Metropolitan Mosquito Control District
IXODES SCAPULARIS DISTRIBUTION STUDY
2021

Abstract

The Metropolitan Mosquito Control District continued its black legged tick (*Ixodes scapularis*) distribution study across our seven-county metropolitan service area. We collect ticks from small mammals that were trapped in 100 wooded locations, all of which have been sampled since either 1990 or 1991. We maintain this study to detect changes in *Is* distribution over a many year period and to remain prepared in the event that an operationally and economically feasible tick control method becomes available. Except for 2011, each year since 2007 we have collected *Is* from at least one site in all seven counties. In 2021 it was a low collection year for both ticks (767) and small mammals (799). All five of our low total tick collection years have been in low mammal collection years. We removed a total of 574 *Is* from those 799 mammals for a season mean of 0.718 *Is* per mammal. This season mean is lower than most yearly averages tabulated in recent years. The total number of sites positive for *Is* in 2021 was 61. Collectively, the sites in the three counties located north of the Mississippi River accounted for the majority (59%) of our 2021 *Is* collections. However, when comparing the numbers of *Is* collected within each county, our Hennepin County sites accounted for the majority (36%) of the season's *Is* collections. Bloomington township had the highest *Is* collections (96L; 31N) in the county. This is the first year that the most *Is* in a county were collected from a county located south of the Mississippi River. Small mammal species diversity in 2021 is comparable to past years as *Peromyscus leucopus* was again the predominant mammal species collected. The immature tick species diversity continues to be comparable to past years as well, but the yearly collection percentages of *Is* and *Dermacentor variabilis* had flipped some time ago from predominantly *Dv* to predominantly *Is*. In 2021 *Is* comprised 75% of all ticks collected. The low collection success level of both *Is* and *P. leucopus* in 2021 was likely due to 2021 being an intense drought year throughout Minnesota. Due to the diversion of all epidemiology staff to assisting in work associated with the SARS-CoV-2 pandemic, the MN Department of Health (MDH) has not compiled tick-borne disease case totals since 2019. However, we continue to collect *Is* ticks from a broader geographic area now, and in higher numbers, than we had in the past. The risk of an *Is* tick encounter is high in the wooded habitats of our service area.

Introduction

In 1990 the Metropolitan Mosquito Control District initiated a Lyme Disease Tick Surveillance Program to determine the distribution and prevalence of *Is* 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 *Is* 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 *Is* 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 changes in *Is* 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 *Is* range expansion and to remain prepared should an operationally and economically feasible tick control method become available.

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 *Is* 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 *Is* 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 we had sampled a larger number of our sites inside metropolitan parks to provide a primitive assessment of park user risk to *Is* 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 *Is* 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 *Is* 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. *Is* 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 *Is* had been collected in late July 2009), was sampled for all three rounds. *Is* was not found at Joy Park in 2010 but was detected at both Priory Reserve and Laketown Township.

Materials and Methods

Of the 100 repeat sites, 56 are located north of the Mississippi River in Anoka (28 sites), Washington (25 sites), and Ramsey (3 sites) counties. The 44 repeat sites located south of the Mississippi River are distributed throughout the counties of Dakota (15 sites), Hennepin (14 sites), Scott (8 sites), and Carver (7 sites).

Sampling was initiated on April 26, 2021 and ended on October 28, 2021. 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.

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

- **2021 Study (Repeat Sites):**

In 2021 we found at least one *Is* at 61 of our 100 sampling sites. Most (39) were distributed within Anoka (20 sites positive of 28 sites sampled), Washington (16 sites positive of 25 sites sampled), and Ramsey (3 sites positive of 3 sites sampled) counties, all located north of the Mississippi River. Twenty-two additional positive sites were detected south of the river in Hennepin (9), Dakota (8), Scott (3), and Carver (1) counties (Figure 5A).

The 799 mammals (Figure 1 and 2021 results in Table 2) were distributed evenly north (389) and south (410) of the river with the 574 *Is* distributed as 337 (261L; 76N) north and 237 (178L; 59N) south. As in other years, our sites located north of the Mississippi River accounted for the majority (59%) of our 2021 *Is* collections. However, our Hennepin County sites accounted for the majority (36%) of collections from an individual county in 2021, with Bloomington (96L; 31N) township having the highest *Is* collections within the county. This is the first time the highest county *Is* total was from a county south of the river. Except for 2021 (Hennepin County) and 2013 (Ramsey County), the majority of our *Is* collections have been from Anoka or Washington County.

The season mean number of *Is* collected per mammal in 2021 was 0.718 (larvae: .549, nymphs: .169). The mean increases to 1.164 (larvae: .890, nymphs: .744) when all sites negative for *Is* are excluded (2021 results in Figure 6). The highest average number of *Is* per mammal was calculated for Hennepin County (2.176), then Washington (0.924) and Anoka (0.804) counties (2021 results in Figure 3). Townships averaging $\geq$ 1.0 *Is* per mammal in 2021 north of the Mississippi River were, in Washington County, Afton (3.889), Hugo (1.753), Grant (1.313), and May (1.179), in Anoka County, East Bethel (3.143), Coon Rapids (2.727), Oak Grove and Saint Francis (both 1.375), Ramsey (1.125), and Ham Lake (1.0) (Figure 4), and in Ramsey County, Roseville (2.0). South[1] of the Mississippi River, townships maintaining averages $\geq$ 1.0 *Is* per mammal were, in Hennepin County, Bloomington (5.777), Dayton (4.500), Brooklyn Park (2.400) Hassan (1.556), Minnetonka (1.400), and Eden Prairie (1.250), and in Carver County, Victoria (1.0).

