Tick Surveillance

2019 Summary

May 2020

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Summary

Tick surveillance can be passive (examining ticks that are voluntarily submitted by the public) or active (targeted collection of ticks in their natural habitat). Both methods are useful for monitoring changes to the risk from Lyme disease and other tick-borne diseases.

Both active and passive tick surveillance are carried out in Saskatchewan and provide useful information on tick activity in the province. Surveillance began in 1995 and active surveillance for *Ixodes scapularis* (the blacklegged tick) has been ongoing in Saskatchewan since 2009. The blacklegged tick is the primary carrier for the agents that cause Lyme disease and a number of other tick-borne diseases in Canada and the U.S. The active surveillance program has the objectives of assessing the risk of Lyme disease in the province by checking for blacklegged ticks and determining if they have become established in any areas of the province, and determining what fraction of them carry the bacteria responsible for Lyme disease or other tick-borne diseases such as anaplasmosis and babesiosis. Confirmed human cases of Lyme disease or other tick-borne diseases are also recorded. The risk of acquiring Lyme disease from infected ticks increases substantially in areas where the blacklegged tick has become established.

Blacklegged ticks submitted or collected through the surveillance program are tested for *Borrelia burgdorferi* (the agent that causes Lyme disease), *Anaplasma phagocytophilum* (the agent that causes anaplasmosis) and as of 2013, *Babesia microti* (the agent that causes babesiosis), *Borrelia miyamotoi* (the agent that causes relapsing fever) and *Borrelia mayonii*, a newly described organism that can cause Lyme disease.

The sampling locations for active tick surveillance are determined by a number of factors including: computer modelling to map habitats likely to sustain tick populations, information from the passive sampling program (such as where blacklegged ticks have been collected), and any known human or animal Lyme disease cases that can be tracked to a definitive location. Other factors that are considered in sample site selection include sampling in suitable habitat areas such as parks and recreational areas where there is a high interaction between people, pets, wildlife, and proximity to known risk areas in neighbouring jurisdictions.

A small number of blacklegged ticks have been found over past years of passive sampling, but no reproducing populations of ticks have been detected in any areas of the province despite several years of active sampling. This means that, at present, there are no known Lyme disease risk areas in the province. However, the possibility of blacklegged ticks being dropped by migrating birds exists across the province, and approximately 13 percent of these ticks are infected with the bacteria that causes Lyme disease. Thus, there is still a risk to humans of contracting Lyme disease from an infected tick in Saskatchewan; even in the absence of known risk areas. Furthermore, since adult blacklegged ticks are active in the spring and fall months, and nymphs are found in the late spring and summer, the risk of being bitten by an infected tick can exist for the entire spring, summer, and fall period.

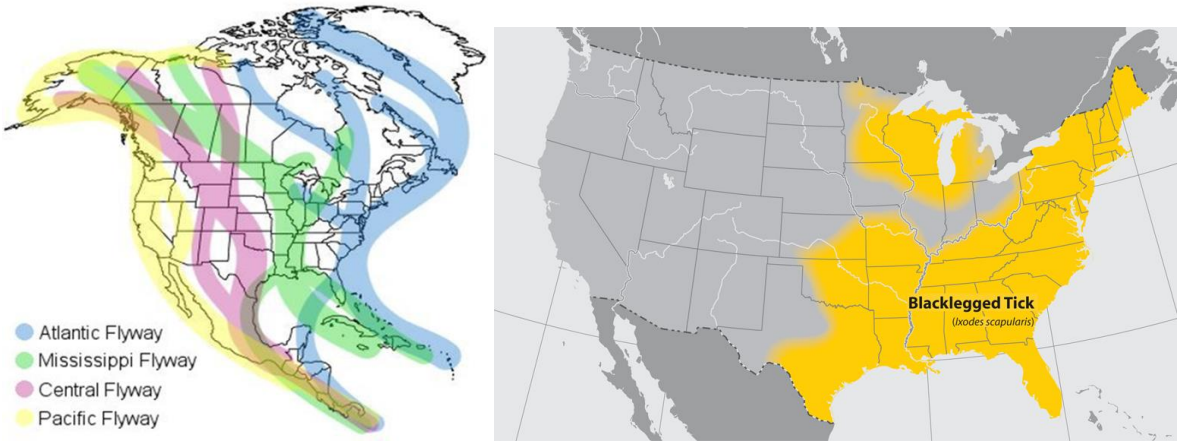
2019 Tick Surveillance Summary

- The majority of ticks (>96%) obtained through the surveillance program were the American dog tick (*Dermacentor variabilis*). This species is not a competent vector of Lyme disease.
- In 2019, 2,393 ticks were collected through voluntary submissions. Seven blacklegged ticks were identified; zero tested positive for the bacteria that causes Lyme disease.
- Of the 31, 292 ticks collected through voluntary submissions since 2008, ten of 78 blacklegged ticks (13%) tested positive for the bacteria that causes Lyme disease. Five ticks (6 %) have tested positive for the bacteria that causes anaplasmosis. Three ticks were co-infected with both agents.
- Active tick surveys have increased in recent years. Since 2014, 201 active surveys have been completed in the province; 25 surveys at 20 sites were completed in 2019.
- Through active surveys in 2019, 674 ticks were collected - all identified as American dog ticks.

