

Tick Surveillance

2018 Summary

March 2019

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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 black-legged tick) has been ongoing in Saskatchewan since 2009. The black-legged 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 black-legged 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 risks of acquiring Lyme disease from infected ticks increases substantially in areas where the black-legged tick has become established.

Black-legged 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 black-legged 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 black-legged 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 black-legged ticks being dropped by migrating birds exists across the province, and approximately 14 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 black-legged 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.

2018 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 2018, 2,233 ticks were collected through voluntary submissions. Six black-legged ticks were identified; two (33 %) tested positive for the bacteria that causes Lyme disease.
- Of the 28,899 ticks collected through voluntary submissions since 2008, ten of 71 black-legged ticks (14%) tested positive for the bacteria that causes Lyme disease. Five ticks (7 %) 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, 176 active surveys have been completed in the province; 25 surveys at 26 sites were completed in 2018.
- Through active surveys in 2018, 263 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 black-legged 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 black-legged ticks are established. Another vector of Lyme disease, *Ixodes pacificus* or Western black-legged tick, is established in areas of southern British Columbia. Populations of black-legged ticks are not known to be established in Saskatchewan at this time however, small numbers of infected black-legged 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 in the midwestern and central states in 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 black-legged tick; these are occasionally found in the southern and central part of the province. Ten of 71 (14%) black-legged ticks submitted for testing since 2008 tested positive for *Borrelia burgdorferi*, the bacteria that causes Lyme disease (Table 1). Black-legged 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 black-legged ticks have tested positive for the bacteria that causes anaplasmosis.

Determining Lyme Disease Risk

Monitoring for black-legged 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 black-legged 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 ticks¹; and,
- 2) field-validated signals from passive tick surveillance².

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 areas³.

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 black-legged 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 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 2018, 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 black-legged tick populations, within an area; monitor the infection prevalence; and, assess the possible risk of infection to humans. The status of black-legged 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 black-legged 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 populations⁴.

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 black-legged tick populations and to identify Lyme disease risk areas (if any) in the province. Active surveillance uses targeted surveys to look for black-legged 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 black-legged 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 black-legged 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 black-legged 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 black-legged 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 black-legged 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 black-legged 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 2018, 2,233 ticks were submitted by passive surveillance and six (0.3%) were adult black-legged ticks (Table 1). Two ticks were positive for the Lyme disease agent, *B. burgdorferi*. Five of the six black-legged ticks were collected from dogs, one was from a human host.

There was no significant change in black-legged 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 black-legged ticks. In 2018, fewer black-legged ticks were collected but two of six (33%) tested positive (Table 1).

Over the last 11 years (2008-2018), 28,899 ticks were collected and of these 71 (0.3%) were black-legged ticks. Ten (14%) of these were infected with *B. burgdorferi* and five (7%) were infected with *A. phagocytophilum*. Three ticks were co-infected with both agents (Table 1).

Table 1: Number of Ticks collected, Black-legged Ticks and Ticks Positive for *Borrelia burgdorferi* and *Anaplasma phagocytophilum* (2008-2018)

Year	Ticks					
	Ticks (all species)	Black-legged ticks	Black-legged ticks positive for <i>Borrelia burgdorferi</i> ¹	Black-legged ticks positive for <i>Anaplasma phagocytophilum</i> ²	Black-legged ticks co-infected with both <i>Borrelia</i> and <i>Anaplasma</i>	Total Black-legged 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
Total	28,899	71	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.