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

- **Compiled Results (Repeat Sites) from 1990 – 2021 or 1991 - 2021:**

The compiled 1990-2021 average number of *Is* collected per mammal is .685. We first tabulated a higher *Is* per mammal average of .806 in 2000. It has been maintained (≥ .806) in most years since. Prior to 2014 we had only tabulated an average > 1.0 once, in 2005, but tabulated > 1.0 from 2014 – 2018 and 2020. The 2019 - 2021 period as a whole shows a reduction to the levels tabulated since 2000 (Figures 3 and 6).

The 2021 field season was the first time a county located south of the Mississippi River has ever maintained the highest yearly county season mean. *Is* had already been established north of the Mississippi River in Anoka and Washington counties prior to the inception of our study. Washington County had the highest county means from 1990-1997, and 2010, 2012, 2019, and 2021. Anoka County had highest means for the rest of the years except for 2013. Ramsey County had the highest county season mean in 2013 (Figure 3).

Anoka County has consistently maintained the highest compiled season means. The 1990-2021 mean is 1.167. Washington County's mean (1.044) follows. The 1990-2021 township averages (all > 1.0), north of the Mississippi River include Blaine, Coon Rapids, Ham Lake, Saint Francis, East Bethel, and Linwood of Anoka County, May, Hugo, Afton, Grant, and New Scandia of Washington County, and Shoreview of Ramsey County. The averages for Oak Grove, Andover, and Lino Lakes of Anoka County and Lakeland, Lake Elmo, and Cottage Grove townships of Washington County were > .500 *Is* per mammal (Figures 4A and B—inserts on Figure 4).

As shown underneath the graph in Figure 3, yearly averages for the counties south of the Mississippi River have increased over time. In compiled 1991 – 2021 results from south of the river, Burnsville (2.596), Inver Grove Heights (1.047), Vermillion (.860) and Hastings (.625) townships of Dakota County, and Bloomington (.799) and Eden Prairie (.710) townships of Hennepin County maintained 1991-2020 averages > .500 *Is* per mammal[2]; comparable with some townships north of the river.

Is status at the 100 repeat sampling locations is shown on Figure 5. The number of sites where *Is* is detected every year has decreased since 1992, but *Is* has been detected at more (97) sites over time. The number of sites (3) where *Is* has not yet been detected has been unchanged since 2016 (Table 1).

Since 2007 *Is* has been found in all seven counties every year except 2011. The progression of the numbers of sites found to be positive for *Is* south of the river is shown in Table 1A. In general, only a few (3-4) positive sites (all in Dakota County) had been found each year until 1998, when *Is* was detected in Hennepin and Scott counties[3]. We did not detect any positive sites in Carver County until 2007 and we did not tabulate 30 positive sites south of the river until 2014. In 2021 there were 20 sites positive (Table 1A). North of the river, we had not tabulated two positive Ramsey County sites (both of our Shoreview Township sites) in one season until 2003. Both were positive for *Is* again in 2005, 2006, 2008, 2010, 2013-2017 and 2021. Our Roseville site has been positive since 2013.

Small mammal (Table 2) species diversity in 2021 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[4] (Figure 1 and Table 2). However, the 2021 average number of mammals collected per site (7.99) is a low yearly small mammal collection total (Table 2). Our compiled average small mammal collection success level per site for 1990 through 2021 is 12.21 (range: 5.96 mammals in 2013 to the high in 1991 of 20.61 (23.54 for the 100 repeat sites only)).

[2]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.

[3]*Is* was collected previously in Hennepin County in a collaborative study with Dr. R. Johnson (University of Minnesota). Our 1991 database and report indicates that *Is* had been detected in Scott and Carver counties (one site each). However, these two ticks were likely misidentified *Ixodes muris*. In 1995 District staff performing pest mosquito activities inadvertently found a single *Is* adult tick in Scott County's New Market Township. No additional *Is* were detected there in 3 years. Staff or the public have occasionally turned in adult *Is* from Scott County, especially from New Market Township, since 1995.

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

The immature tick species diversity appears comparable to past years, although the yearly collection percentages of *Is* and *Dv* in Table 3 have reversed. We had collected mostly *Dv* in the early years and collect mostly *Is* now. *Is* comprised ≥ 50% of our collections for the first time in 2002.

The number of ticks collected (*Dv*, *Is*, and *Ixodes muris* combined) of 767 is roughly half the 1993-2021 average of 1,560 ticks. Including 2021, we have now had tick totals only in the hundreds five times in 32 years. We have collected small mammal totals in the hundreds in 11 of those 32 years. All five of the low total tick collection years were in low mammal collection years. Our 2021 small mammal collection total was the seventh lowest of those 11 years (Tables 2 and 3).

Discussion

Is populations have been established throughout our seven-county service area for over a decade. In earlier years, Lyme risk and human cases had been highest in the northern metropolitan area where *Is* had been established prior to the inception of this study. However, as *Is* expanded across our service area, tick-borne disease risk and tick-borne disease cases correspondingly began to increase, too. All residents and visitors throughout our seven county service area should be aware that there is risk of encountering *Is*, and take precautions, when visiting wooded habitat throughout our seven county service area. South of the Mississippi River especially, however, risk level varies, and some areas do not contain the wooded or brushy *Is* habitat needed to sustain *Is*.

In 2021, drought conditions throughout Minnesota had been both strong and extensive in area. The MNDNR State Climatology office stated[5] that lower departures from the 1990-2020 state-averaged precipitation amount had actually begun to be tabulated over a year earlier, in January 2020, and then had continued on a slow downslide for another year and four months. Then, from April to July 2021, the decrease became rapid, so that by July 2021 over 70% of Minnesota was experiencing Moderate Drought. By the end of August 2021, our seven county service area was in Severe Drought and parts of northern Minnesota were in Extreme or Exceptional drought. By December 2021 approximately half of Minnesota was out of drought and back to normal conditions. However, the other half, including our seven county metro service area, was still classified as in Moderate Drought conditions.