Introduction

Lyme disease is caused by a bacterial infection transmitted to humans through the bite of certain types of ticks, most notably some species within the genus *Ixodes*. The range of the primary vector of Lyme disease in Canada, *Ixodes scapularis,* the blacklegged tick, has been rapidly expanding in Canada in recent years. Localized areas in southern Ontario, Quebec, New Brunswick, Nova Scotia, and Manitoba are now considered endemic for this tick. The risk of acquiring Lyme disease increases in areas where populations of infected blacklegged ticks are established. Another vector of Lyme disease, *Ixodes pacificus* or Western blacklegged tick, is established in areas of southern British Columbia. Populations of blacklegged ticks are not known to be established in Saskatchewan at this time; however, small numbers of infected blacklegged ticks are transported into the province by birds migrating north. Several major flyways converge over Saskatchewan and can have birds that have picked up infected ticks from the midwestern and central states of the U.S. (Figure 1).

Figure 1: North American Bird Flyways and Reported Cases of Lyme Disease – United States, 2016



(Source: http://birding.about.com/od/birdingbasics/ss/North-America-Migration-Flyways.htm and https://www.cdc.gov/ticks/geographic_distribution.html)

The majority of ticks found in Saskatchewan are the American dog tick *(Dermacentor variabilis*). Other common species include the Rocky Mountain wood tick (*Dermacentor andersoni*) and the winter tick (*Dermacentor albipictus*). These species are not competent vectors of Lyme disease. A few ticks (0.3%) are the blacklegged tick; these are occasionally found in the southern and central part of the province. Ten of 78 (13%) blacklegged ticks submitted for testing since 2008 tested positive for *Borrelia burgdorferi,* the bacteria that causes Lyme disease (Table 1). Blacklegged ticks may carry other organisms that cause human disease, including anaplasmosis and babesiosis. These diseases have not been documented in humans in Saskatchewan although, five blacklegged ticks have tested positive for the bacteria that causes anaplasmosis.

Determining Lyme Disease Risk

Monitoring for blacklegged ticks and the prevalence of infection with *Borrelia* or other bacteria allows public health officials to assess the risk of human exposure to infected ticks in a given area. A Lyme disease risk area is defined as a location in which there is:

- evidence of established (reproducing) populations of blacklegged ticks. This is indicated by the presence of all three life-cycle stages (larva, nymph, adult) in an area, found over more than one year; and,
- likely transmission of *B. burgdorferi.* This is demonstrated by laboratory testing (molecular detection or culture) of *B. burgdorferi* in ticks and/or rodent samples.

The following methods are used to determine risk areas in Saskatchewan:

1. drag sampling for ticks [1]; and,
2. field-validated signals from passive tick surveillance[2].

The risk can increase substantially in areas where infected tick populations become established. Tick abundance and infection rates for the bacteria that cause Lyme disease can be much higher and more localized in established areas than in non-established areas[3].

Lyme disease risk areas identified in Canada are summarized at: http://www.healthycanadians.gc.ca/diseases-conditions-maladies-affections/disease-maladie/lyme/risks-risques-eng.php#a3. The relevant provincial and territorial websites can be found at this same link.

In order to maximize the probability of finding any risk areas (i.e. sites with established blacklegged tick populations) in Saskatchewan, the active surveillance program prioritizes the locations with the highest likelihood (risk) of supporting an established tick population. If such populations were found, this would be the first Lyme disease risk area known in Saskatchewan.

Several sources of information are used in determining these priority locations for active tick surveillance. These information sources include computer models, information from the passive surveillance program, any known human or animal cases of Lyme disease, and information from other nearby jurisdictions with known tick populations.

[1] Ogden NH, Koffi JK, Pelcat Y, Lindsay LR. Environmental risk from Lyme disease in central and eastern Canada: a summary of recent surveillance information. Can Comm Dis Rep 2014; 40: 74-82

[2] Koffi JK, Leighton PA, Pelcat Y et al. Passive surveillance for *Ixodes scapularis* ticks: enhanced analysis for early detection of emerging Lyme disease risk. J Med Entomol 2012; 49: 400-409

[3] Lindsay LR (National Microbiology Laboratory)(Personal communication)

Tick Surveillance in Saskatchewan

The Ministry of Health (Population Health Branch) has collaborated since 1995 with the Roy Romanow Provincial Laboratory (RRPL), the Public Health Agency of Canada - National Microbiology Laboratory (NML), and, since 2009, the University of Saskatchewan (U of S) to monitor ticks in the province. From 2016 to 2019, the Saskatchewan Health Authority (Regina area) assisted with the spring and fall surveys of ticks in southeastern Saskatchewan.

The goal of the Tick Surveillance Program is to assess the risk of acquiring Lyme disease and other tick-borne disease by determining whether the vector is present and/or established in Saskatchewan. Tick surveillance can determine the distribution and level of establishment of tick populations, specifically blacklegged tick populations, within an area; monitor the infection prevalence; and, assess the possible risk of infection to humans. The status of blacklegged tick populations in an area are classified as one of:

- Established – field surveillance suggests that reproducing populations occur;
- Adventitious – ticks are found only sporadically, both in time and space, and usually only a single stage of tick (i.e. adult females) is present; or,
- Not Present – ticks have not been found in an area after studies have been conducted to assess the level of establishment.

Tick surveillance can be passive (examining ticks voluntarily submitted by the public) or active (targeted collection of ticks in their natural habitat). Both methods are useful for monitoring changes to the risk from Lyme disease or other tick-borne diseases.

