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Metropolitan Mosquito Control District

***Ixodes scapularis* Distribution Study Report**

Janet Jarnefeld
Tick Vector Services

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Metropolitan Mosquito Control District

IXODES SCAPULARIS DISTRIBUTION STUDY

1999

Abstract

A black legged tick (*Ixodes scapularis*) distribution study, designed to detect any changes in *I. scapularis* distribution over a many year period, was conducted in the seven county metropolitan area by the Metropolitan Mosquito Control District. Small mammal sampling was used to collect ticks from 100 wooded areas that have all been sampled since 1990 or 1991. At least one *I. scapularis* was collected from 46 of these sites during 1999; the highest total number of positive sites tabulated for a season to date. A total of 634 *I. scapularis* were removed from 1627 mammals for an overall season mean of .390 *I. scapularis* per mammal. Most of the *I. scapularis* collections continue to occur north of the Mississippi River, with the majority of collections occurring for the second consecutive year in Anoka county (51% of the total (292 larvae; 30 nymphs)). Washington county collections accounted for an additional 38% of the total. The highest average number of *I. scapularis* per mammal was calculated for Anoka county; a season mean of .873 compared with Washington county's season mean of .579 overall. Zero *I. scapularis* were collected in either of the Hennepin and Scott county parks where *I. scapularis* had been first detected with this study methodology in 1998. Townships maintaining the highest (all > 1.0) 1990-1999 *I. scapularis* per mammal averages include Hugo [zero in 1999], New Scandia [.500 in 1999], and May [.556 in 1999] of Washington county, with 1990-1999 averages of > .500 *I. scapularis* per mammal tabulated for East Bethel [1.500 in 1999], Linwood [.705 in 1999], Grant [1.476 in 1999], and Afton [1.527 in 1999]. Additional townships with high 1999 averages were Blaine (2.700), Lino Lakes (1.571), and Lakeland (1.500). *I. scapularis* collections for 1999 appear similar to our 1994 and 1998 results while *P. leucopus* consistently has been the predominant mammal species collected each year with some variability in the total percentages collected. We again conclude that *I. scapularis* range expansion has not been detected because we have seen no significant change in where our tick collections are occurring.

Introduction

In 1990 the Metropolitan Mosquito Control District initiated a Lyme Disease Tick Surveillance Program to determine the distribution and prevalence of *Ixodes scapularis* and *Borrelia burgdorferi* within the Minneapolis- Saint Paul metropolitan area. District re-structuring in 1996 integrated the former tick surveillance program activities into the District's overall field processes. Small mammal trapping has been the primary sampling method used, with examination of road-killed mammals and dragging flannel cloth along vegetation both used in the past as secondary collection methods.

A total of 545 sites were sampled from 1990 through 1992, including 100 sites that had been selected for repetitive sampling prior to the 1991 or 1992 field season. Baseline *I. scapularis* distribution data for our area was determined from the 1990 and 1991 studies with most of the ticks collected north of the Mississippi River in Anoka, Washington, and northern Ramsey counties. The 1992 study was designed to inspect areas that had not been sampled as intensely in the past, with emphasis on locations south and west of the Mississippi River, but the majority of *I. scapularis* collections continued to be obtained in the northeastern counties.

Since 1993, our distribution study has focused on the re-sampling of 100 sites to detect any potential changes in *I. scapularis* distribution over time. Seventy-five of these sites were re-sampled beginning in 1991 and were selected from the previous study based on three criteria: representative habitat of an area, locations that were unlikely to be developed, and areas where small mammal collections had been sufficient in the past. An additional twenty-five sites were selected from Dakota, Hennepin, Scott, and Carver counties in 1992 to increase our data collections south of the Mississippi River. We plan to monitor these sites indefinitely and will intensify our sampling effort in areas that have shown potential *I. scapularis* range expansion.

Two additional sites were sampled from 1995-1997; section 7 of New Market township in Scott county (where a single adult *I. scapularis* tick had been collected in 1995) and section 19 of West Saint Paul township in Dakota county (Dodge Nature Center-- to foster improved relations through providing a general risk assessment). Sampling at these two locations was discontinued in 1998 since zero *I. scapularis* had been collected in either location in this three-year period.

Materials and Methods

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

Sampling was initiated on April 26, 1999 and ended on October 28, 1999 with small mammal trapping used as the primary sampling method. As in past years, the twenty-seven week study was divided into three nine-week sampling periods, and all sites were sampled for twenty-one trap nights (7 traps x 3 consecutive nights) per period. Weeks of site visitation were randomly selected within each sampling period.

One three-hundred foot transect was established at each sampling location, and Sherman live traps (H. B. Sherman Traps, Inc., Tallahassee, Fla.), baited with peanut butter and oats, were placed along these transects at fifty foot intervals. We euthanized all small mammals caught in the traps, removed any ticks found, and stored the ticks in alcohol for later identification.

Results

➤ 1999 Study (Repeat Sites):

We found at least one *I. scapularis* at 46 of 100 sampling sites, with 42 of these positive sites located north of the Mississippi River in Washington (21 sites positive/25 sites sampled), Anoka (20 sites positive/28 sites sampled), and Ramsey (1 site positive/3 sites sampled) counties. Four positive sites were detected south of the river in Dakota county as well. Zero *I. scapularis* were collected in Hennepin, Scott, or Carver counties in 1999.