This intense drought most likely contributed to our low tick (*Is*) and *P. leucopus* collections. Since roughly 80% of our yearly small mammal collections are *P. leucopus* and because we now collect more *Is* than other tick species, they are the drivers for our small mammal and tick totals. However, because drought conditions had been shown to affect *P. leucopus* but not *Tamias striatus* by Rahul, et al. (2018)[6], and because *Is* had been shown to be more susceptible to desiccation when relative humidity is lower than 90% by Stafford (1994)[7], drought conditions seems to be supported as a likely conclusion to make. While *Ixodes* ticks can find places with better conditions that could allow them to wait for improvements for short periods, Nieto et al. (2010)[8] found that long periods of dry conditions had reduced how long *I. pacificus* had been able to survive. We presume that drought conditions would affect other tick species also susceptible to desiccating (like *Is*). Our data does seem to suggest that drought had impacted our tick and small mammal collections as determined from these studies. Table 2 appears to show only collections of *P. leucopus* affected while Table 3 appears to show the impact of drought on our *Is* collections but not *Dv*. Collections of *Dv* had also been low in 2021, but both larval *Dv* and nymphal *Dv* collections were higher than they had been in 2020.

[5] https://www.dnr.state.mn.us/climate/journal/drought-2021.html

[6] Rahul D., I.R. Fischhoff, and R.S. Ostfeld. 2018. Journal of Mammology. 99(6): 1436-1443. https://doi.org/10.1093/jmammal/gyy126

[7] Stafford K.C. 1994. Survival of immature *Ixodes scapularis* (Acari, Ixodidae) at different relative humidities. J. Med. Entomol. 31, 310–314. DOI: 10.1093/jmedent/31.2.310

[8] Nieto N.C., E.A. Holmes, J.E. Foley. 2010. Survival rates of immature *Ixodes pacificus* (Acari: Ixodidae) ticks estimated using field-placed enclosures. J. Vector Ecol. 35: 43–49. DOI: 10.1111/j.1948-7134.2010.00026.x

Minnesota human tick-borne disease statewide case data is provided by the Minnesota Department of Health (MDH) and due to staff diversion into SARS-CoV-2 work, has not been available since 2019. The latest available data is from 2018, when there had been 950 Lyme and 496 human anaplasmosis (HA) cases. 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.

At the same time (2000) that we detected a definite elevation in the number of *Is* ticks we collect, the MDH began to tabulate higher numbers of tick-borne disease cases. 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). HA had been detected in MMCD collaborative research in metro-collected small mammals in 1995 (and in later studies)[9], but metro-acquired human HA cases had not been documented by the MDH until 2000. From 2000 – 2007 the MDH had typically tabulated a few metro-exposed HA cases each year (range 0-9). For the period 2000 – 2009 across the entire state, the HA median was 163 (range 76-322) and from 2010-2017, 633 (range 448-788).

Cases of tick-borne disease contracted within the seven county metropolitan area have not been tabulated for many years, but had consistently been lower compared with the number of cases contracted in other areas of the state. However, residents of our service area had been infected at an equal rate compared with residents in other areas of the state. The MDH had consistently tabulated that metro residents had comprised roughly half of the both the state-wide and metro-wide Minnesota Lyme cases tallied[10].

The risk of *Is* tick encounters is higher than it used to be throughout our service area. This 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. Anyone visiting wooded areas in any part of the seven county metropolitan area should follow the precautions that are intended to reduce their risk of acquiring a tick-borne disease.

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

[10]Slide 37 www.health.state.mn.us/divs/idepc/diseases/**lyme**/**lyme**slide.ppt

ADDITIONAL UPDATES/RESEARCH:

STUDIES/PROJECT UPDATES AND PLANS FOR 2022.

- ***Ixodes scapularis* distribution study** (sites unchanged from 1993).
- **Publication in progress.** A revised manuscript of tick surveillance results through 2020 is under review with the Journal of Medical Entomology.
- **Publication in progress.** Jacob Cassens, with Dr Jon Oliver's lab at the University of Minnesota's School of Public Health, was provided our tick data and has performed various analyses. He plans publish as soon as this fall.
- **Unpublished work.** In 2014 MMCD had provided *I. scapularis* nymphs from 1990 - 2014 to Steve Bennett (UM-St Paul), for testing. He wrote a dissertation titled "The Complex Eco-Epidemiology of Tick Borne Disease: Ticks, Hosts and Pathobiomes in an Urbanizing Environment".
- ***Ixodes scapularis* ticks** collected in fall 2021 were sent to the CDC. More collections are planned for spring 2022**.**

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

Since the initial suggestion of the Technical Advisory Board (TAB) in 2010, we had been visiting 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.

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.

NOT ESTABLISHED IN MN /NON-NATIVE TICKS:

AMBLYOMMA AMERICANUM (The increase in *Aa* collections in 2020 was presumably due to an increase in walking locally due to stay at home orders caused by the SARS-CoV-2 pandemic. Unknown why there were zero *Aa* turned in in 2021.)

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. Then from 2009 -2020 one or both agencies had received *Aa* on a yearly basis, as shown in Table 4. Neither agency received any *Aa* in 2021.

