]  | 88% (979)                              | 3% (31)                            | 5% (53)   | 2% (24)                               | 1% (9)             |

\*Other includes *Microtus pennsylvanicus*, *Spermophilus tridecemlineatus*, *Zapus hudsonius*, *Mustela erminea*, *Tamiasciurus hudsonicus*, *Glaucomys volans*, *Sorex arcticus*, *Sorex cinereus*, *Mus musculus* 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)                                 |
| 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)                                |
| 2007              | 100       | 1700                  | 47% (807)  | 8% (136)   | 33% (566)   | 10% (178)   | 1% (13)                                |
| 2008              | 100       | 1005                  | 48% (485)  | 6% (61)  | 34% (340)   | 11% (112)   | 1% (7)                                 |
| 2009              | 100       | 1897                  | 48% (916)  | 9% (170)   | 39% (747)   | 3% (61)   | 0% (3)                                 |
| 2010              | 100       | 1553                  | 21% (330)  | 7% (101)   | 65% (1009)  | 7% (107)  | 0% (6)                                 |
| 2011              | 100       | 938                   | 40% (373)  | 10% (97)   | 28% (261)   | 22% (205)   | 0% (2)                                 |
| 2012              | 100       | 2223                  | 25% (547)  | 9% (211)   | 59% (1321)  | 6% (139)  | 0% (5)                                 |
| 2013              | 100       | 370                   | 24% (88)   | 11% (42)   | 40% (147)   | 25% (92)  | 0% (1)                                 |
| 2014              | 100       | 2427                  | 24% (580)  | 6% (149)   | 67% (1620)  | 3% (74)   | 0% (4)                                 |
| 2015              | 100       | 2217                  | 15% (390)  | 4% (91)  | 65% (1442)  | 13% (291)   | 0% (3)                                 |
| 2016              | 100       | 3038                  | 19% (576)  | 5% (153)   | 68% (2055)  | 8% (252)  | 0% (2)                                 |
| 2017              | 100       | 1609                  | 16% (253)  | 3% (45)  | 68% (1101)  | 13% (204)   | 0% (6)                                 |
| 2018              | 100       | 1430                  | 15% (219)  | 4% (63)  | 70% (1007)  | 10% (139)   | 1% (2)                                 |
| 2019              | 100       | 1164                  | 24% (280)  | 5% (54)  | 55% (645)   | 15% (181)   | 1% (4)                                 |
| 2020              | 100       | 1264                  | 6% (75)  | 5% (61)  | 85% (1072)  | 4% (49)   | 0% (7)                                 |