Overall, 1627 mammals (Figure 1 and 1999 results in Table 1) were inspected: 826 from north of the Mississippi River and 802 from south of the river, and a total of 634 *I. scapularis* (Figure 2 and 1999 results in Table 2) were collected from them. The Anoka county sampling locations accounted for 51% (292 larvae; 30 nymphs) of the total with the greatest number of *I. scapularis* obtained from Blaine (100 larvae; 8 nymphs), Lino Lakes (65 larvae; 1 nymph), Linwood (40 larvae; 3 nymphs), and Coon Rapids (30 larvae) townships. Collections from Washington county accounted for an additional 38% (242/634) of the total (209 larvae; 33 nymphs), with Afton (77 larvae; 7 nymphs), May (43 larvae; 12 nymphs), Grant (26 larvae; 5 nymphs), and Lakeland (30 larvae) township collections the highest. Another 10% of the total (63 larvae; 1 nymph) were collected from Dakota county.

The overall season mean number of *I. scapularis* collected per mammal in 1999 was .390 (larvae: .350, nymphs: .039). The mean increases to .784 (larvae: .705, nymphs: .079) when all sites negative for *I. scapularis* are excluded (see 1999 results in Figure 6). The highest average number of *I. scapularis* per mammal was calculated for Anoka county, which had a season mean of .873, compared with Washington county's season mean of .579 overall (see 1999 results in Figure 3). The 1999 township averages for Blaine, Lino Lakes, East Bethel (Anoka county), Afton, Lakeland, and Grant (Washington county) averaged > 1.0 *I. scapularis* per mammal, while Saint Francis, Coon Rapids, Linwood, Burns (Anoka county), New Scandia, and May (Washington county) townships all maintained an average of > .500 *I. scapularis* per mammal (Figure 4).

➤ Compiled 1990-1999 Results (Repeat Sites):

The 1990-1999 season mean number of *I. scapularis* collected per mammal was .247, with the highest averages continuing to occur north of the Mississippi River. The yearly season mean for Anoka county as a whole were the highest for the second consecutive year in 1999 and were followed by Washington county. Averages for Ramsey county have been consistently low, yet greater overall than those occurring south of the river (Figure 3). The 1990-1999 township averages for Hugo, New Scandia, and May townships of Washington county were > 1.0 *I. scapularis* per mammal, while the averages for East Bethel, Linwood, (Anoka county), Grant, and Afton (Washington co.) townships were > .500 *I. scapularis* per mammal (Figure 4A/B—insert on Fig. 4).

I. scapularis status at the 100 repeat sampling locations is shown on Figure 5. The status has changed at 59 of the sites since 1990 or 1991 (see 1999 results in Table 1). While the number of sites where *I. scapularis* is detected every year continues to decrease, we continue to detect *I. scapularis* at several new sampling locations each year (Table 1).

Table 1: Comparison of *I. scapularis* Presence/Absence Status at 100 Repeat Sampling Locations: 1992 - 1999

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

Comparing 1999 results with past study efforts, we collected the highest percentages to date of both *Peromyscus leucopus* (Table 2) and *I. scapularis* (Table 3) in 1999, but these percentages are not significantly higher than those found in past years. In particular, 1999 *I. scapularis* collections appear similar to the 1994 and 1998 results (Table 3 & Figure 6), while *P. leucopus* consistently has been the predominant mammal species collected each year with some variability in the total percentages collected¹. The 1999 average number of mammals collected per site (16.27) appears at a minimum to have reached normal collection levels. Our compiled average small mammal collection success level per site for 1990 through 1999 is 14.63 (1991-1999 average of 14.09 for 100 repeat sites only), with results ranging from the low of 7.28 mammals collected per site in 1997 to the high of 20.61 (23.54 at the 100 repeat sites only) in 1991.

Discussion

Our results seem to indicate that *I. scapularis* populations are established within northeastern Anoka and northern Washington counties while remaining localized or nonexistent in areas south of the Mississippi River. Although our study was not designed to specifically answer the question of tick establishment, we feel that our relative *I. scapularis* density estimates are accurate enough for a general risk assessment. Given the consistency of our results over the years, where greater numbers of *I. scapularis* continue to be collected in the northeastern metropolitan area each season, we believe that the greatest Lyme disease risk continues to occur in the northeastern metropolitan area. Of interest, however, are the Anoka county *I. scapularis* collections accounting for the greatest number of ticks collected through this study for the second consecutive year. While the northern county collection number differences are not significant overall, we wonder whether this trend will continue with our 2000 study data. We do know that a decrease in *I. scapularis* collections has been occurring in one Washington county location (Hugo township) since a home was built late in 1997.

We did not re-detect *I. scapularis* using this study methodology in either of the Hennepin or Scott county parks where they were first detected in 1998, and we do not feel any closer to achieving a complete understanding of what these results mean than we did in 1998. We acknowledge that we have not eliminated any of several possible interpretations to our 1998 results² simply via these 1999 negative results. It will be interesting to see whether any *I. scapularis* are re-detected at either of these locations in future years and to what degree their numbers may occur. We again conclude that *I. scapularis* range expansion has not been detected because we have seen no significant change in where our tick collections are occurring.

¹see the discussion sections in the 1993 (*I. scapularis* population estimates) and 1994 (mammal density equality across sites) *I. scapularis* distribution study reports.

²see the discussion section in the 1998 *I. scapularis* distribution study report.

ADDITIONAL UPDATES/RESEARCH:

RESULTS 1999.