Passive Surveillance

The objectives of passive tick surveillance are to assess potential risk of Lyme disease across the province and to provide input to the active program regarding when and where to sample for ticks.

Methods

Ticks voluntarily submitted by veterinarians, health care workers, general public, and other interested parties are sorted and identified at the RRPL and the U of S. All blacklegged ticks are submitted to the NML for identification and testing for *Borrelia burgdorferi* (the agent that causes Lyme disease), *Anaplasma phagocytophilum* (the agent that causes anaplasmosis), *Babesia microti* (the agent that causes babesiosis) and, *Babesia miyamotoi* (an agent that causes infection with symptoms similar to Lyme disease).

More information about how to submit ticks under the program can be found at: https://www.saskatchewan.ca/residents/health/diseases-and-conditions/lyme-disease#submitting-ticks-for-testing

Passive surveillance is recommended for jurisdictions, such as Saskatchewan, where established populations do not exist. It is found to be less useful in areas where there are known established tick populations[4].

[4] Koffi JK, Leighton PA, Pelcat Y et al. Passive surveillance for *Ixodes scapularis* ticks: enhanced analysis for early detection of emerging Lyme disease risk. J Med Entomol 2012; 49: 400-409

Active Surveillance

The objective of active surveillance is to detect the location of any established blacklegged tick populations and to identify Lyme disease risk areas (if any) in the province. Active surveillance uses targeted surveys to look for blacklegged ticks in locations where other information (passive surveillance, human cases, and suitable habitat) suggest the possibility of tick populations occurring. In order to establish baseline information on tick populations, an important goal of active surveillance is to do repeated sampling at many of the same sites every year and seasonal sampling (i.e. spring or fall) at other sites.

Methods

Figure 2: Tick Surveillance Using a Drag

Active surveillance in Saskatchewan is primarily done by tick dragging. This consists of dragging a white flannel cloth over and around vegetation where ticks may be present, as shown in Figure 2. The cloth is 1m² and is attached to a 1.2m wooden dowel or plastic piping, with a cord or rope used to pull the drag cloth (Figure 2). To be consistent with sampling methods in other provinces, a standard 2 km survey per site has been adopted in Saskatchewan. Each survey consists of collecting and recording ticks every 10m; a total of 200 times. After each 10m drag, ticks are removed from the drag cloth, and from the clothing of the sampler, using fine forceps or a fine paint brush. Numbers and species found are recorded for each 10m. The total distance of each survey is 2000m or 2 km. Because the drag cloth is 1m², the total area sampled per site is 2000m² or 0.2 hectare. Any adult blacklegged ticks and nymphs found are placed into collection vials and sent to the NML for identification and testing.

Occasionally tick flagging may be used instead of dragging, which involves moving the cloth in a waving motion over and through vegetation. With flagging, the end of the drag cloth can be gripped at one end so that the cloth hangs vertically downwards, and swept over the vegetation. Ticks that are questing for passing hosts cling to the cloth and can be removed for identification and counting. The dragging technique is used over relatively open ground, whereas flagging is usually done in densely brushy ground.

Active tick surveillance by drag or flag sampling is done by staff from the Ministry of Health, the former Regina Qu'Appelle Health Region, or the U of S, and occurs throughout the tick season between April and November. Drag/flag sampling is usually done in the late morning or early afternoon. Sampling is not done when it is raining, when the vegetation is wet (from rain or dew), or when temperatures are below 4°C. Adult blacklegged ticks are mostly active in the spring and fall months, while nymphs are found in the spring and summer months. Sampling schedules are created with this timing in mind.

Site Determination

Sites for active sampling include provincial parks, provincial recreation/historic sites and ecological reserves, national historic sites, regional parks, urban parkways, sites where blacklegged ticks have been collected by passive surveillance, as well as sites of most likely exposure for human or domestic animal Lyme disease cases. Sites also include those tested annually or several times per year as "sentinel" sites along the Upper Assiniboine, Qu'Appelle and Souris River watersheds, which are tributaries to the larger Assiniboine River watershed in southern Manitoba where established populations of blacklegged ticks have been found. A more detailed summary of the site selection criteria is included in Appendix A.

The potential habitat sites have been identified through a climate and habitat suitability mapping project for the blacklegged tick in the province (Appendix A – Figure 5). This is a joint project between the Ministry of Health and Public Health Agency of Canada (PHAC) and integrates various layers of data such as temperature, relative humidity, woodland habitat, and other factors such as deer density. This project has identified areas of low to high potential (risk index 0-5) for establishment of blacklegged ticks and this has helped to further guide tick surveillance efforts. Of the 64.6 million hectares of habitat classified, 181,984 ha have been classified as having a high risk potential (risk category 4-5) for establishment of *I. scapularis*. Most active tick surveys are conducted in high risk areas.

Surveillance Results

Passive Surveillance

In 2019, 2,393 ticks were submitted by passive surveillance and seven (0.3%) were adult blacklegged ticks (Table 1). Zero ticks tested positive for the Lyme disease agent, *B. burgdorferi*. All blacklegged ticks were collected from dogs.

