Tick Surveillance

2023 Summary

September 2024

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Summary

Tick surveillance can be passive (examining ticks or photographs of 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 2008[1]. The blacklegged tick is the primary carrier for the agents that cause Lyme disease and several other tick-borne diseases in Canada and the United States of America. 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 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* and occasionally *Babesia odocoile*i (agents 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 level of interaction among 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 surveillance, 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 the ticks submitted for pathogen testing 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.

[1] Corrected from previous reports which stated active tick surveillance started in 2009.

2023 Tick Surveillance Summary

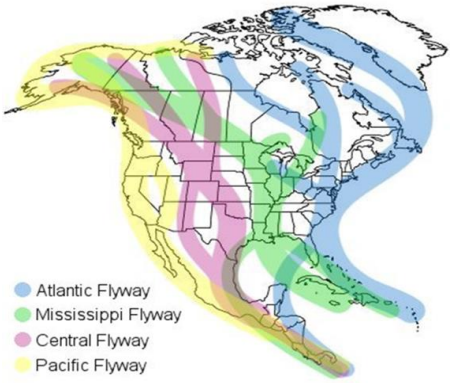
- In Saskatchewan, both passive surveillance (via voluntary submissions) and active surveillance (via tick surveys) are conducted to monitor tick activity in the province.
- Most ticks (about 95%) obtained through the surveillance programs are the American dog tick (*Dermacentor variabilis*), winter or moose tick (*Dermacentor albipictus*) or the Rocky Mountain wood tick (*Dermacentor andersoni)*. These species are not known to be competent vectors of Lyme disease but may transmit other diseases such as Rocky Mountain Spotted Fever, tularemia and tick paralysis, although only rarely in western Canada.
- In 2023, 1,011 ticks were identified through voluntary submissions and 27 were blacklegged ticks. Ten blacklegged ticks were submitted for pathogen testing; one tested positive for the bacteria that causes Lyme disease. One tick tested positive for *Babesia odocoilei*, which can cause babesiosis in humans.
- Since 2008, 37,258 ticks have been identified through voluntary submissions and 150 (0.4%) were blacklegged ticks. Of the 150 blacklegged ticks, 111 were submitted for testing, and 14 (13%) tested positive for the bacteria that causes Lyme disease. Eight of the tested ticks (7%) were positive for the bacteria that causes anaplasmosis. Three ticks (3%) were co-infected with both agents.
- Active tick surveys have increased in recent years. In 2023, 46 surveys at 40 sites were completed during the spring, summer and fall periods.
- Through active surveys in 2023, 2,029 ticks were collected. Three blacklegged ticks were collected through active surveys for the first time since surveys began in 2008. In addition, 1,833 American dog ticks, eight Rocky Mountain wood ticks, and 185 larvae of the winter or moose tick were collected. The blacklegged ticks collected through active surveillance were archived and not tested for pathogens.

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, *I. scapularis,* the blacklegged tick, has been rapidly expanding in Canada in recent years. This tick is now considered to be endemic to some localized areas of southern Ontario, Quebec, New Brunswick, Nova Scotia, and Manitoba. 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[2]. 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 and Figure 2).

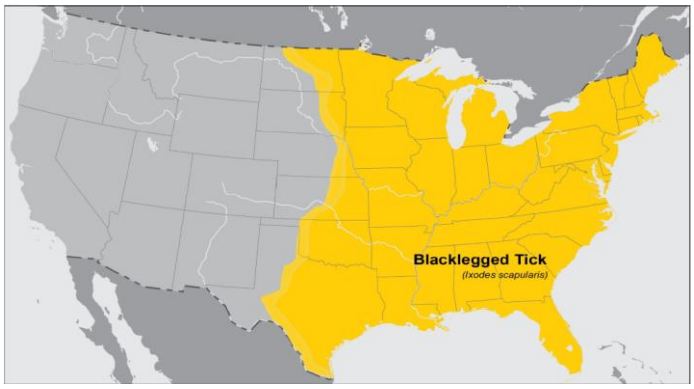
[2] Henry B, Morshed M. Lyme disease in British Columbia: Are we really missing an epidemic? BC Med J. 2011; 53(5): 224-229