Black-legged 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: Black-legged Tick Locations in Saskatchewan 2008-2018 (N=68)*

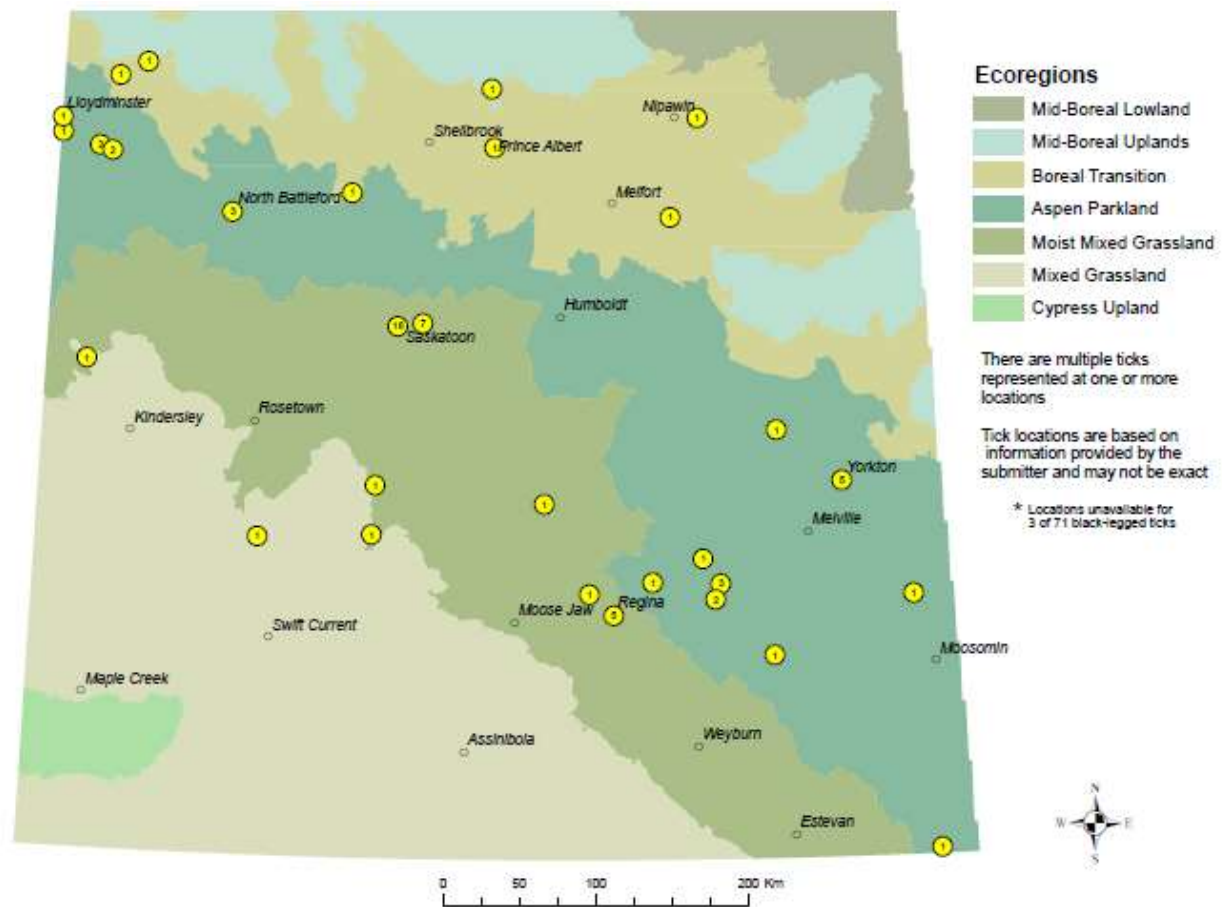
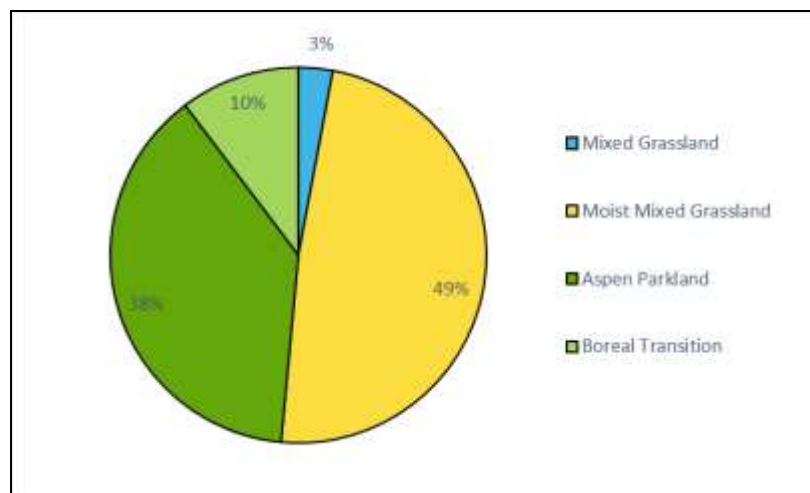