There was no significant change in blacklegged ticks collected or positive test results from 2008-2016(Av. 1 positive tick/yr.; range 0-2). In 2017, however, the numbers collected and numbers that tested positive increased to 15 and four, respectively (4/15 = 27%) (Table 1). It is unclear whether this represents an actual increase in tick numbers and infected ticks or is a result of increased awareness by the public to submit blacklegged ticks. In 2018 and 2019, fewer blacklegged ticks were collected; however in 2018 two of six (33%) tested positive while in 2019 zero ticks tested positive (Table 1).

Over the last 12 years (2008-2019), 31,292 ticks were collected and of these 78(0.3%) were blacklegged ticks. Ten (13%) of these were infected with *B. burgdorferi* and five (6%) were infected with *A. phagocytophilum.* Three ticks were co-infected with both agents (Table 1).

Table 1: Number of Ticks collected, Blacklegged Ticks and Ticks Positive for *Borrelia burgdorferi* and *Anaplasma phagocytophilum* (2008-2019)

Year	Ticks					
	Ticks (all species)	Blacklegged ticks	Blacklegged ticks positive for *Borrelia burgdorferi* [1]	Blacklegged ticks positive for *Anaplasma phagocytophilum*[2]	Blacklegged ticks co-infected with both *Borrelia* and *Anaplasma*	Total Blacklegged ticks positive
2008	N/A	5	0	1	0	1
2009	1,478	5	1	1	1	1
2010	1,139	3	0	0	0	0
2011	736	3	1	0	0	1
2012	2,896	1	0	0	0	0
2013	1,726	10	1	2	1	2
2014	3,176	5	0	0	0	0
2015	5,103	9	1	1	1	1
2016	5,300	9	0	0	0	0
2017	5,112	15	4	0	0	4
2018	2,233	6	2	0	0	2
2019	2,393	7[3]	0	0	0	0
Total	**31, 292**	**78**	**10**	**5**	**3**	**12**

Notes:

[1] *Borrelia burgdorferi* is the bacteria that causes Lyme disease.

[2] *Anaplasma phagocytophilum* is the bacteria that causes anaplasmosis, an illness with symptoms that can range from fever, muscle pain, head ache to severe symptoms such as difficulty breathing, hemorrhage, renal failure or neurological problems that can be fatal.

[3] One blacklegged tick tested positive for *Borrelia miyamotoi.*

Blacklegged ticks have been collected throughout the province but predominantly in the moister and more wooded moist mixed-grass prairie, aspen parkland and boreal transition areas (Figure 3). Only three percent have been found in the drier and less wooded, mixed-grass prairie ecoregion (Figure 4).