➤ Cooperative studies with Dr. Russell Johnson (University of Minnesota-Mpls):

Our cooperative study regarding the distribution and prevalence of *B. burgdorferi* and the HGE agent in the metropolitan area was continued at a reduced scope from 1998 levels.¹ The same three sampling locations that had been selected for the 1998 season (May (2) and Hugo (1) townships) were re-sampled for a six-week period (July 14 – August 19, 1999).² A total of 45 small mammals were collected (38 *P. leucopus*, 1 *Clethrionomys gapperi*, and 6 *Tamias striatus*) with 13 (29%) samples testing HGE PCR positive and 0% culture positive. 40% were *B. burgdorferi*- culture positive (heart and/or bladder).

¹ decision based on the low overall *Ehrlichia* exposure results that had been seen in the past several years in tandem with finding comparable *B. burgdorferi* results over time.

² literature published in spring of 1999 suggested that *P. leucopus* may not be as effective an amplifying-reservoir for the HGE agent as they are for *B. burgdorferi*, so a decision was made to utilize larger Sherman traps (3" x 3" x 10") in an attempt to increase *T. striatus* collections.

CONTINUING STUDIES FOR 2000.

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

➤ Cooperative studies with Dr. Russell Johnson (University of Minnesota-Mpls):

Our cooperative study regarding the distribution and prevalence of *B. burgdorferi* and the HGE agent continued and consisted of a three-pronged effort (two within; one outside of the Minneapolis – Saint Paul metropolitan area).

Effort 1: Re-sampling Washington county (May and Hugo townships).

The effort involving sites sampled since 1998 was reduced in scope from three sites in 1999 to two locations in 2000, but these sites were sampled for a full season (April 25 – October 12). A preliminary total of the number of mammals collected is 99 (59 *P. leucopus*, 28 *C. gapperi*, 6 *T. striatus*, 3 *Sorex cinereus*, 2 *Blarina brevicauda*, 1 *Zapus hudsonius*). None were culture-positive for HGE, but 3% were PCR-positive for HGE. In contrast, 18% of the mammals were culture-positive for *Borrelia burgdorferi*. *B. burgdorferi* PCR data is pending, as are serology data for both HGE and *B. burgdorferi*, and dragging/flagging results. Nymphs collected in the dragging effort will be tested in an attempt to determine the specific host that each larva had fed on.

Effort 2: Re-sampling North Oaks (Ramsey county).

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

We wanted to determine whether any changes over time had occurred at two areas located on the eastern side of North Oaks. Sampling was re-established for a four-week period (June 5 – July 11, 2000; no sampling during the week of July 4). Serology results and *B. burgdorferi* PCR are not completed yet, but the total number of small mammals collected was nineteen (11 *P. leucopus*, 8 *C. gapperi*). None were positive for HGE by either PCR or culture. 53% were heart and/or bladder culture-positive for *B. burgdorferi*.

NEW COOPERATIVE RESEARCH STUDY FOR 2000.

- **Cooperative studies with Dr. Russell Johnson (UM-Mpls) and Marty Scoglund and Jay Brezinka (Dept of Military Affairs, Little Falls, MN)-assisted by the US Army:**

Effort 3: Small mammal trapping and dragging for questing ticks in Little Falls, Arden Hills, and North Oaks, Minnesota.

Background: see enclosed 2 pages titled "Research Proposal for cooperative studies at Camp Ripley".

Small mammals were collected from a total of eight sites (4 in Little Falls; 4 in the metro area) approximately monthly from May 22 – October 27, 2000 for one trapnight each sample period. Sera was collected and processed and final results are pending. 42% of the Little Falls specimens (whole blood in EDTA) tested PCR-positive for the HGE agent. The HGE culture-positive rate was 23%. Each of the HGE culture-positives was also PCR-positive. *B. burgdorferi* PCR is not completed yet, but *B. burgdorferi* cultures were positive in 5% of the blood specimens. Results of tick load comparisons between the Little Falls and metro area samples will be made after all of the ticks have been removed and identified. Dragging/flagging results are also pending, and nymphs collected in the dragging effort will be tested in an attempt to determine the specific host that each larva had fed on. *Note: Two mammals tested positive for what seems to be a non-human pathogenetic hantavirus strain (likely Prospect Hill) by the US Army Center for Health Promotion and Preventive Medicine Direct Support Activity (USACHIPPM)-West; Major Bill Sames and Bill Irwin collected duplicate samples in this study effort. Results are pending.

DEER SEROLOGY EFFORT

University of Minnesota and the Department of Military Affairs, Little Falls, MN—fall & winter 1999/2000.

Jay Brezinka and fellow Camp Ripley staff collected blood samples from several October, 1999 hunts and one white-tailed deer live-trapping effort from January, 2000. Testing results from the October 1999 collections showed 52% of the deer PCR-positive for the HGE agent. *B. burgdorferi* PCR is pending. 78% of the October deer were seropositive for anti-HGE antibodies. For the samples collected in the January live-trapping effort, none were HGE PCR-positive, but preliminary serology results were 100% positive for the HGE agent. Collections occurred again in October 2000.

CONTINUING STUDIES FOR 2001:

- *Ixodes scapularis* distribution study (sites unchanged from 1993).
- **Cooperative studies with Dr. Russell Johnson (UM-Mpls) and Marty Scoglund and Jay Brezinka (Dept of Military Affairs, Little Falls, MN):**

Effort 3: Small mammal trapping and dragging for questing ticks in Little Falls and Arden Hills, Minnesota. We expect to continue sampling in Little Falls and Arden Hills, MN and will likely expand the collection season by beginning our monthly sampling in March 2001. North Oaks sampling will likely be eliminated-no major differences to past study efforts have been noted.