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

Year	Stage and sex	Location	Agency
2009	1 female 1 nymph	? ?	MDH MMCD
2010	3 females	Eagan, Mound, Orono/Lk Mtka area	MMCD
2011	3 females	Shakopee, Lindstrom, Hennepin Co.	MDH
2012	3 females	Eden Prairie or Burnsville, 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 1 female	Elk River area ? – collected by Jordan dog groomer	MMCD
2016	2 nymphs 3 females (pictures) 2 females (reported)	Florida travel history Scott Co., Ramsey Co., on a dog – loc ? Wabasha Co., Dakota Co.	MMCD MDH MDH
2017	1 male (dragging) May 6 1 female (picture) 1 female (reported) June 27 1 female July 6 1 female July 7	Cold Spring (Stearns Co.) Ottertail Co. found on child Chippewa Co Stillwater, Washington Co. Golden Valley, Hennepin Co.	MDH
2018	1 adult (reported) before June 29 1 female (dragging) June 29	Itasca State Park Near same area as above tick, at Itasca State Park	MDH
2019	1 female July 12 1 female roughly July 16	Shakopee (1 mi from PetSmart) Lives in Wayzata, found right after Woodbury	MMCD MDH
2020	1 unknown April 11 1 female April 30 1 unknown unverified May 7 1 female May 18 1 male may 18 unverified 1 female May 28 1 female June 11 1 male June 22 1 female June 30 1 male July 2 1 Earlier this year	“imported”. Not from tc metro from Miss Becker County Northfield (fell off my garden glove) Deephaven Itasca St park 770 brookline ave st paul Burnsville Douglas County Anoka County 7132 whipporwill ln Nicollet Co N Mankato 519 W Wheeler A N Mankato Belgrade twp 10 min n of this 1	MDH MDH MMCD MMCD MDH MDH MMCD MDH MDH MDH MMCD
2021	0	Neither MMCD nor the MDH received *Aa*	
TOTAL	32 female, 5 male, 4 nymph 4 unknown adult	45 *Amblyomma americanum* 2009-2021	

HAEMAPHYSALIS LONGICORNIS

The Asian longhorned tick (*H. longicornus*, or bush tick/cattle tick) has the potential to spread various diseases. Its principle host is cattle, but it has fed on various domestic animals and wildlife in the United States, and has the potential to feed on humans, too. There are several ways this tick species can reproduce, and the type introduced into the U.S. is parthenogenetic, which means that all ticks found have been females which can lay eggs without needing to mate. Therefore, an introduction of a single female tick into an area could potentially establish the tick there. It was first detected in New Jersey in the fall of 2017 but had actually been in the United States since at least 2010. It has been found primarily on the eastern seaboard but has also been detected inland, in Arkansas for example.

MMCD is in a good position to detect introductions of *Hl*. 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. We continue to utilize Facebook to keep the public informed and to enlist their help to turn in unusual ticks as well.

We are also partnering with other Minnesota agencies, including the MDH, so that all agencies will be aware in the event that any *Hl* were to be found here. All agencies will alert the rest should any *Hl* be found, and all ticks tentatively identified as *Hl* will be sent to Dr. Ulrike Munderloh, UM – St Paul, for identification confirmation.

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

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

No. sites	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2017	2018	2019	2020	2021
changing status	26	38	47	58	61	69	75	78	81	88	91	94	96	96	96	96	96	96
Ticks found:																		
all years	21	17	11	5	5	4	1	1	1	1	1	1	1	1	1	1	1	1
most years	5	15	19	27	31	35	38	41	42	44	45	45	45	51	50	55	54	55
least	21	23	28	31	30	34	37	37	39	44	46	49	51	45	46	43	42	41
(not found)	53	45	42	37	34	27	24	21	18	11	8	5	3	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	2016	2017	2018	2019	2020	2021
Total sites south of river	*1	2	4	4	7	12	9	12	19	24	27	30	29	30	23	23	24	22
By county:																		
Dakota	*1	2	4	2	6	8	8	9	12	10	13	11	11	12	9	7	9	8
Hennepin	*0	0	0	1	1	3	0	2	3	6	7	8	9	7	8	7	7	9
Scott	*0	0	0	1	0	1	1	1	2	6	4	7	7	8	5	6	6	3
Carver	*0	0	0	0	0	0	0	0	2	2	3	4	2	3	1	3	2	1

*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]	*Peromyscus leucopus* percent (n)	*Tamias striatus* percent (n)	*Myodes (Clethrionomys) gapperi* percent (n)	*Blarina brevicauda* percent (n)	Other* percent (n)
[a] 1990	250	3651	14.6 [17.15 @75 sites]	80% (2921)	6% (224)	7% (240)	4% (155)	3% (111)
1991	270	5566	20.61 [23.54]	77% (4308)	7% (395)	5% (264)	7% (402)	4% (197)
1992	200	2544	12.72 [12.68]	71% (1804)	9% (223)	4% (103)	13% (329)	3% (85)
1993	100	1543	[15.43]	81% (1243)	4% (69)	7% (101)	7% (107)	1% (23)
1994	100	1672	[16.72]	78% (1309)	10% (171)	5% (79)	5% (76)	2% (37)
1995	100	1406	[14.06]	79% (1115)	11% (156)	4% (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% (561)	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% (981)	3% (31)	5% (53)	2% (24)	1% (20)
2021	100	799	[7.99]	84% (670)	4% (28)	9% (71)	2% (16)	1% (14)