Figure 3: Blacklegged Tick Locations in Saskatchewan 2008-2019 (N=74)*

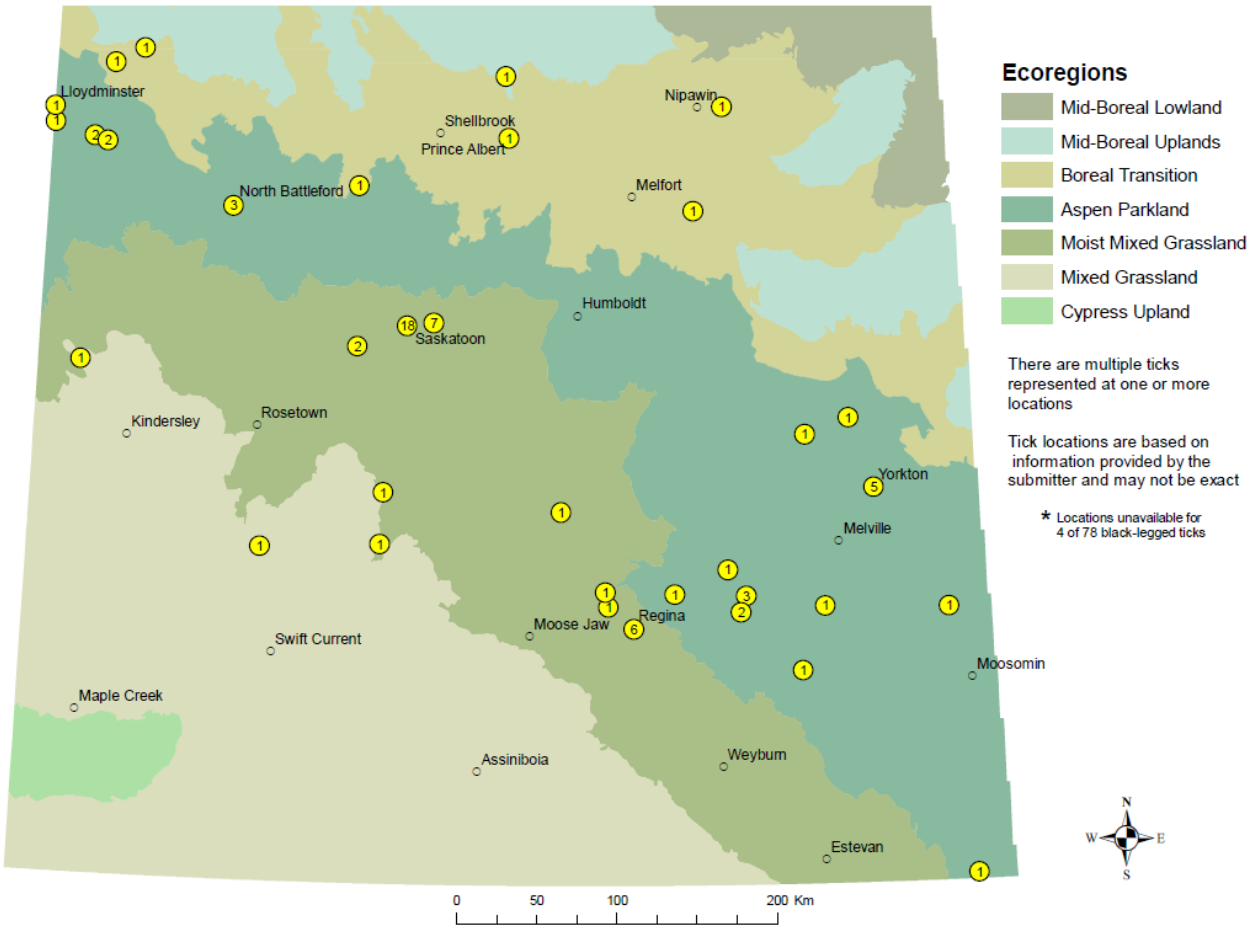
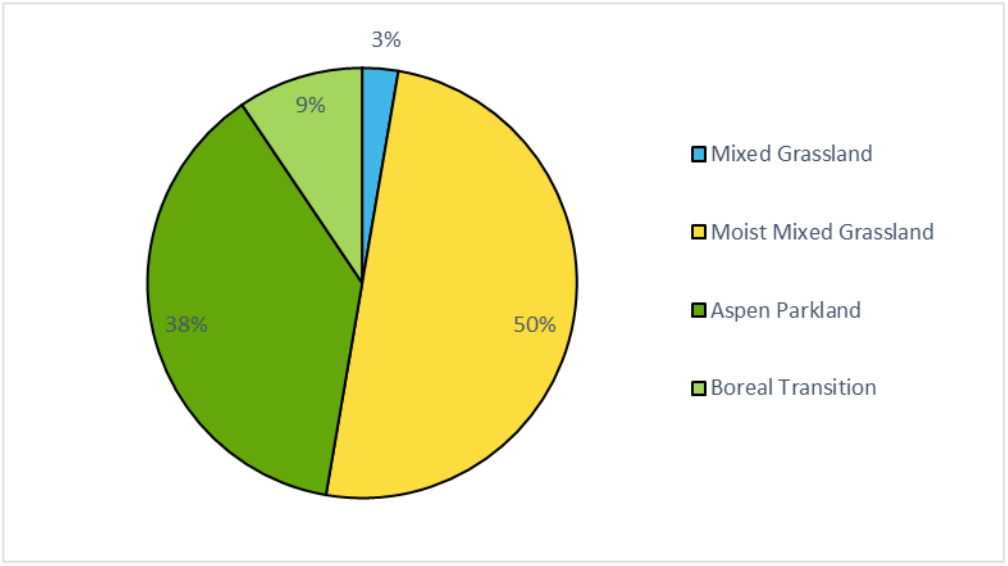


Figure 4: Percent Blacklegged Ticks by Ecoregion in Saskatchewan, 2008-2019 (N=74)*



* Locations unavailable for 4 of 78 blacklegged ticks.

Active Surveillance

Results

Spring surveys – Thirteen (13) surveys at 13 sites were completed in the spring of 2019 in southeastern Saskatchewan (Table 2). These included six provincial parks, two regional parks, two provincial ecological areas, two national historic sites and one small community. The surveys were done between May 6, 2019 and June 30, 2019.

Sampling was done during the late morning-early afternoon period when conditions were generally favorable for tick activity (i.e. sunny or partly overcast, low winds). Temperatures during the spring sampling period were generally warm and ranged from 18 – 28°C (mean 22°C).

Through the spring surveys, 674 ticks were collected (341 females, 332 males, 1 nymph) and all were the American dog tick (*Dermacentor variabilis*). There were no blacklegged ticks collected in any of the spring surveys.

Table 2: Active surveys completed in Saskatchewan (2019)

Location	Latitude	Longitude	Date	Ix. scapularis	D. variabilis
Crooked Lake Prov. Park	50.596030	-102.658183	May 28, 2019	0	34
Duck Mountain Prov. Park	51.637862	-101.637882	May 29, 2019	0	102
Echo Valley Prov. Park	50.793290	-103.894600	June 4,2019	0	35
Moose Mountain Prov. Park	49.824480	-102.345650	May 23, 2019	0	137
Birds Point Ecol. Area	50.536900	-102.334999	May 28,2019	0	24
Fort Esperance N.H.S.	50.492222	-101.577500	May 22,2019	0	78
Fort Livingstone N.H.S.	51.902629	-101.957103	May 6,2019	0	20
Tantallon	50.533589	-101.842452	June 14,2019	0	100
Canora Beach Reg. Park	51.591194	-102.671812	June 12,2019	0	67
Good Spirit Prov. Park	51.527303	-102.697369	June 12,2019	0	46
Buffalo Pound Prov. Park	50.583300	-105.415800	June 26,2019	0	14
Outlook and District Reg. Park.	51.485192	-107.066567	June 30,2019	0	1
Wascana Trails Ecol. Area	50.5605065	-104.8425610	June, 14 2019	0	16
Spy Hill-Ellice-Archie South	50.4968580	-101.4777450	Oct. 8, 2019	0	0
Spy Hill-Ellice-Archie North	50.5799720	-101.5961740	Oct. 18, 2019	0	0
Echo Valley Prov. Park	50.793290	-103.894600	Oct. 10, 2019	0	0
Crooked Lake Prov. Park	50.596030	-102.658183	Oct. 25, 2019	0	0
Fort Esperance N.H.S.	50.492222	-101.577500	Oct. 7,2019	0	0
Fort Esperance N.H.S.	50.583300	-105.415800	Oct. 25, 2019	0	0
Welwyn Reg. Park	50.339490	-101.522740	Oct. 17, 2019	0	0
Esterhazy Reg. Park	50.659440	-102.066380	Oct. 25,2019	0	0
Hamona P.H.S.	50.603901	-101.688004	Oct. 17, 2019	0	0
Strawberry Hills	52.194506	-106.379856	Oct. 18,2019	0	0
Carlton Trail Reg. Park	50.675180	-101.694870	Oct. 25, 2019	0	0
Wascana Trails Ecol. Area	50.560506	-104.842561	Nov. 23, 2019	0	0