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

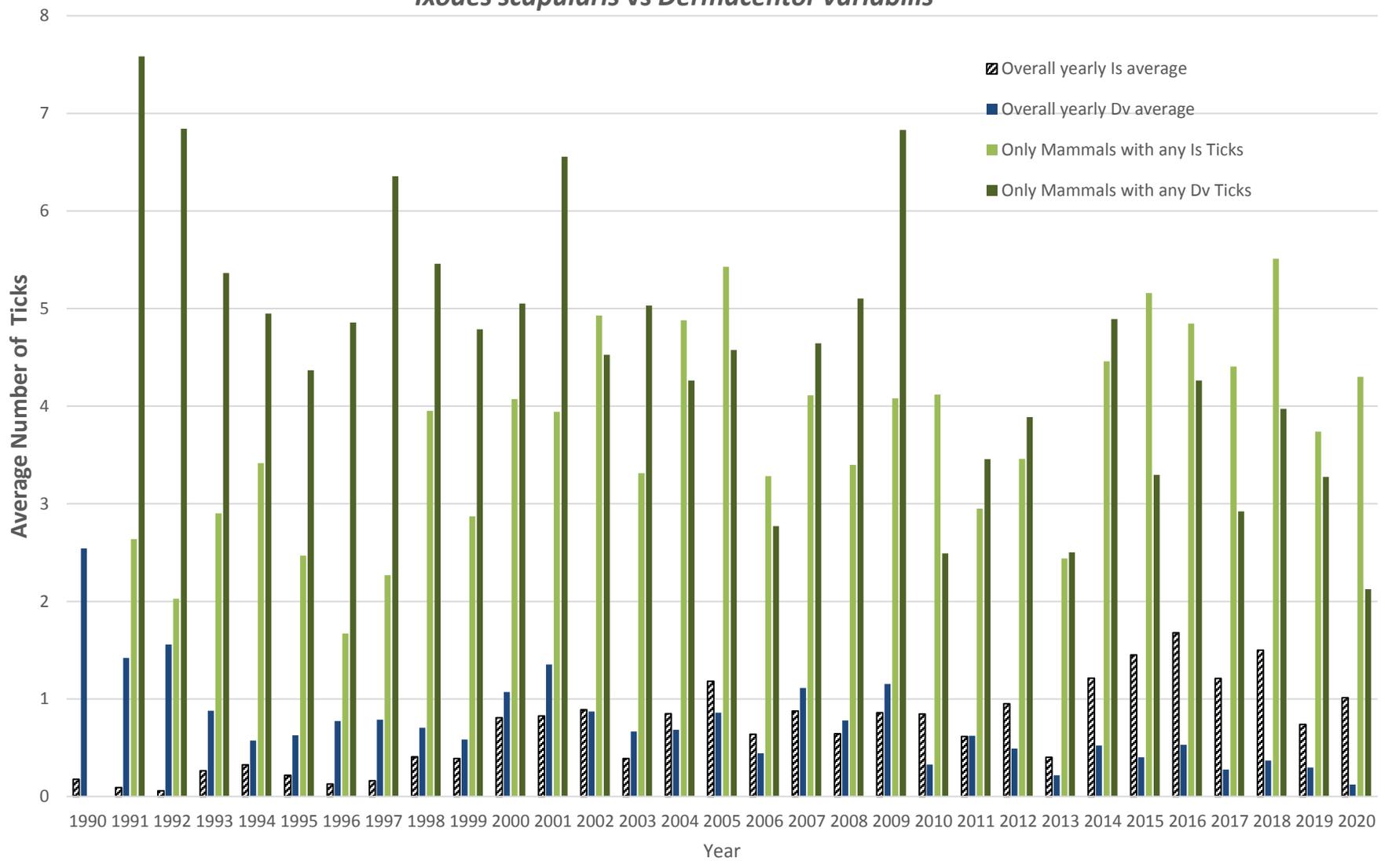
<sup>b</sup> L = larvae

<sup>c</sup> N = nymphs

<sup>d</sup> Other species mostly *Ixodes muris* 1999-2nd adult *I. muris* collected 2007-collected 7 *I. marxi* nymphs

mean

**Figure EXTRA.** Comparing Overall Yearly Averages and Yearly Averages Only On Mammals with Ticks:  
*Ixodes scapularis* vs *Dermacentor variabilis*



**Table EXTRA. (Table 2 plus last two columns). Numbers and Percentages of Small Mammals Collected by Year, and yearly percent of small mammals with at least one *Ixodes scapularis* and yearly percent of small mammals with at least one *Derma-centor variabilis***