*Other includes *Microtus pennsylvanicus, Spermophilus tridecemlineatus, Zapus hudsonius, Mustela erminea, Tamiasciurus hudsonicus, Glaucomys volans, Sorex articus, 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	*Dermacentor variabilis* L[b] percent (n)	*Dermacentor variabilis* N[c] percent (n)	*Ixodes scapularis* L[b] percent (n)	*Ixodes scapularis* N[c] percent (n)	Other species[d] percent (n)
[a] 1990	250	9957	83% (8289)	10% (994)	6% (573)	1% (74)	0% (27)
1991	270	8452	81% (6807)	13% (1094)	5% (441)	1% (73)	0% (37)
1992	200	4130	79% (3259)	17% (703)	3% (114)	1% (34)	0% (20)
1993	100	1785	64% (1136)	12% (221)	22% (388)	1% (21)	1% (19)
1994	100	1514	53% (797)	11% (163)	31% (476)	4% (67)	1% (11)
1995	100	1196	54% (650)	19% (232)	22% (258)	4% (48)	1% (8)
1996	100	724	64% (466)	20% (146)	11% (82)	3% (20)	1% (10)
1997	100	693	73% (506)	10% (66)	14% (96)	3% (22)	0% (3)
1998	100	1389	56% (779)	7% (100)	32% (439)	5% (67)	0% (4)
1999	100	1594	51% (820)	8% (128)	36% (570)	4% (64)	1% (12)
2000	100	2207	47% (1030)	10% (228)	31% (688)	12% (257)	0% (4)
2001	100	1957	54% (1054)	8% (159)	36% (697)	2% (44)	0% (3)
2002	100	2185	36% (797)	13% (280)	42% (922)	8% (177)	0% (9)
2003	100	1293	52% (676)	11% (139)	26% (337)	11% (140)	0% (1)
2004	100	1773	37% (653)	8% (136)	51% (901)	4% (75)	0% (8)
2005	100	1974	36% (708)	6% (120)	53% (1054)	4% (85)	0% (7)
2006	100	1353	30% (411)	10% (140)	54% (733)	4% (58)	1% (11)
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)
2021	100	767	17% (131)	8% (61)	57% (439)	18% (135)	0% (1)

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

[b] L = larvae

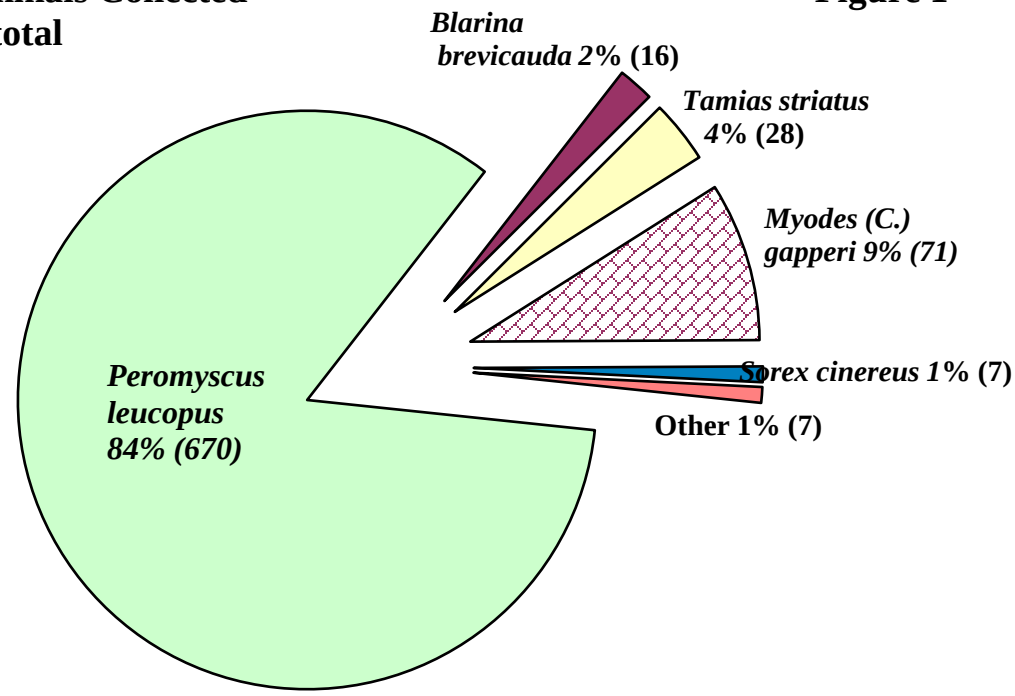
[c] N = nymphs

mean

[d] Other species mostly *Ixodes muris* 1999-2nd adult *I. muris* collected 2007-collected 7 *I. marxi* nymphs

Small Mammals Collected
2021: 799 total

Figure 1



Ticks, by Species and Stage, Removed from Small Mammals
2021: 1,264 total

Figure 2

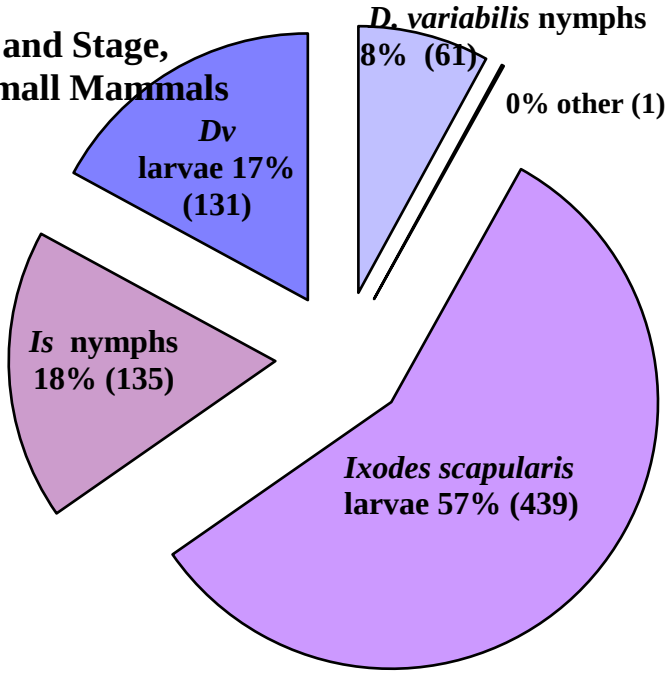


Figure 3

Average number of *I. scapularis* collected per mammal at 100 sampling locations in Anoka, Washington, and Ramsey counties: 1990 - 2021
(white box shows the total number of sites where at least one *I. scapularis* was found: by year)