Fall surveys – In the fall of 2019 in southeastern and east central Saskatchewan, twelve (12) surveys at 12 sites were completed (Table 2). These included two provincial parks, three regional parks, one provincial ecological area, one provincial historic site, two surveys at a national historic site, two surveys at a large

community pasture and one private ecological preserve. Spring and fall surveys were also conducted at sites where blacklegged ticks had been detected through passive surveillance (Wascana Trails Ecological Area, Strawberry Hills and Tantallon). Some sites were surveyed more than once due to their large amount of suitable habitat (Fort Esperance NHS and Spy Hill-Ellis-Archie Community Pasture). The fall survey program began on October 7, 2019 and the last survey was completed on November 23, 2019.

Sampling was done during the early afternoon period when temperatures warmed up enough to stimulate tick activity. No sampling was done in September due to cold, wet conditions. Temperatures for most of the surveys done in October were relatively warm and ranged from 8– 19°C (mean 12°C). Colder temperatures and snow curtailed survey efforts during the last week of October and the first three weeks of November. Only one survey was completed during a brief warming period in November. Normally, the first two weeks of November are warm enough for blacklegged ticks to remain active.

Weather during the spring and fall sampling period – The 2019 tick season in southern Saskatchewan can be described as being cooler and drier than normal during the spring period (April-May) and extremely wet during the summer and fall periods. It was the driest spring on record for many communities. The rains finally returned in late June with well above normal levels of precipitation recorded during the summer and fall period (June-Nov.) throughout most of the area. Temperatures were normal to slightly below normal in south and central Saskatchewan during the spring, summer and fall periods (May – Nov.) with the exception of October which was normal to slightly above normal (0 to +2°C) (Table 3). It will be interesting to see what effects three successive years of dry spring conditions (2017-2019) will have on the establishment and maintenance of tick species that require relatively moist and humid conditions, species such as *Ixodes scapularis* and *Dermacentor variabilis.* While data on *Dermacentor variabilis* numbers from spring surveys at three provincial parks suggest that there might be a decline at two of the parks (Echo Valley and Buffalo Pound) between 2014 and 2019 (Table 4), there is insufficient data at this stage to say numbers are actually declining – for example, they increased in 2015 at Echo Valley but declined at Moose Mountain in the same year. Also, the numbers increased during the three year period 2017-2019 at Moose Mountain Provincial Park. This park is more heavily wooded and at a higher elevation than the other two parks and therefore may have provided a more humid environment for tick establishment and development. However, additional long-term surveys at multiple sites are required to see if this trend to lower numbers during dry conditions is actually occurring.

Table 3: Mean Monthly Temperatures Difference from Normal – Southern Saskatchewan 2019

Month	Difference from normal
May	0 to -2° C
June	0 to -2° C
July	0 to -2° C
Aug	0 to -2° C
September	0 to -2° C
October	0 to +2° C
November	-2 to -3° C

Source: Drought Watch, Agriculture and Agri-Food Canada. www.agr.gc.ca\drought

Table 4: Total *Dermacentor variabilis* numbers from spring surveys at three provincial parks 2014-15 and 2017-19

Location	2014	2015	2017	2018	2019
Echo Valley Prov. Park	214	509	42	67	35
Moose Mountain Prov. Park	121	57	38	53	137
Buffalo Pound Prov. Park	106	242	57	-	14

Habitat quality – All sites were located in areas with high potential risk for blacklegged tick establishment – classes 4-5 (Figure 5). Habitat quality was rated as excellent at most sites and ranged from brushy sites with high grass along walking or game trails, campsites in wooded areas to wooded understory vegetation in undisturbed aspen poplar and oak bluffs. Special attention for sampling was focused along hiking and game trails, deer bedding areas, and woodpiles in campsites (Appendix B – Figures 6-9, 10).

Habitat quality and suitability also varied depending on geographic location in the watershed. Sites further west along the upper Qu'Appelle River and Souris River valleys were more arid and dominated by native mixed grass and shrub vegetation. Although these areas contained suitable habitat, shrub and treed areas were characteristically shorter and confined to narrower strips along the river and creek areas (Appendix B - Figures 11, 12).

Conversely, sites along the eastern sections of Qu'Appelle River valley and its tributaries such as Beaver Creek and Deerhorn Creek are moister with larger tracts of aspen, ash, and bur oak predominating (Appendix B - Figures 13-15).