➤ DEER SEROLOGY EFFORT

University of Minnesota and the Department of Military Affairs, Little Falls, MN—fall & winter 2000/2001.

Collections in Little Falls continued during the fall of 2000, are planned for January 2001, and may be expanded to include Arden Hills, MN (TCAAP) samples in 2001.

LIKELY DISCONTINUATIONS FOR 2001.

Discontinued Effort 1: Re-sampling Washington county (May and Hugo townships).

Due to what appears to be consistent three-year results (low HGE agent and consistent *B. burgdorferi* infection rates), and likely expansion of the collaborative research effort in Little Falls and Arden Hills, this component will likely discontinue in 2001.

Discontinued Effort 2 & part of Effort 3: Re-sampling North Oaks (Ramsey county).

Preliminary results of the four-week re-sampling effort in eastern North Oaks, along with the additional North Oaks sampling that operated in tandem with the Little Falls project did not show any major changes to past results. Both will likely discontinue in 2001.

GRANT PROPOSALS (NOT APPROVED AS OF DECEMBER 4, 2000).

➤ Risk Assessment of the Expanding Distribution of Lyme Disease in the North – Central US:

The goal of this potential effort would be to expand the known risk model and maps developed for Illinois and Wisconsin to include the rest of the north-central U.S. and areas south as far as Tennessee using digitized data bases available from the USGS, GAP programs, etc. Known negative and positive sites from Michigan, Indiana, Minnesota, Ohio and Tennessee would be overlaid on the risk maps.

Co-investigators: Uriel Kitron, Ph.D. University of Illinois-Urbana Champaign
Edward D. Walker, Ph.D. Michigan State University
Mark L. Wilson, SC.D. University of Michigan-Ann Arbor

Collaborators: Richard L. Berry, Ph.D. VBDP-Ohio Dept Health
Robert Pinger, Ph.D. Ball State University
David Neitzel, M.S. Minnesota Dept Health
Janet Jarnefeld, Mpls-St Paul Metropolitan Mosquito Control District
Carl Jones, Ph.D. The University of Tennessee

➤ Cooperative efforts with the Minnesota Department of Health- Lyme Disease Prevention Plan February 15, 2001 - February 14, 2002

In addition to providing their ongoing Existing Statewide Lyme Disease Prevention Activities, MDH would like a grant to create & implement a sustainable Lyme disease prevention program that would reduce Lyme disease incidence to less than 9.6 per 100,000 population in two endemic counties (Pine and Washington). The feasibility of implementing various tick control strategies would be examined, and in May 2001, MDH would work with the District to initiate monitoring of tick abundance and tick infection rates. By February 2004, the MDH would implement population-based educational activities in these 2 counties, focusing on community participation, personal protection measures, and tick habitat modification to reduce the Lyme disease incidence in each county. The degree of District involvement has not been fully established at this time. This project would be principally the responsibility of the Minnesota Department of Health.

MDH staff-Lyme Disease Prevention Plan February 15, 2001 - February 14, 2002:

Dr Richard Danila--Principal Investigator for the Lyme Disease Prevention Cooperative Agreement.
Section Manager-Acute Disease Epidemiology Section (ADES)

Kirk Smith, DVM, Ph.D., Supervisor--Foodborne, Vectorborne, & Zoonotic Diseases Unit
David Neitzel, M.S., Tickborne Diseases Surveillance Coordinator

Professional staff from MDH-Acute Disease Prevention Services Section:

Kristen Ehresmann, R.N., M.P.H., Acting Section Manager
Susan Ersted, M.S., Assistant Section Manager
Marcia Rob  rt, M.P.H., Health Educator.

LITERATURE TO BE PUBLISHED JANUARY 2001.

Background: Cases of human ehrlichiosis have occurred in Minnesota residents and *I. scapularis* populations are established within portions of the metropolitan area. Human granulocytic ehrlichiosis (HGE) agent DNA was found in rodent blood samples drawn from small mammals collected for our distribution study in a 1995 collaboration with Dr. Barb Greig DVM (formerly of UM-St Paul), and portions of this work were published in the April 1997 issue of the Journal of Clinical Microbiology. Dr. Russell Johnson (UM-Mpls) tested mammals collected during our 1996 cooperative North Oaks studies with negative results. In 1997 and 1998, *Peromyscus leucopus* collected for our *I. scapularis* distribution study were used to obtain blood samples that were analyzed for the presence/absence of antibodies to *Ehrlichia* species. District staff performed the majority of the blood sample collections while the University performed the laboratory analyses. 1997 results yielded eleven samples that reacted positively to immunofluorescent antibody (IFA) testing and two more borderline positive samples, with the sample described below being the single culture positive result.

An article titled "Isolation of the Etiologic Agent of Human Granulocytic Ehrlichiosis from the White-footed Mouse (*Peromyscus leucopus*)" is due to be published in the January, 2001 issue of the Journal of Clinical Microbiology. Co-authors, in order, are M. Dana Ravyn, Sarah Carter, Carrie Kodner, Janet Jarnefeld, and Dr. Russell Johnson (corresponding author).