Figure 4: Percent Black-legged Ticks by Ecoregion in Saskatchewan, 2008-2018 (N=68)*



* Locations unavailable for 3 of 71 black-legged ticks.

Active Surveillance

Results

Spring surveys – Five surveys were completed in the spring of 2018 in southeastern Saskatchewan (Table 2). These included three provincial parks and two national historic sites. The surveys were done between May 5, 2018 and June 26, 2018.

Sampling was done during the late morning-early afternoon period when conditions were generally favourable for tick activity (i.e. sunny or partly overcast, low winds). Temperatures during the spring sampling period were generally warm and ranged from 22 – 28°C (mean 25°C).

Through the spring surveys, 263 ticks were collected (114 females, 149 males) - all were the American dog tick (*Dermacentor variabilis*). There were no black-legged ticks collected in any of the spring surveys.

Table 2: Mean Monthly Temperatures Difference from Normal – Southern Saskatchewan 2018

Month	Difference from normal
May	+3 to +4° C
June	0 to +2° C
July	0 to -2° C
Aug	0 to -2° C
September	-2 to -3° C
October	-2 to -3° C
November	-1 to -2° C

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

Fall surveys – In the fall of 2018 in southeastern and east central Saskatchewan, 20 surveys and 21 site visits were completed (Table 3). These included six provincial parks, three regional parks, one provincial ecological reserve and five national historic sites. Surveys were also conducted at sites where black-legged ticks had been detected through passive surveillance (Fort Qu'Appelle, Earl Grey, Regina off-leash dog park, Stushnoff). Some sites were surveyed more than once due to their large amount of suitable habitat (Buffalo Pound Provincial Park and Stushnoff). Survey conditions were limited at several sites due to their small size (Battle of Tourond's Coulee NHS), cool temperatures (13th Avenue off-leash dog park – Regina) or the site was not surveyed at all (Souris Ecological Area). The latter site was small and had limited access. The fall survey program began on October 7, 2018 and the last survey was completed on November 22, 2018.

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 temperatures and snow. Temperatures for most of the surveys done in October were relatively warm and ranged from 6 – 22°C (mean 11°C). However, fall sampling was halted due to an abrupt change to winter conditions, including snow and freezing temperatures, at the end of October. Only one survey was completed during a brief warming period in November. Normally, the first two weeks of November are warm enough for black-legged ticks to remain active.

Table 3: Active Tick Surveillance Sites in Saskatchewan (2018)