Figure 1: North American bird flyways



https://www.michiganaudubon.org/bfc/safe-passage-great-lakes/

Figure 2: Estimated distribution of *Ixodes scapularis* – United States, 2018



https://www.cdc.gov/ticks/geographic_distribution.html)

Most 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 or moose tick (*Dermacentor albipictus*). *Dermacentor* species are not competent vectors of Lyme disease but may transmit other diseases such as Rocky Mountain Spotted Fever, tularemia and tick paralysis, although only rarely in western Canada[3]. A few ticks (0.4%) detected through voluntary submissions are the blacklegged ticks; these are occasionally found in the southern and central part of the province. Since 2008, 150 blacklegged ticks have been detected through passive surveillance (voluntary submissions) in the province, and of the 111 ticks submitted for testing, 14 (13%) tested positive for *B. 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, eight (7%) blacklegged ticks have tested positive for the bacteria that causes anaplasmosis. In 2023, for the first time since active surveys began in 2008, three blacklegged ticks (0.15%) were collected out of a total 2,029 ticks. A reproducing population of blacklegged ticks has not yet been detected in Saskatchewan.

Determining Lyme Disease Risk

Monitoring for blacklegged ticks and the prevalence of infection with *Borrelia* spp. or other pathogens 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[4]; and,
2. field-validated signals from passive tick surveillance[5].

[3] Dermacentor variabilis: American dog tick - Learn About Parasites - Western College of Veterinary Medicine [Internet]. 2021. Available from: https://wcvm.usask.ca/learnaboutparasites/parasites/dermacentor-variabilis-american-dog-tick.php#:~:text=Dermacentor%20variabilis%20will%20readily%20feed,only%20rarely%20in%20western%20Canada

[4] 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

[5] 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

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[6].

Lyme disease risk areas identified in Canada are summarized at: https://www.canada.ca/en/public-health/services/diseases/lyme-disease/surveillance-lyme-disease.html. Relevant provincial and territorial websites can be found at the following link: https://www.canada.ca/en/public-health/services/diseases/lyme-disease.html#a5

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 of supporting an established tick population. If such populations were found, these would be the first Lyme disease risk areas known in Saskatchewan.

Several sources of information are used in determining 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.

Tick Surveillance in Saskatchewan

Since 1995, the Ministry of Health (Population Health Branch) has collaborated 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 2021, the Saskatchewan Health Authority (Regina environmental public health), assisted with the spring and fall surveys of ticks in southeastern Saskatchewan.

The goal of tick surveillance 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 confirms that reproducing populations occur;
- adventitious – ticks are found only sporadically, both in time and space, and usually only a single stage of tick (e.g., adult females) is present; or
- not present – ticks have not been found in an area after surveys have been conducted to assess the level of establishment.

Tick surveillance can be passive (examining ticks or photographs of 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.

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

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 surveillance program regarding when and where to sample for ticks. Passive surveillance is recommended for jurisdictions, such as Saskatchewan, where established blacklegged tick populations do not exist. It is found to be less useful in areas where there are known established tick populations[7].

Methods

From 2009-2019, ticks were voluntarily submitted by veterinarians, health care workers, the general public, and other interested parties to the RRPL or the U of S for sorting and identification. In 2020, eTick was implemented, and has since become the primary platform for passive tick surveillance in the province. More information on eTick can be found at www.eTick.ca.

Through eTick, individuals submit photographs of ticks they encounter. Researchers at the U of S identify ticks and request all blacklegged ticks and other non-native tick species by mail for validation and testing purposes. Mailed-in blacklegged ticks are tested for *B. burgdorferi, B. miyamotoi*, *B. mayonii* (occasionally), *A. phagocytophilum*, *Ba. microti* and *Ba. odocoilei* (occasionally) at the NML or U of S.