Figure 3

Average number of *I. scapularis* collected per mammal at 100* sampling locations in Anoka, Washington, and Ramsey counties: 1990 - 1999
(and the total number of sites where at least one *I. scapularis* was found: by year)

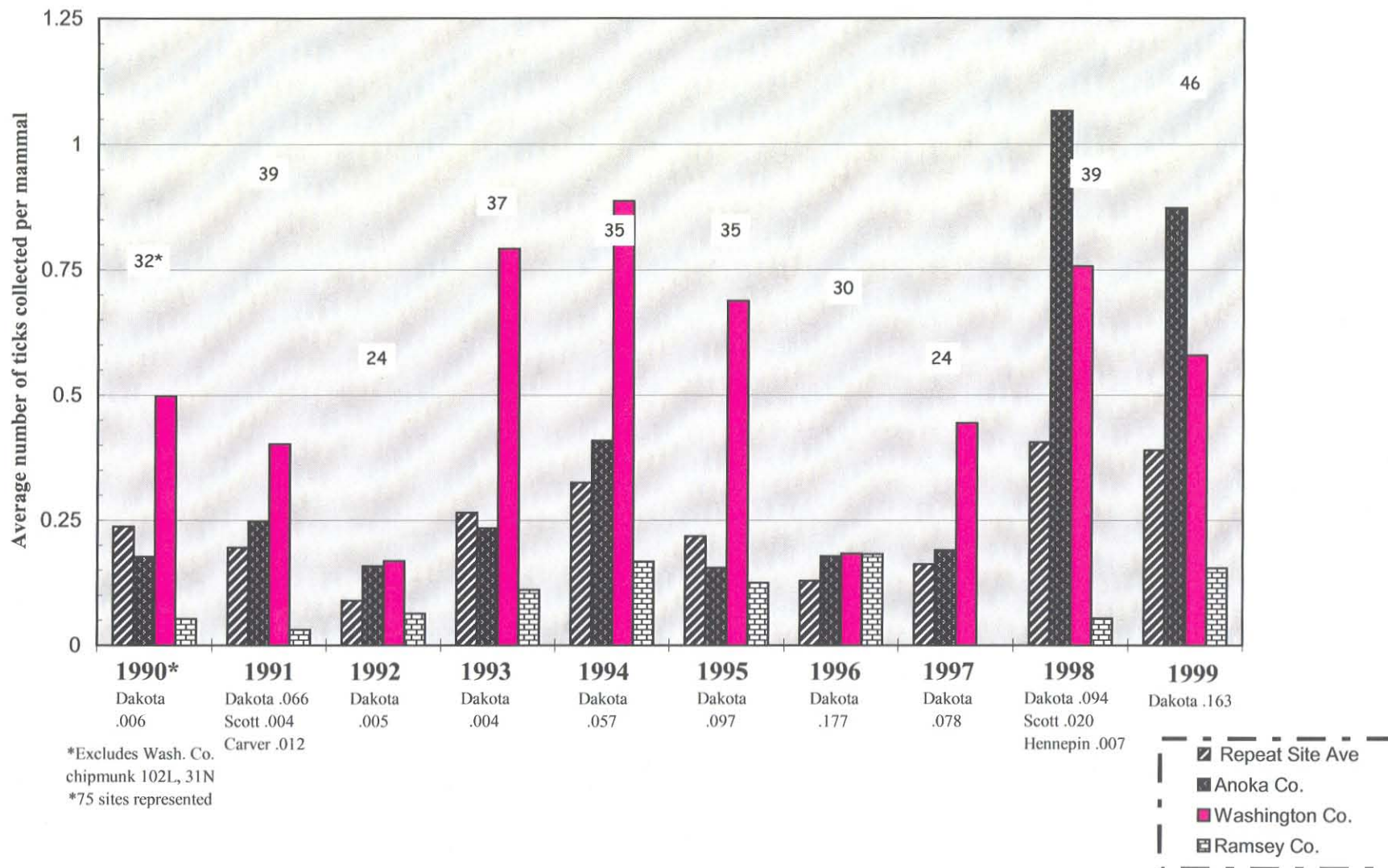
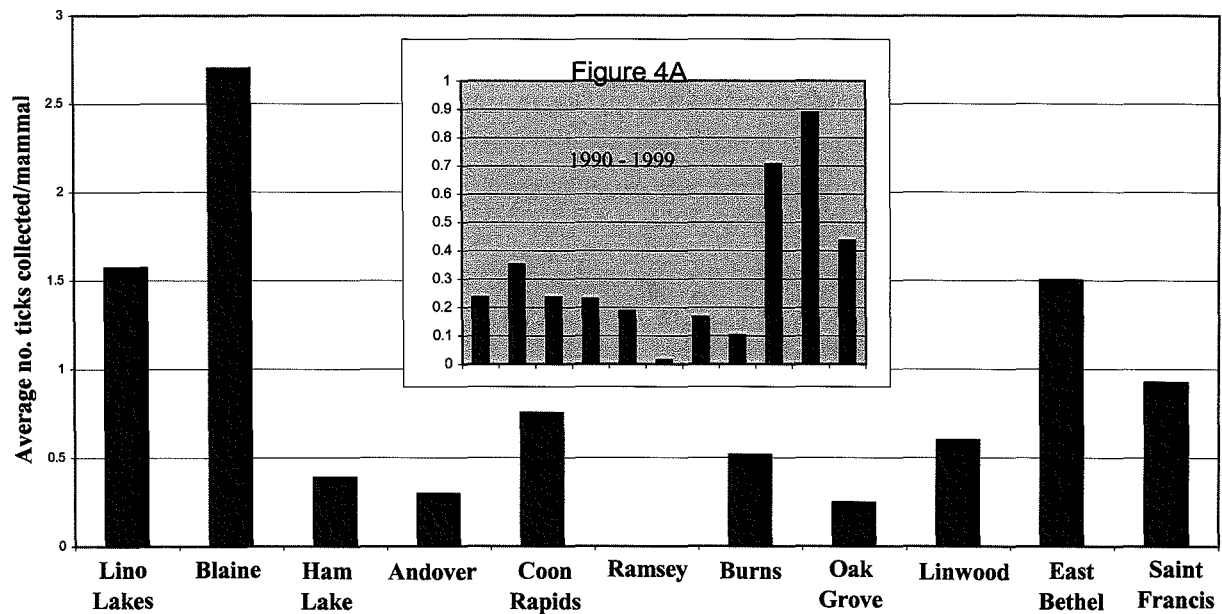
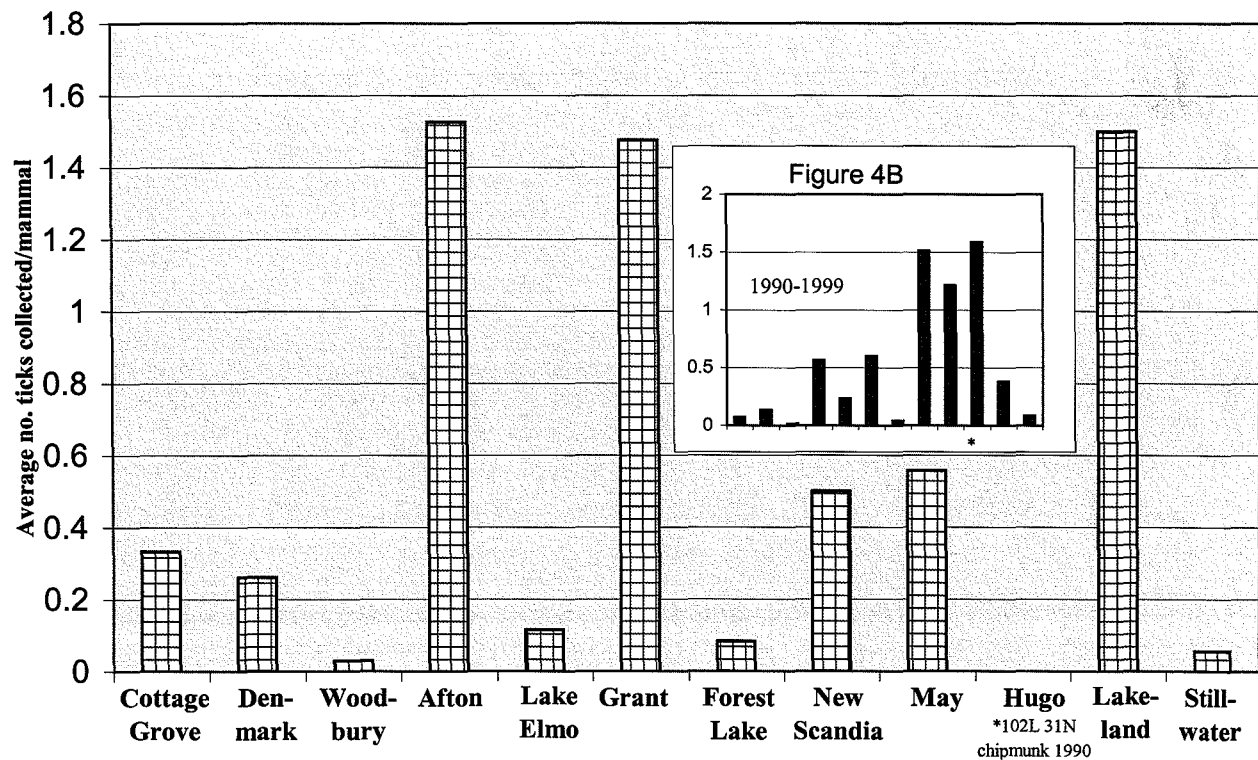