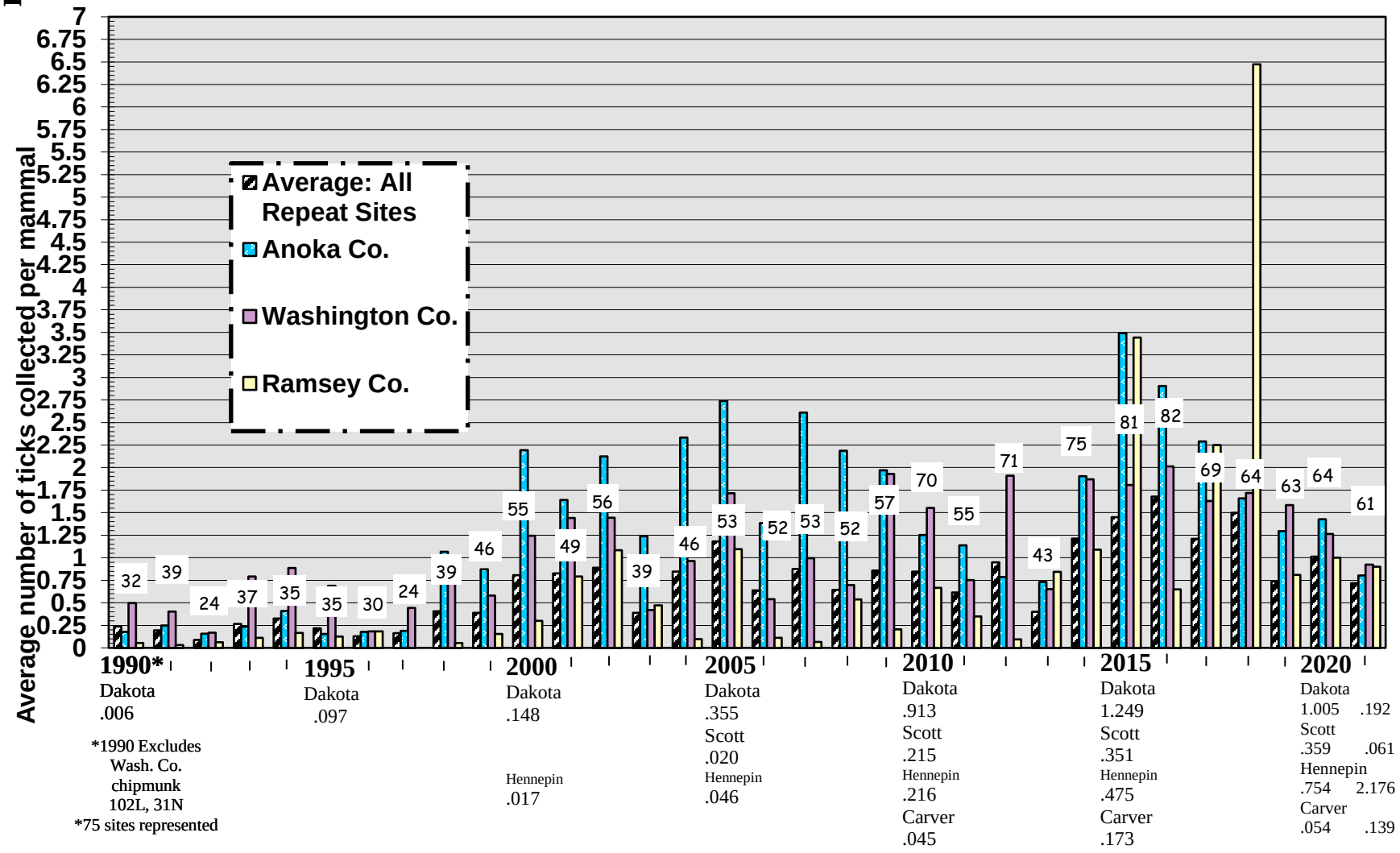
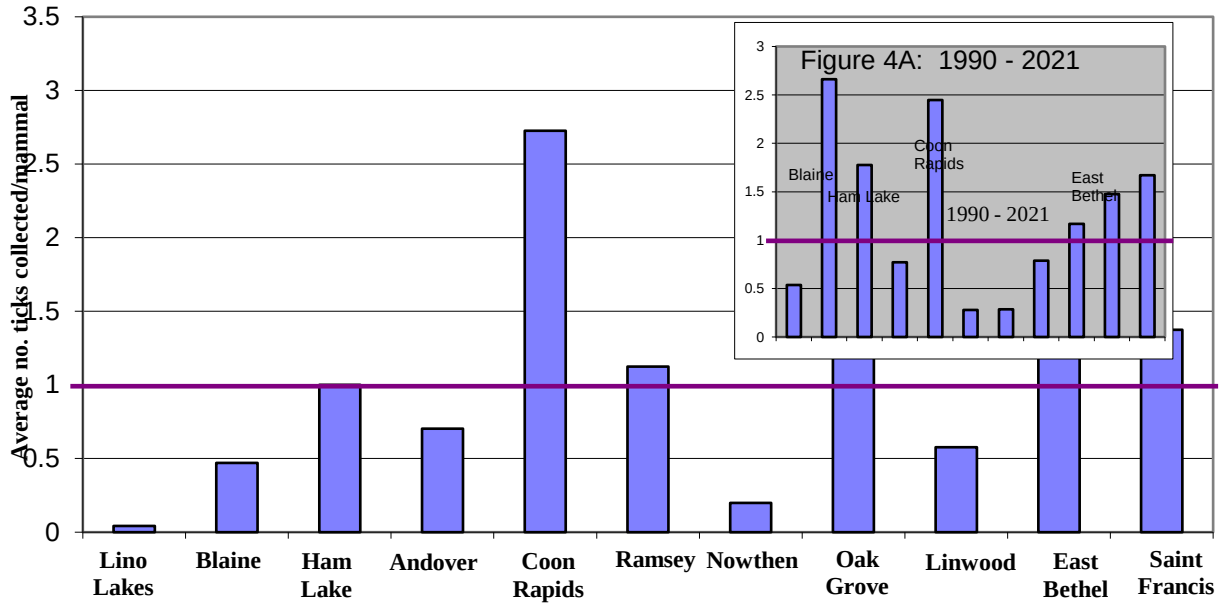