Next Steps

In 2020, staff from the Saskatchewan Health Authority (SHA) will conduct 60 tick surveys at 51 sites in southeast and east central Saskatchewan. The majority of surveys will be done at 39 high risk potential sites in the Upper Assiniboine River and Qu'Appelle River watersheds near Yorkton and the Pipestone Creek-Souris River watersheds north and east of Estevan. An intensive sampling effort (15-20 surveys) will be conducted in high risk potential sites in a focus area near the Manitoba border where established blacklegged tick populations have been detected in adjacent rural municipalities in Manitoba (Appendix A – Figure 5). These include the communities of Langenburg, Esterhazy and Rocanville and the Rural Municipalities of Moosomin, Rocanville, Spy Hill, Langenburg, Churchbridge and Calder. Approximately 11 high risk potential sites will be surveyed in aspen parkland and boreal transition habitat in east central and central Saskatchewan between Yorkton and Saskatoon, with particular emphasis in areas along the South Saskatchewan River between Saskatoon and Outlook. (Six "sentinel" sites along the Qu'Appelle, Upper Assiniboine and Souris River watersheds that were sampled annually from 2017 to 2019 will be re-sampled in the spring and fall of 2020. Three new sentinel sites in the focus area near the Manitoba border will be added in 2020.

Passive surveillance will continue with increased emphasis placed on submissions through eTick, a public platform for image-based identification of ticks. Currently implemented in multiple Canadian provinces, eTick will be expanded to Saskatchewan as of April 1, 2020. Saskatchewan residents will be able to take photos of ticks found on people or animals and upload them to the online database, where researchers

will identify the tick within 24 business hours. It is expected that implementation of eTick will result in more tick submissions.

Conclusion

The Saskatchewan Tick Surveillance Program has expanded in recent years. Communication efforts have resulted in an increase in voluntary submissions from veterinarians, health care workers and the general public. Through active surveillance, 201 active surveys have been completed in the province since 2014 and will continue in 2020. In spite of this increased effort, no known blacklegged tick populations have been detected in Saskatchewan. However, over 70 blacklegged ticks have been collected through the passive surveillance system since 2008 and a number of these have been infected with the agents that cause Lyme disease and human granulocytic anaplasmosis. These ticks have most likely been brought into the province by migratory birds.

Acknowledgements

We would like to thank our primary tick surveyors – Branden Hilts and the staff from the Saskatchewan Health Authority (SHA) (including the Roy Romanow Provincial Lab) for their hard work during the spring and fall surveys. We would also like to thank Neil Chilton and Emily Jenkins, U. of S., Rob Schuba and Ian Harrison, SHA, Jules Koffi, Nick Ogden and Yann Pelcat, PHAC, and Phil Curry, Brightwater Consulting, for their assistance with the Saskatchewan Tick Surveillance Program. Our thanks is also extended to the staff and management of provincial parks, provincial recreation/historic sites and ecological reserves, national historic sites, and regional parks for their ongoing support. Lastly, we would like to thank PHAC for their support and funding of the surveys from 2016 – 2019.

Appendix A: Site Selection for Active Surveillance

In Saskatchewan, active tick surveillance efforts are prioritized based on a number of criteria including:

- sites where blacklegged ticks have been detected through the passive surveillance program;
- sites of most likely exposure for human or domestic animal cases;
- sites in suitable habitat areas where climate models have predicted the establishment of the blacklegged ticks [5] [6] [7] (Figure 5). These models suggest that areas in southern Saskatchewan, and in particular southeastern Saskatchewan, are suitable for the potential establishment of this tick. Areas include wooded riparian and lake edges in river valleys, aspen poplar bluffs, and fragmented forested uplands (i.e. Moose Mountain Provincial Park, Duck Mountain Provincial Park) because of their potentially more hospitable habitat and abundance of host species (i.e. small rodents, rabbits, birds, deer). In addition, this region of the province is in close proximity to areas of southern Manitoba where established populations of the blacklegged tick have been detected[8]; and,
- sites with suitable habitat where there is a high degree of interaction among people, domestic animals, and wildlife (i.e. provincial parks, provincial ecological reserves, recreation and historic sites, national historic sites, urban parkways, and regional parks).

Active surveillance for the blacklegged tick has been conducted in the province since 2008 and the number of surveys was increased in 2014. Surveillance has continued at several sites that were systematically surveyed as part of a province-wide surveillance project over a 5-year period (2013-2017)[9] and at additional sites identified through a pilot project for surveys in the southeast and east central regions conducted yearly from 2016 – 2019. Funding for the surveys from 2016 to 2019 has been provided through the Public Health Agency of Canada (PHAC).

It is important to note that reproducing or established blacklegged tick populations have not been detected in Saskatchewan. In order to establish baseline information on tick populations, an important goal of active surveillance is to do repeated sampling at many of the same sites every year, and seasonal sampling (i.e. spring or fall) at other sites.