Figure 4

Average number of *I. scapularis* collected per mammal in Anoka county (by township): 1999 results only



Average number of *I. scapularis* collected per mammal in Washington county (by township): 1999 results only

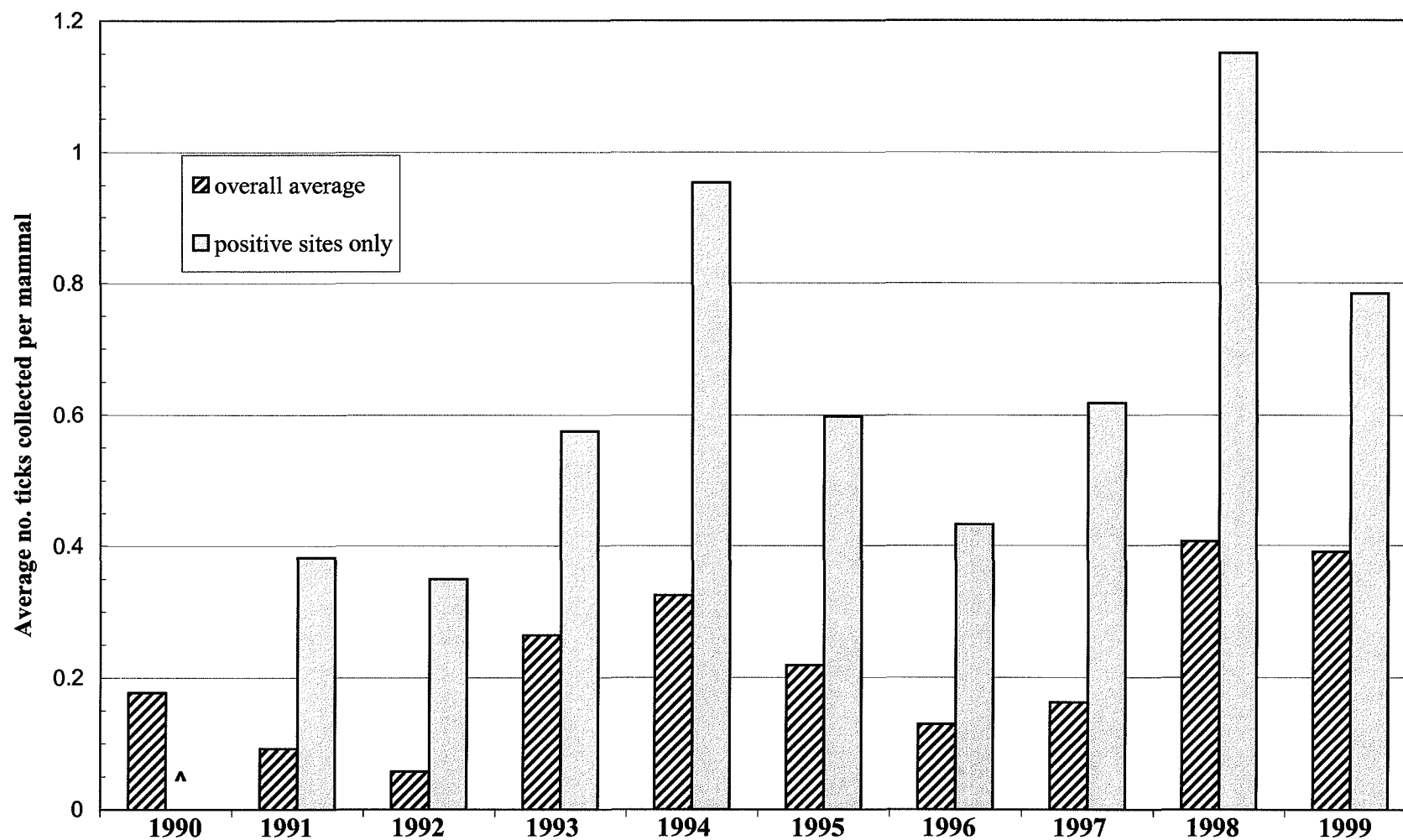


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1999 *Ixodes scapularis*
distribution study report

Figure 6

Average number of *I. scapularis* collected per mammal at 100* repeat sampling locations 1990-1999: overall vs. sites where at least one *I. scapularis* was collected (positive sites)



*75 sites

^data unavailable

Table 2. Numbers and Percentages of Small Mammals Collected by Year

| Year | No. sites | Total mammals collected | Ave collected per site and [100 repeat sites only] | <i>Peromyscus leucopus</i> percent (n) | <i>Tamias striatus</i> percent (n) | <i>Clethrionomys gapperi</i> percent (n) | <i>Blarina brevicauda</i> percent (n) | Other* percent (n) |
|-------------------|-----------|-------------------------|--|--|------------------------------------|--|---------------------------------------|--------------------|
| ¹ 1990 | 250 | 3651 | 14.6 [17.15 @75 sites] | 80% (2921) | 6% (224) | 7% (240) | 4% (155) | 3% (111) |
| 1991 | 270 | 5566 | 20.61 [23.54] | 77% (4308) | 7% (395) | 5% (264) | 7% (402) | 4% (197) |
| 1992 | 200 | 2544 | 12.72 [12.68] | 71% (1804) | 9% (223) | 4% (103) | 13% (329) | 3% (85) |
| 1993 | 100 | 1543 | [15.43] | 81% (1243) | 4% (69) | 7% (101) | 7% (107) | 1% (23) |
| 1994 | 100 | 1672 | [16.72] | 78% (1309) | 10% (171) | 5% (79) | 5% (76) | 2% (37) |
| 1995 | 100 | 1406 | [14.06] | 79% (1115) | 11% (156) | 4% (55) | 4% (61) | 1% (19) |
| 1996 | 100 | 791 | [7.91] | 79% (628) | 11% (84) | 3.5% (29) | 3.5% (28) | 3% (22) |
| 1997 | 100 | 728 | [7.28] | 71% (515) | 13% (98) | 3% (24) | 10% (71) | 3% (20) |
| 1998 | 100 | 1246 | [12.46] | 84% (1041) | 4% (51) | 3% (42) | 6% (72) | 3% (40) |
| 1999 | 100 | 1627 | [16.27] | 85% (1376) | 7% (108) | 3% (46) | 4% (63) | 1% (9) |

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

Table 3. Numbers and Percentages of Tick Species Collected by Stage and Year

| Year | No. sites | Total ticks collected | <i>Dermacentor variabilis</i> L ² percent (n) | <i>Dermacentor variabilis</i> N ³ percent (n) | <i>Ixodes scapularis</i> L ² percent (n) | <i>Ixodes scapularis</i> N ³ percent (n) | Other species ⁴ percent (n) |
|-------------------|-----------|-----------------------|--|--|---|---|--|
| ¹ 1990 | 250 | 9957 | 83% (8289) | 10% (994) | 6% (573) | 1% (74) | 0% (27) |
| 1991 | 270 | 8452 | 81% (6807) | 13% (1094) | 5% (441) | 1% (73) | 0% (37) |
| 1992 | 200 | 4130 | 79% (3259) | 17% (703) | 3% (114) | 1% (34) | 0% (20) |
| 1993 | 100 | 1785 | 64% (1136) | 12% (221) | 22% (388) | 1% (21) | 1% (19) |
| 1994 | 100 | 1514 | 53% (797) | 11% (163) | 31% (476) | 4% (67) | 1% (11) |
| 1995 | 100 | 1196 | 54% (650) | 19% (232) | 22% (258) | 4% (48) | 0% (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) | 1% (3) |
| 1998 | 100 | 1389 | 56% (779) | 7% (100) | 32% (439) | 5% (67) | 1% (4) |
| 1999 | 100 | 1594 | 51% (820) | 8% (128) | 36% (570) | 4% (64) | 1% (12) |