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 repeatedly sample many of the same sites every year and conduct seasonal sampling (i.e., spring or fall) at other sites.

Site Selection

Potential risk areas for the establishment of blacklegged ticks have been identified through development of a risk model for the Prairie Provinces[8]. This model integrates temperature, habitat as a combined geo-layer of forest cover and agricultural land use, and rainfall to produce a risk map for Saskatchewan, Manitoba and Alberta. The map identifies low to high potential (risk index 0-5) for *I. scapularis* (blacklegged ticks) and has helped to further guide active tick surveillance in Saskatchewan (**Appendix A – Figure 7**). Of the 64.6 million hectares of habitat classified in Saskatchewan, 1,463,322 ha have been classified as having some risk for establishment of the blacklegged tick, with 181,984 ha classified as having a high risk potential (risk category 4-5) for establishment of blacklegged ticks[9]. Sites with high risk potential have been identified in aspen parkland and boreal transition habitat throughout southeastern and central Saskatchewan (Table 2). Most targeted surveys are conducted in these sites.

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.

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[7] 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

[8] 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. Med. Entomol. 54: 862-868

[9] Saskatchewan Ministry of Health, unpublished data

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. In addition, a number of sites have been identified in the North and South Saskatchewan River watersheds in central Saskatchewan and in urban parks and naturalized areas where blacklegged ticks have been submitted through passive surveillance.

Included in the active survey sites for 2023 (n=40) were 12 Canadian Lyme Sentinel Network (CaLSeN) sites in Saskatchewan (Table 2). Of the 46 active surveys completed in 2023, 14 surveys were in CaLSeN sites. Located near the cities of Saskatoon, Regina, Yorkton, and Prince Albert, CaLSeN surveillance sites provide detailed and standardized collection of data on tick distribution and abundance in Saskatchewan and will provide baseline information on current and future Lyme disease risk as the vector and disease becomes established in the province. In previous reports, these sites were referred to as Canadian Lyme Disease Research Network sites.

A more detailed summary of the site selection criteria is included in **Appendix A**.

Methods

Adult blacklegged ticks are active in the spring and fall months, while nymphs are found in the spring and summer months. To detect these ticks during the season, active tick surveillance by drag sampling is completed by the Ministry of Health and the Western College of Veterinary Medicine (WCVM) at the U of S. Training in tick surveillance techniques and tick identification is provided by qualified professional with expertise in tick morphology.

Surveyors use a dragging technique which consists of pulling a white flannel cloth over and around vegetation where ticks may be present. The drag resembles a moving host, and the ticks will grab onto the cloth as it moves by. The cloth is 1m² and is attached to a 1.2m wooden dowel, with a cord or rope used to pull the drag cloth (Figure 3 and Figure 4).

Figure 3: Tick surveillance using a drag.

Figure 4: Winter or moose tick (*Dermacentor albipictus*) larvae collected using a drag.

(*Photos courtesy of Phil Curry*)

At non-CaLSeN sites, each survey consists of collecting and recording ticks every 25m, for a total distance of 2km. Because the drag cloth is 1m², the total area sampled per site is 2000m² or 0.2 hectare. For the fall surveys, the distance travelled is often more than 2km. A minimum of two hours of sampling effort by the surveyors is completed at most sites with the exception of some smaller sites where a blacklegged tick had been submitted through passive surveillance and a full survey could not be completed.

CaLSeN surveys are conducted by drag sampling along two 1000m transects (total 2000m² or 2km) in suitable tick habitat. Tick samples are collected every 25m and an in-depth analysis is conducted of the ecological factors that support the establishment of a tick population. Measurements include weather during collection, latitude and longitude coordinates at each sample point, temperature, forest and understory vegetation types, litter depth, soil humidity and percent canopy cover. There are usually four people involved in a CaLSeN survey, two surveyors and two observers recording the data. CaLSeN sites are sampled each year to determine if blacklegged ticks are present and to measure yearly fluctuations in tick activity.