Location	Latitude	Longitude	Date	<i>Ix. scapularis</i>	<i>D. variabilis</i>
Buffalo Pound Prov. Park (1)	50.583300	-105.415800	Oct. 17 2018	0	0
Buffalo Pound Prov. Park (Whitetrack) (2)	50.580465	-105.388560	Oct. 29 2018	0	0
Crooked Lake Prov. Park (1)	50.596030	-102.658183	May 5 2018	0	48
Crooked Lake Prov. Park (2)	50.596030	-102.658183	Oct. 18 2018	0	0
Echo Valley Prov. Park (1)	50.793290	-103.894600	May 5 2018	0	67
Echo Valley Prov. Park (2)	50.793290	-103.894600	Oct. 12 2018	0	0
Good Spirit Prov. Park	51.527303	-102.697369	Oct. 24 2018	0	0
Moose Mountain Prov. Park (1)	49.824480	-102.345650	June 20 2018	0	53
Moose Mountain Prov. Park (2)	49.824480	-102.345650	Oct. 17 2018	0	0
Pike Lake Prov. Park	51.910214	-106.827419	Oct. 28 2018	0	0
Roche Percee Ecol. Area	49.065498	-102.804001	Oct. 18 2018	0	0
Moose Creek Reg. Park (Oxbow)	49.295440	-102.203630	Oct. 18 2018	0	0
Outlook and District Reg. Park.	51.485192	-107.066567	Oct. 7 2018	0	0
Woodlawn Reg. Park (Estevan)	49.114750	-102.985560	Oct. 19 2018	0	0
Fort Livingstone NHS	51.902629	-101.957103	May 29 2018	0	63
Fort Esperance NHS (1)	50.492222	-101.577500	May 30 2018	0	32
Fort Esperance NHS (2)	50.492222	-101.577500	Oct. 15 2018	0	0
Fort Pelly NHS (Norquay)	51.765930	-101.992401	Oct. 25 2018	0	0
Batoche NHS	52.708950	-106.099486	Oct. 27 2018	0	0
Stushnoff SE23 (1)	50.619523	-103.622216	Oct. 16 2018	0	0
Stushnoff W1/2 24 (2)	50.619523	-103.622216	Oct. 26 2018	0	0
Fort Qu'Appelle	50.773974	-103.783590	Oct. 30 2018	0	0
Earl Grey	50.932613	-104.713629	Oct. 23 2018	0	0
Sites with limitations					
Battle of Tourond's Coulee NHS	52.540000	-106.148318	Oct. 27 2018	0	0
13th Ave. Off-leash dog park (Regina)	50.444999	-104.650012	Nov. 22 2018	0	0
Totals					263
Souris Ecol. Area (Alameda) (Not sampled in 2018)	49.265400	-102.285004	Oct. 18 2018		

Weather during the spring and fall sampling period – The 2018 tick season in Saskatchewan was shorter, cooler and drier than normal. Temperatures were normal to below-normal throughout the spring and fall sampling period (May to November), with the exception of May, which was 3 to 4 °C above normal (Table 2). Precipitation was below normal throughout most of southern and central Saskatchewan during the May to November period (ranging from 40 – 60 percent of normal in southwestern areas, 60 – 85 percent of normal in central areas, and 85 – 115 percent of normal in southeastern and northwestern areas). Two successive years of dry conditions may deter the establishment and maintenance of tick species that require relatively moist and humid conditions, species such as *Ixodes scapularis* and *Dermacentor variabilis*. While numbers of *Dermacentor variabilis* from spring surveys at two provincial parks suggest a decline between 2014 and 2018 (Table 4), there is insufficient data at this stage to say numbers are actually declining – for example, numbers increased in 2015 at Echo Valley but declined at Moose Mountain in the same year. Additional long-term surveys at multiple sites are required to determine if this trend to lower numbers during dry conditions is actually occurring.

Table 4: Total *Dermaacentor variabilis* numbers from spring surveys at two provincial parks 2014-15 and 2017-18

Location	2014	2015	2017	2018
Echo Valley Prov. Park	214	509	42	67
Moose Mountain Prov. Park	121	57	38	53

Active tick surveys have increased in recent years. Since 2014, 176 active surveys have been completed in the province.

Habitat quality – All sites were located in areas with high potential risk for black-legged tick establishment – classes 4-5 (Figure 1). 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 bluffs. Special attention for sampling was focused along hiking and game trails, deer bedding areas, and woodpiles in campsites (Appendix B – Figures 6-9).

Habitat quality and suitability also varied depending on geographic location in the watershed. For example sites were warmer on the south-facing slopes of the Qu’Appelle River valley than on the north facing slopes. 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 9, 10).

Conversely, sites along the more northerly South Saskatchewan River Valley and eastern sections of Qu’Appelle River valley are moister with larger tracts of aspen, ash, and other treed vegetation predominating (Appendix B - Figures 11, 12).