Figure 4

Average number of *I. scapularis*collected per mammal in Anoka county (by township): 2021 results



Average number of *I. scapularis*collected per mammal in Washington county (by township): 2021 results

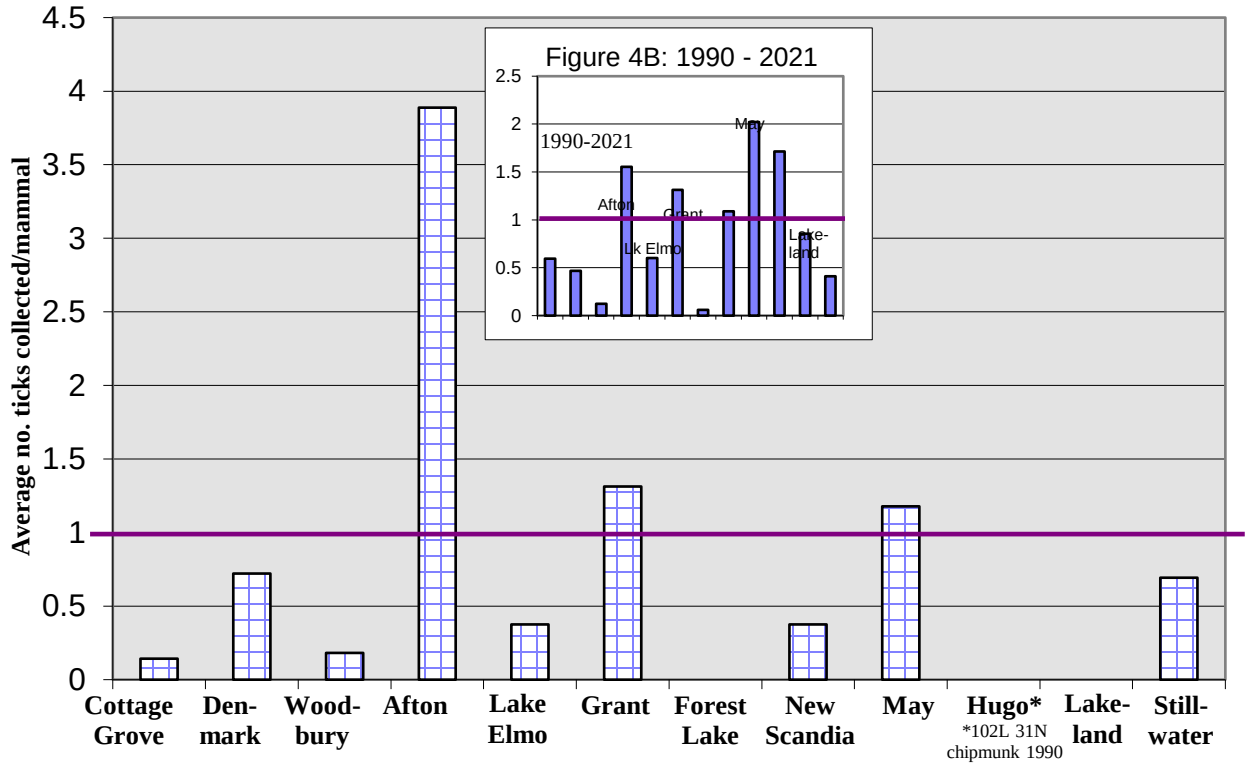
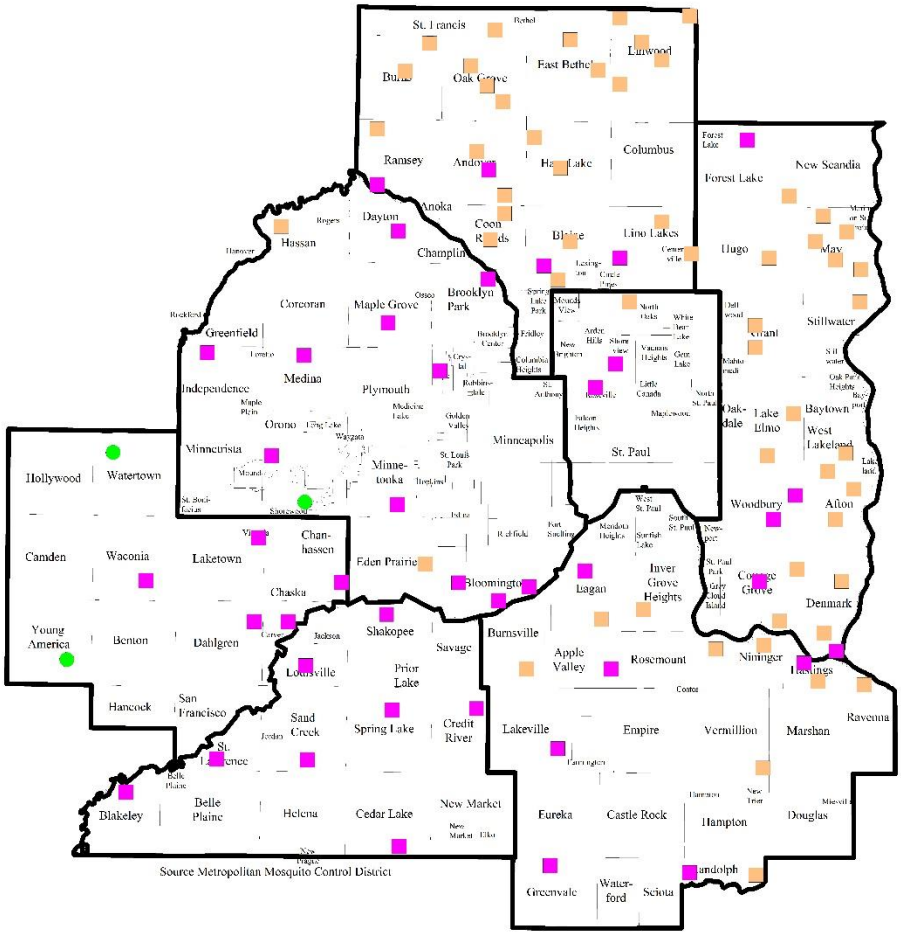