| Year              | No. sites | Total mammals collected | Avg collected per site and [100 repeat sites only] | <i>Myodes</i>                          |                                    |  |                                       |          | Other* percent (n) | percent of <i>smal</i> mammals with at least 1 <i>Is</i> | percent of <i>small</i> mammals with at least 1 <i>Dv</i> |
|-------------------|-----------|-------------------------|--|--|------------------------------------|--|---------------------------------------|----------|--------------------|--|---|
|                   |           |                         |  | <i>Peromyscus leucopus</i> percent (n) | <i>Tamias striatus</i> percent (n) | <i>(Clethrionomys) gapperi</i> percent (n) | <i>Blarina brevicauda</i> 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) | 4%                 | 19%  |   |
| 1992              | 200       | 2544                    | 12.72 [12.68]                                      | 71% (1804)                             | 9% (223)                           | 4% (103)                                   | 13% (329)                             | 3% (85)  | 3%                 | 23%  |   |
| 1993              | 100       | 1543                    | [15.43]  | 81% (1243)                             | 4% (69)                            | 7% (101)                                   | 7% (107)                              | 1% (23)  | 9%                 | 16%  |   |
| 1994              | 100       | 1672                    | [16.72]  | 78% (1309)                             | 10% (171)                          | 5% (79)                                    | 5% (76)                               | 2% (37)  | 10%                | 12%  |   |
| 1995              | 100       | 1406                    | [14.06]  | 79% (1114)                             | 11% (156)                          | 4% (56)                                    | 4% (61)                               | 1% (19)  | 9%                 | 14%  |   |
| 1996              | 100       | 791                     | [7.91]   | 79% (628)                              | 11% (84)                           | 3.5% (29)                                  | 3.5% (28)                             | 3% (22)  | 8%                 | 16%  |   |
| 1997              | 100       | 728                     | [7.28]   | 71% (515)                              | 13% (98)                           | 3% (24)                                    | 10% (71)                              | 3% (20)  | 7%                 | 12%  |   |
| 1998              | 100       | 1246                    | [12.46]  | 84% (1041)                             | 4% (51)                            | 3% (42)                                    | 6% (72)                               | 3% (40)  | 10%                | 13%  |   |
| 1999              | 100       | 1627                    | [16.27]  | 85% (1376)                             | 7% (108)                           | 3% (46)                                    | 4% (63)                               | 2% (34)  | 14%                | 12%  |   |
| 2000              | 100       | 1173                    | [11.73]  | 83% (968)                              | 7% (86)                            | 5% (55)                                    | 2% (28)                               | 3% (36)  | 20%                | 21%  |   |
| 2001              | 100       | 897                     | [8.97]   | 80% (719)                              | 6% (58)                            | 7% (63)                                    | 4% (39)                               | 2% (18)  | 21%                | 21%  |   |
| 2002              | 100       | 1236                    | [12.36]  | 87% (1074)                             | 6% (73)                            | 3% (42)                                    | 2% (27)                               | 2% (20)  | 18%                | 19%  |   |
| 2003              | 100       | 1226                    | [12.26]  | 88% (1081)                             | 6% (72)                            | 3% (36)                                    | 1% (16)                               | 2% (21)  | 12%                | 13%  |   |
| 2004              | 100       | 1152                    | [11.52]  | 87% (1007)                             | 6% (71)                            | 3% (40)                                    | 2% (20)                               | 1% (14)  | 17%                | 15%  |   |
| 2005              | 100       | 965                     | [9.65]   | 87% (841)                              | 6% (54)                            | 4% (37)                                    | 2% (16)                               | 2% (17)  | 21%                | 19%  |   |
| 2006              | 100       | 1241                    | [12.41]  | 85% (1056)                             | 4% (54)                            | 8% (94)                                    | 0% (2)                                | 3% (35)  | 19%                | 16%  |   |
| 2007              | 100       | 849                     | [8.49]   | 85% (721)                              | 8% (71)                            | 5% (42)                                    | 1% (5)                                | 1% (10)  | 21%                | 24%  |   |
| 2008              | 100       | 702                     | [7.02]   | 80% (560)                              | 8% (53)                            | 6% (45)                                    | 4% (29)                               | 2% (15)  | 19%                | 15%  |   |
| 2009              | 100       | 941                     | [9.41]   | 86% (809)                              | 4% (40)                            | 5% (47)                                    | 1% (14)                               | 3% (31)  | 21%                | 17%  |   |
| 2010              | 100       | 1320                    | [13.20]  | 82% (1084)                             | 4% (55)                            | 6% (78)                                    | 5% (70)                               | 3% (33)  | 21%                | 13%  |   |
| 2011              | 100       | 756                     | [7.56]   | 73% (549)                              | 8% (62)                            | 11% (81)                                   | 6% (43)                               | 3% (21)  | 21%                | 18%  |   |
| 2012              | 100       | 1537                    | [15.37]  | 86% (1322)                             | 3% (49)                            | 7% (103)                                   | 2% (31)                               | 2% (32)  | 27%                | 13%  |   |
| 2013              | 100       | 596                     | [5.96]   | 80% (474)                              | 5% (31)                            | 9% (56)                                    | 3% (18)                               | 3% (17)  | 16%                | 9%   |   |
| 2014              | 100       | 1396                    | [13.96]  | 85% (1192)                             | 5% (69)                            | 7% (101)                                   | 2% (23)                               | 1% (11)  | 27%                | 11%  |   |
| 2015              | 100       | 1195                    | [11.95]  | 84% (1006)                             | 5% (62)                            | 7% (83)                                    | 2% (22)                               | 2% (22)  | 28%                | 12%  |   |
| 2016              | 100       | 1374                    | [13.74]  | 84% (1149)                             | 5% (67)                            | 6% (86)                                    | 3% (46)                               | 2% (26)  | 35%                | 12%  |   |
| 2017              | 100       | 1079                    | [10.79]  | 83% (894)                              | 5% (56)                            | 8% (88)                                    | 2% (25)                               | 1% (16)  | 27%                | 9%   |   |
| 2018              | 100       | 765                     | [7.65]   | 83% (637)                              | 3% (26)                            | 9% (69)                                    | 3% (23)                               | 1% (10)  | 27%                | 9%   |   |
| 2019              | 100       | 1121                    | [11.21]  | 88% (984)                              | 4% (42)                            | 6% (73)                                    | 1% (14)                               | 1% (8)   | 20%                | 9%   |   |
| 2020              | 100       | 1109                    | [11.09]  | 88% (979)                              | 3% (31)                            | 5% (53)                                    | 2% (24)                               | 1% (9)   | 24%                | 6%   |   |

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