Next Steps

In 2019, staff from the Saskatchewan Health Authority (SHA) will conduct 54 tick surveys at 48 sites in southeast and east central Saskatchewan in 2019. The majority of surveys will be done at 38 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. Particular emphasis will be placed on those sites closest to the Manitoba border where established populations of *Ixodes scapularis* have been found. Five established black-legged tick sites have been detected in western Manitoba, 15-40 km from the Saskatchewan border. Three of the five sites are located on creeks that directly flow into the Assiniboine River (Appendix A – Figure 5). Six “sentinel” sites along the Qu’Appelle, Upper Assiniboine and Souris River watershed that were sampled in 2016, 2017 and 2018 will be re-sampled in the spring and fall of 2019. These sites include: Buffalo Pound, Echo Valley, Moose Mountain and Crooked Lake Provincial Parks, and Fort Esperance and Fort Livingstone National Historic Sites.

Approximately 10 high risk potential sites will be investigated in the aspen parkland and boreal transition areas further north and west where small numbers of black-legged ticks have been found through submissions to the passive surveillance program.

Passive surveillance will continue with increased emphasis placed on submissions from veterinary clinics and provincial park staff in southeastern and east central Saskatchewan. An instructional video and information package on tick identification and shipping and handling instructions may be developed and sent to all veterinary clinics in southeastern and east central Saskatchewan. In addition, consideration may be given to the development of individualized training sessions for veterinarians and veterinary technicians at regional meetings and/or at the annual meeting of the Saskatchewan Veterinary Medical Association and the Saskatchewan Veterinary Technician Association.

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, 176 active surveys have been completed in the province since 2014 and will continue in 2019. In spite of this increased effort, no known blacklegged tick populations have been detected in Saskatchewan. However, 71 black-legged 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 and Nick Ogden, 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 – 2018.

Appendix A: Site Selection for Active Surveillance

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

- sites where black-legged 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 black-legged ticks^{5 6 7} (Figure 6). 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 (e.g. 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 black-legged tick have been detected⁸; 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 black-legged tick has been conducted in the province since 2008 and the number of surveys was increased in 2014. Surveillance included surveys throughout southern Saskatchewan in 2014 and 2015, and at additional sites identified through a pilot project for surveys in the southeast region in 2016 and 2017. Funding for the surveys in the last two years has been provided through the PHAC.

It is important to note that reproducing or established black-legged 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.