During the surveys, "flagging" is done at a few of the individual survey points where the shrubs and trees are too thick to allow for dragging. Dragging is done by dragging the white cloth over relatively open ground, whereas flagging (i.e., moving the cloth in a waving motion over and through vegetation) is usually done in densely brushy ground. With flagging, the end of the drag cloth can be gripped at one end so that the cloth hangs vertically downwards, and the device used to flag vegetation. Ticks that are questing for passing hosts cling to the cloth and can be removed for identification and counting. Any blacklegged ticks that were collected would be tested for a range of pathogens.

Ticks are removed from the drag cloth and the numbers and species are recorded. All male and female adult ticks and nymphs of any species from CaLSeN sites are placed into collection vials for identification. For all other sites, ticks are identified and counted, and a subsample may be collected for further studies. Blacklegged ticks and nymphs, or species that require further identification, are placed in vials for identification and testing.

Drag or flag sampling is usually done in the late morning or early afternoon and is not effective when it is raining, when the vegetation is wet (from rain or dew), or when temperatures are less than 4°C or greater than 25°C.

Surveillance Results

Passive surveillance

In 2023, 1,011 ticks were identified through passive tick surveillance and 27 (2.7%) were blacklegged ticks collected from Saskatchewan (Table 1). Four blacklegged ticks were collected from humans, five from cats, and 18 from dogs. Of the 27 blacklegged ticks, 10 were submitted via mail for pathogen testing. One tick was in a poor physical state and did not yield any genetic material for testing. Of the remaining 9 ticks, one tested positive for the Lyme disease agent, *B. burgdorferi*; this tick was collected from the boreal transition ecoregion (Figure 5). One blacklegged tick, collected from a cat in the boreal transition ecoregion, tested positive for *Ba. odocoilei*, which can cause babesiosis in humans[10]. All ticks tested negative for *A. phagocytophilum, Ba. microti,* and *B. miyamotoi*. Ticks were not tested for *B. mayonii* in 2023.

In addition, two blacklegged ticks, likely collected outside Saskatchewan were submitted to the surveillance program, one from Ontario and one from the United States. The tick collected from Ontario tested positive for *B. burgdorferi* and negative for all other pathogens tested while the tick from the United States tested negative for all pathogens. Both ticks were excluded from the data in Table 1.

[10] Scott JD, Sajid MS, Pascoe EL, Foley JE. Detection of Babesia odocoilei in Humans with Babesiosis Symptoms. Diagnostics. 2021 May 25;11(6):947.

In addition to the blacklegged ticks, other notable *Ixodes* ticks detected in 2023 through eTick include an *Ixodes muris* (mouse tick), collected in September from a cat, and an *Ixodes sculptus*, collected in June, from a human. Research evidence suggests that *I. muris* is capable of transmitting *B. burgdorferi*, however it is a poor vector compared to blacklegged ticks[11]. The *I. muris* specimen was submitted for pathogen testing and tested negative for all pathogens, including *B. burgdorferi*. Saskatchewan is within the known geographic distribution of *I. sculptus.* While *I. sculptus* ticks usually host on burrowing rodents, they have occasionally been found on humans[12]. The *I. sculptus* specimen was not submitted for pathogen testing because it is not a known vector for *B. burgdorferi.* An *Ixodes pacificus* tick, collected from British Columbia was also submitted to the surveillance program. It was in a poor physical state and did not yield genetic material for pathogen testing.

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 (Table 1). In 2018 and 2019, fewer blacklegged ticks were collected; however, in 2018 two of six tested positive while in 2019 zero ticks tested positive. Compared to 2018 and 2019, blacklegged tick submissions increased each year from 2020-2023. It is unclear whether this represents an actual increase in tick numbers or is a result of increased awareness by the public to submit blacklegged ticks.