Figure 5

Ixodes scapularis Presence/Absence status: 1990 - 2021

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



At least one tick found during:

- all/most years (56)
- at least one year (41)
- not yet found (3)

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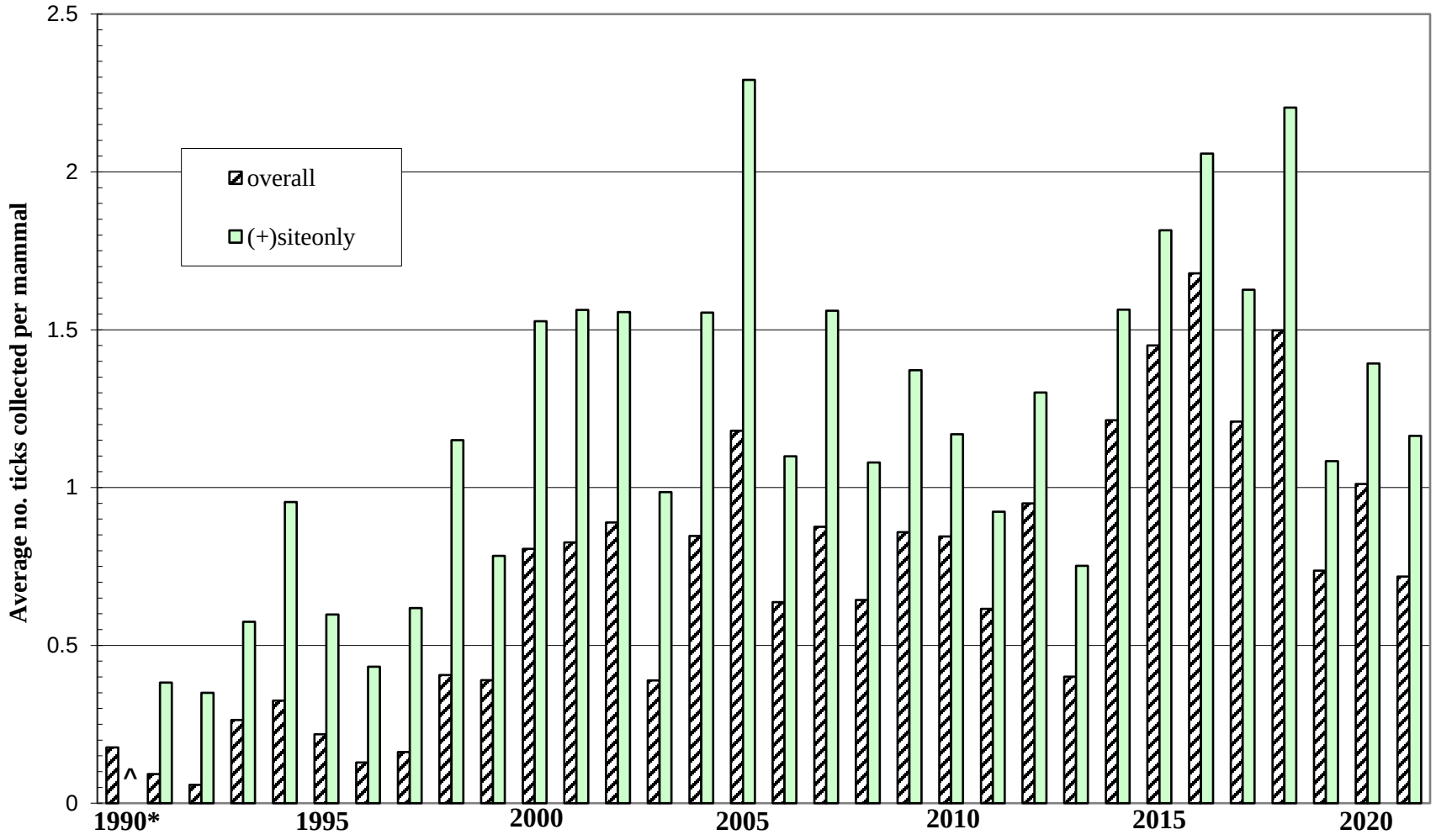
Figure 6

Average number of *I. scapularis* collected per mammal at 100 repeat sampling locations 1990-2021 overall vs. sites where at least one *I. scapularis* was collected (positive sites)



*75 sites

^data unavailable