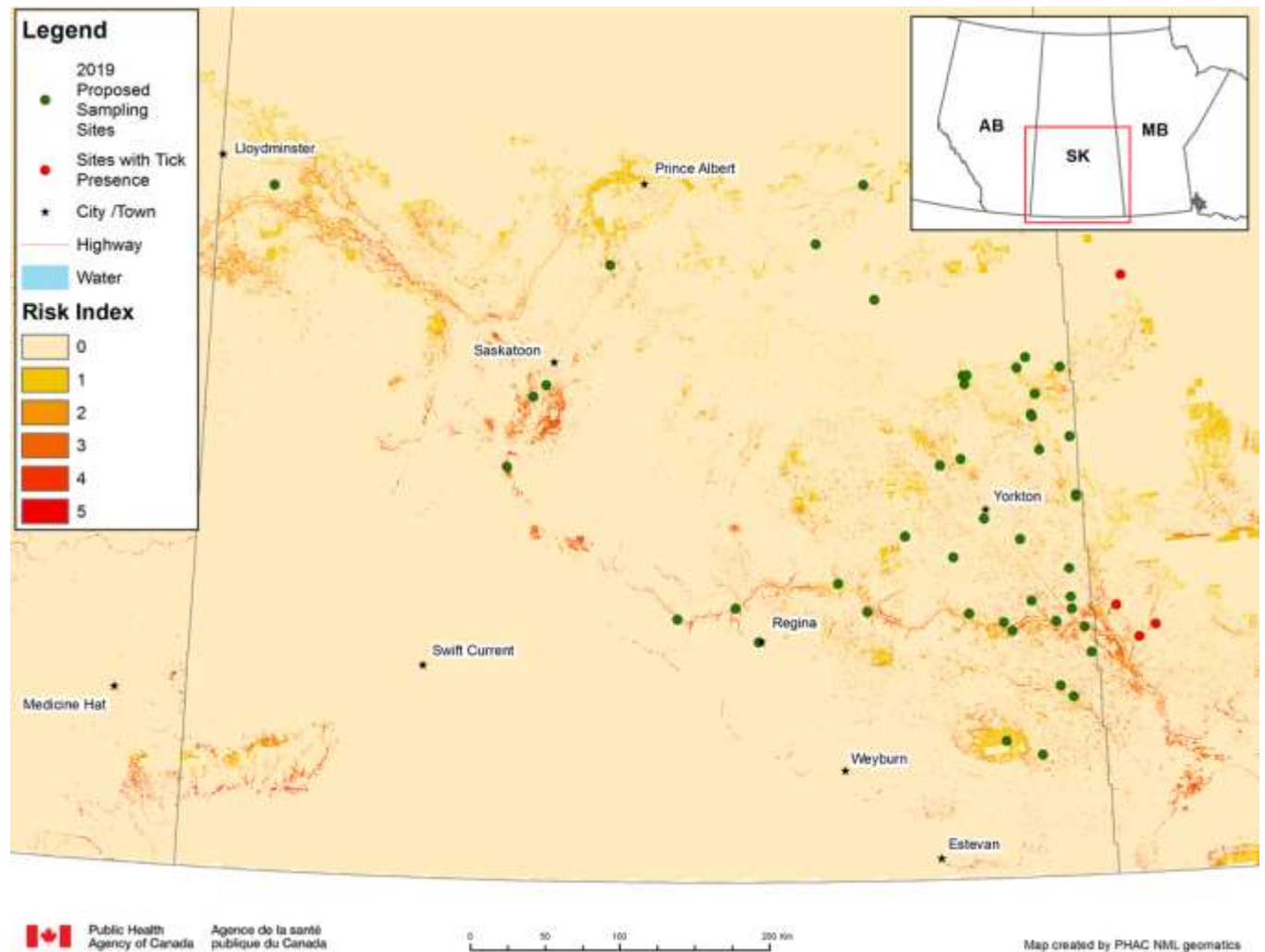
⁵ Ogden NH, Maarouf A, Barker IK et al. Projections for range expansion of the Lyme disease vector *Ixodes scapularis*, in response to climate change. Int J Parasitol. 2006. 36: 63-70

⁶ Gabriele-Rivet V, Koffi J, Pelcat Y et al. A risk model for the Lyme disease vector *Ixodes scapularis* (Acari: Ixodidae) in the Prairie provinces of Canada. 2017. J. of Med. Ent. (in press)

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)

Figure 5: Figure 1: Habitat Suitability for Black-legged Tick Establishment in Saskatchewan - Low to High Potential Risk (Risk Index 0 – 5) and 2019 Sampling Sites (green dots) – Manitoba Sites With Tick Presence (red dots).



Appendix B – Habitat Quality

Figures 6,7: Campground and hiking trail (Pike Lake Prov. Park and Outlook Regional Park)



Figures 7,8: Trail and picnic area – Woodlawn (Estevan) and Outlook Regional Parks



(Photos courtesy of Phil Curry)

Figure 9: Woodlawn Regional Park – Souris River at Estevan



(Photo courtesy of Phil Curry)

Figure 10: Riparian habitat – Buffalo Pound Provincial Park



(Photo courtesy of Phil Curry)

Figure 11: Moister, more heavily wooded riparian habitat –South Saskatchewan River at Batoche National Historic Site



(Photo courtesy of Phil Curry)

Figure 12: Bird's Point – Moister, more heavily treed portion of the lower Qu'Appelle River Valley



(Photos courtesy of Jared Schuba)