Over the last 16 years (2008-2023), 37,258 ticks were identified through passive surveillance and of these 150 (0.4%) were blacklegged ticks. Of the 111 blacklegged ticks mailed in for pathogen testing, 14 (13%) were infected with *B. burgdorferi*. Blacklegged ticks positive for *B. burgdorferi* were collected from moist mixed grassland, aspen parkland, boreal transition, and mid-boreal lowland ecoregions. Eight blacklegged ticks (~7%) collected from moist mixed grassland, aspen parkland, and boreal transition were infected with *A. phagocytophilum.* Three ticks (~3%) were co-infected with both agents (Table 1).

[11] Dolan MC, Lacombe EH, Piesman J. Vector Competence for *Ixodes muris* (Acari: Ixodidae) for *Borrelia burgdorferi.* J Med Entomol. 2000 Sep 1;37(5):766-8.

[12] Hutcheson HJ, Mertins JW, Kondratieff BC, White MM. Ticks and Tick-Borne Diseases of Colorado, Including New State Records for *Argas radiatus* (Ixodida: Argasidae) and *Ixodes brunneus* (Ixodida: Ixodidae). J Med Entomol. 2020 Nov 9;58(2):505-17.

Table 1: Number of ticks detected through passive and active surveillance, blacklegged ticks and ticks positive for *Borrelia burgdorferi* and *Anaplasma phagocytophilum* (2008-2023)

Year	Passive surveillance		Active surveillance		Results of Pathogen Testing			
	Total ticks (all species)	Blacklegged ticks	Total 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	-	5	-	0	0	1	0	1
2009	1,478	5	-	0	1	1	1	1
2010	1,139	3	-	0	0	0	0	0
2011	736	3	-	0	1	0	0	1
2012	2,896	1	-	0	0	0	0	0
2013	1,726	10	-	0	1	2	1	2
2014	3,176	5	945	0	0	0	0	0
2015	5,103	9	1,516	0	1	1	1	1
2016	5,300	9	1,823	0	0	0	0	0
2017	5,112	15	511	0	4	0	0	4
2018	2,233	7*	263	0	2	0	0	2
2019	2,393	7[3]	674	0	0	0	0	0
2020	2,678	12[4]	1,746	0	3	1	0	4
2021	969	15[5]	556	0	0	2	0	2
2022	1,308	17[6]	595	0	0	0	0	0
2023	1,011	27[7]	2,029	3[8]	1	0	0	1
Total	**37,258**	**150**	**10,658**	**3**	**14**	**8**	**3**	**19**

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, headache 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.*
[4]Of the 12, only seven blacklegged ticks were mailed in for pathogen testing. All seven ticks tested negative for *Borrelia miyamotoi*, *Borrelia mayonii,* and *Babesia microti.*
[5]Nine out of 15 blacklegged ticks were mailed in for pathogen testing. Blacklegged ticks were not tested for *Borrelia miyamotoi, Borrelia mayonii,* and *Babesia microti* in 2021.
[6]Seven blacklegged ticks were mailed in for pathogen testing. One tick tested positive for *Borrelia miyamotoi*. Ticks were not tested for *Borrelia mayonii* in 2022.
[7]Ten blacklegged ticks were submitted for testing in 2023.
[8]Blacklegged ticks collected through active surveillance were not tested for pathogens.
*Corrected.

Blacklegged ticks have been detected throughout the province but predominantly in the moister and more wooded moist mixed-grass prairie, aspen parkland and boreal transition areas (Figure 5). Only nine percent have been found in the drier and less wooded mixed grassland and mid-boreal ecoregions (Figure 6).