[5] Ogden NH, Maarouf A, Barker IK et al. Projections for range expansion of the Lyme disease vector *Ixodes scapularis*, in response to climate change. Int J Parasitol. 2006. 36: 63-70

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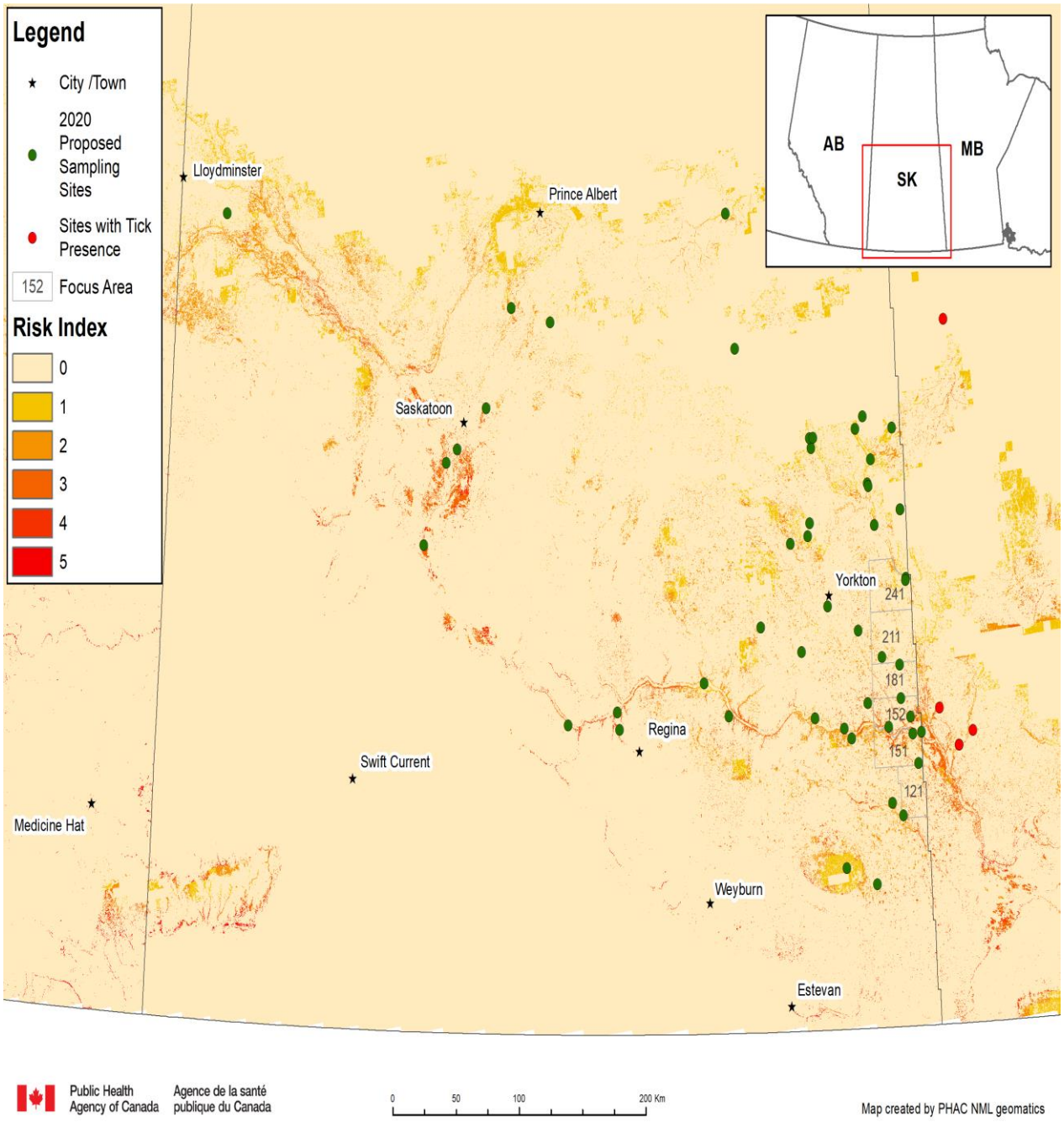
[7] Wittrock V and Wheaton E. Climate connections with vector-borne diseases: a case study of the Ixodes scapularis tick and Lyme disease in the Canadian prairies. 2010. SRC Publication No. 12829-15E10

[8] Graham-Derham S (Manitoba Health, Seniors and Active Living)(personal communication)

[9] Chilton NB, Curry PS, Lindsay LR, Rochon K, Lysyk TJ, Dergousoff. Passive and active surveillance for Ixodes scapularis (Acari: Ixodidae) in Saskatchewan, Canada. J Med Entomol. 2020. 57(1): 156-163

Figure 5: Habitat Suitability for Blacklegged Tick Establishment in Saskatchewan - Low to High Potential Risk (Risk Index 0 – 5), 2020 Sampling Sites (green dots) – Manitoba Sites with Tick Presence (red dots) and Focus Area.



Appendix B – Habitat Quality

Figures 6-9: Campground, hiking trails and woodpile (Pike Lake Prov. Park and Carlton Trail and Welwyn Regional Parks)

(Photos courtesy of Phil Curry)

Figure 10: Hiking trail – Esterhazy Regional Park

(Photo courtesy of Phil Curry)

Figure 11: Riparian habitat – Souris River – Woodlawn Regional Park

(Photo courtesy of Phil Curry)

Figure 12: Riparian habitat with dry hillsides – Buffalo Pound Provincial Park

(Photo courtesy of Phil Curry)

Figure 13: Bird's Point Ecological Area– Moister, more heavily wooded portion of the lower Qu'Appelle River Valley

(Photos courtesy of Jared Schuba)

Figure 14, 15: Mature oak forest cover – Welwyn Regional Park

(Photo courtesy of Phil Curry)