¹ 1990 data excludes one *Tamias striatus* with 102 larval & 31 nymphal *I. scapularis*

² L = larvae

³ N = nymphs

⁴ Other species mostly *Ixodes muris* 1999-2nd adult *I. muris* collected

***Research Proposal for cooperative studies at Camp Ripley**

Background:

The Metropolitan Mosquito Control District was created by the Minnesota state legislature in 1958 to serve the residents of Anoka, Dakota, Hennepin, Ramsey, Scott, Washington, and eastern Carver counties and is governed by a board of 17 county commissioners. Its mission is to promote health and well being by protecting the public from disease and annoyance caused by mosquitoes, black flies, and ticks, in an environmentally sensitive manner. The District has been involved in the area of tick-borne disease research since 1990. To date we have compiled a multi-year tick distribution database in addition to undertaking cooperative studies regarding the distribution and prevalence of *Borrelia burgdorferi* and the human granulocytic ehrlichiosis (HGE) agent with the University of Minnesota, while data and information exchanges between the District and the Minnesota Department of Health occur on a regular basis. Results of these efforts have assisted us (and the Minnesota Department of Health) in assessing disease risk for metropolitan area citizens, but we believe it would be beneficial to collect some information from a higher risk area of Minnesota, hoping to better clarify any epidemiologic similarities and differences than we have been able to detect in here in the lower risk metropolitan area. Additionally, Camp Ripley offers our agency a unique opportunity since you retain superior records on human activities and have completed various relevant tick-borne disease risk model components such as your deer movement study in addition to your direct tick data collections. Our ultimate goal would be to create a risk model that could be extrapolated for our use in the metro area, and we anticipate that an effort such as this could take a period of several years. Any cooperative serologic and statistical human data ventures you undertake with the University of Minnesota and the Minnesota Department of Health would also be extremely beneficial in development of a model such as this and in understanding the full epidemiologic picture.

District focus for this cooperative effort:

For now we plan to focus our energies on collecting data about *Ixodes scapularis* itself. We would like to collect temporal and peak *I. scapularis* data using both flagging/dragging and small mammal trapping methodologies, along with determining the infection rate in the questing tick population. Determining the infection rate in the small mammal population through culturing or testing samples for tick-borne disease exposure is an important aspect of risk determination, but this testing could be added to the study in the future. The District has no testing capabilities but could offer some resources needed for field collections, especially so for any metropolitan area sampling locations and possibly also for limited field work at Camp Ripley. The District will direct resources towards collecting some comparative data from our currently sampled tick surveillance (small mammal trapping) sites.

I understand that if this project is approved, we may be able to utilize the finalized study protocol locally at the Twin City Army Ammunition Plant in Arden Hills. That would greatly assist us in having comparison data within the metro area. If acceptable to you we would like our data to be shared with the Minnesota Department of Health and the University of Minnesota for their uses as well.

Research Proposal for 2000:

Literature regarding modeling for the presence or absence of *Ixodes scapularis* has found factors such as forest (oaks) and soil (sandy) types, along with the degree of development (less) to be

* Metropolitan Mosquito Control District—enclosure to 1999 distribution study report, page 1 of 2

associated with a greater likelihood of detecting *I. scapularis* populations, which could prove useful to public health professionals in creating wide-scale risk assessments for tick-borne diseases. In the broad sense these general categories are compatible with our tick surveillance results here in the metro as well. However, we would like to develop a model with greater resolution since our research results show differences when the data are examined on a smaller scale. Our proposal for a year 2000 study design will help us define temporal, peak, and a general population estimate of *I. scapularis* in a known high risk area of Minnesota compared with the metro, and in itself may help elucidate why humans appear to be at lower risk in general in the Minneapolis-St. Paul area. We would also like to determine the questing tick infection rate status between the two areas through testing *I. scapularis* on an individual basis to aid in our research and further, to determine whether any differences in the numbers of infected ticks over distance are occurring. We may want to replicate the data collections in some or all of the sampling locations in future years to create a multi-year database which can then tell us what we would expect to find in an average year, in addition to collecting additional information that is necessary to the development of a risk model.

General study methodology 2000:

- **trapping**

Camp Ripley: a trapping grid of 50 traps was set in 4 wooded sampling locations.

Twin Cities Army Ammunition Plant (TCAAP-Arden Hills): a trapping grid of 50 traps was set in 2 sampling locations; one wooded and one prairie habitat.

North Oaks: broadly considered as 2 sampling locations: one 50 trap grid was set on the eastern side of the community in an area where past studies detected consistently higher *B. burgdorferi* infection rates and one on a peninsula where low numbers of *I. scapularis* and low *B. burgdorferi* infection rates had been found in the past. Due to the smaller size of appropriate sampling area found at the peninsula, this site was broken into 2 separate traplines of 25 traps each.

- **dragging/flagging**

The eight sites (and one additional metro site in Hugo township) were dragged/flagged in an attempt to collect questing ticks. Notations were made as to whether ticks were collected via a distance drag/flag or found on the sampler(s) clothing. Additional sampling to collect nymphs was attempted at each site at the collector's discretion.