Figure 5: Blacklegged tick locations in Saskatchewan through passive and active surveillance, 2008-2023 (N=148)*

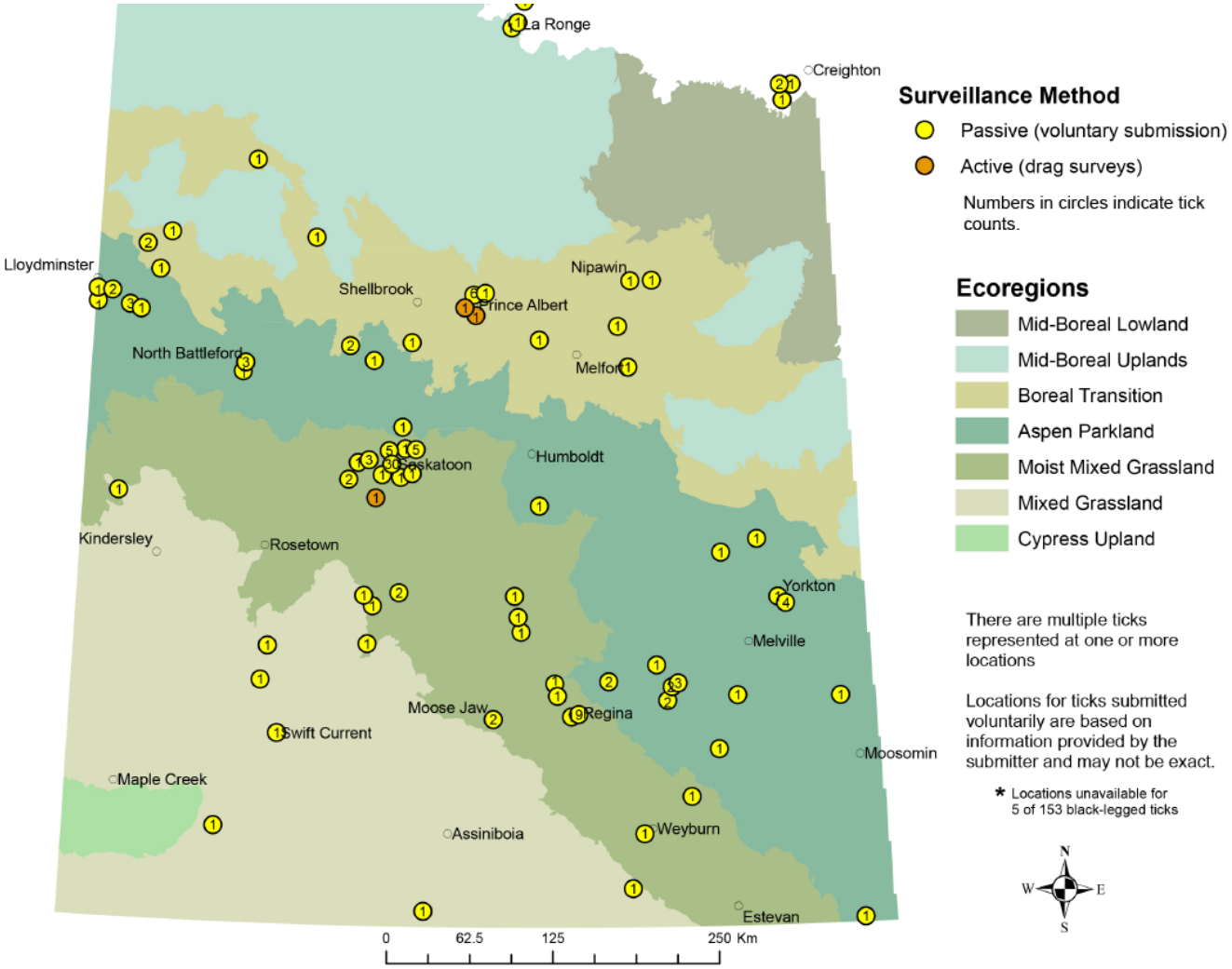
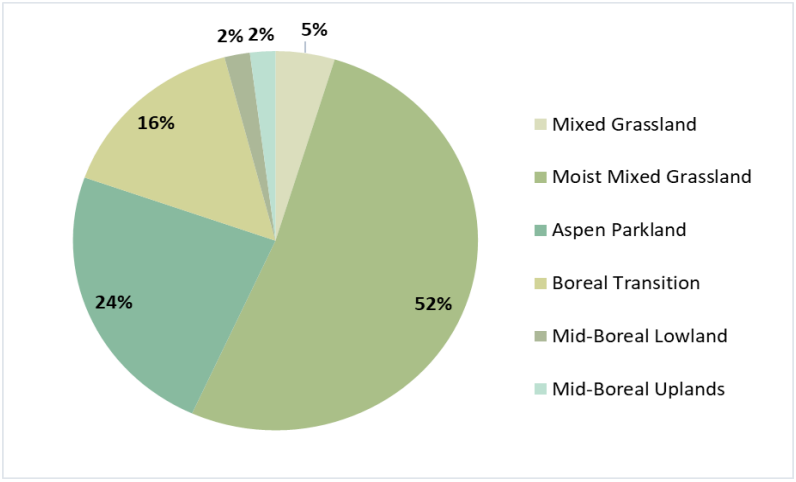


Figure 6: Percent Blacklegged ticks by ecoregion in Saskatchewan, passive and active surveillance, 2008-2023 (N=148)*



*Locations not available for 5 of 153 blacklegged ticks

Active surveillance

Forty-six surveys at 40 sites were completed during the spring, summer and fall periods in 2023. Twenty-seven surveys were completed during the spring and early summer period, and 19 surveys were completed during the fall period (Table 2).

The survey sites included nine Provincial Parks (two individual sites were located at Pike Lake), three Regional Parks, six provincial ecological reserves/historic sites, two National Historic Sites, 16 urban parks, ecological reserves and recreation areas, and three private properties. There were six sentinel sites where two surveys were done in the spring and fall at the same location (i.e., Echo Valley, Crooked Lake, Moose Mountain and Pike Lake Provincial Parks, Chief Whitecap Park South, and Battleford). An additional fall survey was completed at Mair Park in Prince Albert where a blacklegged tick was detected in the spring.

There was an increased number of surveys done in urban parks, ecological reserves and recreation areas close to larger urban areas in response to submissions of blacklegged ticks by the public. These included sites near Saskatoon, Regina, Prince Albert, Yorkton, the Battlefords, and Weyburn.

Spring surveys – Twenty-seven surveys were completed during the spring and early summer period, all in suitable tick habitat (Table 2). Twelve Canadian Lyme Sentinel Network (CaLSeN) sites were surveyed in the spring in cooperation with staff and students from the WCVM. The spring survey program began on May 4, 2023 and ended on June 22, 2023. Surveys started and ended earlier in 2023, to capture early tick activity and to better match the peak tick season. Conditions were dry and mainly sunny at all sites with only a few surveys delayed in some areas due to rain.

Most surveys were a minimum of 2 km in length with the exception of two sites (a small acreage in the R.M. of Weyburn and Anglin Lake). There were 71.5 hours of sampling effort completed for an average of 2.7 (range 2 – 5) hours per site.

Sampling was done during the late morning-early afternoon period when conditions were generally favourable for tick activity (i.e., dry, sunny or partly overcast, low winds). Temperatures during the spring sampling period were generally warm and ranged from 11 – 28°C (mean 20.1°C).

There were 1,833 American dog ticks (*D. variabilis*) (27 nymphs, 944 males, 862 females), eight Rocky Mountain wood ticks (*D. andersoni*) (4 males, 4 females) and one male blacklegged tick (*I. scapularis*) identified. Numbers of the Rocky Mountain wood tick were down from 2022 at several sites, most notably at Beaver Creek Conservation Area near Saskatoon. A single male blacklegged tick was the first one collected through active surveillance in the province.

Fall surveys – Nineteen surveys were completed during the fall period in southern and central Saskatchewan, all in suitable habitat (Table 2). The fall survey program began on September 26, 2023 and the last survey was completed on October 19, 2023.

Conditions during the surveys were dry and mainly sunny at most sites. Surveys were not completed at two sites (Fort Carlton and Sturgis) due to unexpected snow/rain squalls during the surveys and at a number of other sites after cool, wet conditions prevailed after October 20, 2023. Temperatures in September and early to mid-October were above normal throughout the fall survey period (av. 14.1°C; range 8 - 18°C).

The fall surveys were a minimum of 2 km in length with the exception of two small sites (Prince Albert – Miller Hill Park and Petrofka Recreation Area). A total of 43.5 hours of sampling effort were completed during the fall period, with an average of 2.3 hours of survey effort at the sites.

Two male blacklegged ticks (*I. scapularis*) were collected at two different sites during the fall surveys (Prince Albert – Miller Hill Park and Pike Lake Provincial Park). One hundred and eight-five (185) larvae of the winter or moose tick (*D. albipictus*) were collected at Wanuskewin Heritage Park. This tick is a one-host tick that is commonly found on moose, deer, elk, and bison. Horses and cattle can also become infested. It is not known to transmit agents that may cause disease in humans. The three blacklegged ticks collected through active tick surveillance in 2023 were not submitted for pathogen testing. The three blacklegged ticks are archived at the Royal Saskatchewan Museum.

Detailed habitat evaluations (including measurements of temperature, forest and vegetation type, weather during collection, litter depth, soil humidity and percent canopy cover) were completed at the three sites (Prince Albert (2) and Pike Lake Provincial Park) where blacklegged ticks were collected during the spring and fall surveys. These sites will be surveyed again in the spring of 2024.

Table 2: Active surveys completed in Saskatchewan (2023)[1]

Tick Sampling Locations and Sites 2023	Date	*Dermacentor variabilis*				*Dermacentor andersoni*				*Dermacentor albipictus*		*Ixodes scapularis*			
		Nymph	Male	Female	Total	Nymph	Male	Female	Total	Larvae	Total	Nymph	Male	Female	Total
Provincial Parks															
Buffalo Pound	2023-05-29	14	212	201	427		1	3	4						
Crooked Lake (S-F)	2023-05-05		17	9	26										
Crooked Lake (S-F)	2023-09-26				0										
Duck Mountain	2023-10-11				0										
Echo Valley (S-F) - CaLSeN	2023-05-11		6	3	9										
Echo Valley (S-F) - CaLSeN	2023-10-10				0										
Good Spirit – CaLSeN	2023-06-13		106	127	233										
Moose Mountain (S-F)	2023-06-07		12	10	22										
Moose Mountain (S-F)	2023-10-12				0										
Pike Lake (East) S - CaLSeN	2023-05-17		44	67	111										
Pike Lake (West) F	2023-10-17				0								1		1
Saskatchewan Landing	2023-05-31		5	6	11		2		2						
Recreation/Historic Sites and Ecological Reserves															
Wascana Trails – CaLSeN	2023-05-23		21	29	50										
White Butte Trails – CaLSeN	2023-05-10		12	19	31		1		1						
Fairy Hill Trail	2023-09-28				0										
Petrofka	2023-10-17				0										
Anglin Lake	2023-06-02				0										
Condie	2023-05-09		94	81	175										
Regional Parks															
Saltcoats – Leflay Trail - CaLSeN	2023-06-14		37	31	68										
Whitesand	2023-09-27				0										
Outlook and District	2023-05-17		9	11	20										
Urban Parks															
Beaver Creek Cons. Area (Saskatoon -MVA) – CaLSeN	2023-05-19		71	65	136			1	1						
Chief Whitecap Park (Saskatoon- MVA) - CaLSeN	2023-05-30			4	4										
Chief Whitecap Park – South (S-F) (Saskatoon – MVA)	2023-06-22			1	1										
Chief Whitecap Park – South (S-F) (Saskatoon-MVA)	2023-10-18				0										
Cosmopolitan Park (Saskatoon - MVA)	2023-05-18		2	3	5										
Wanuskewin Heritage Park (Saskatoon)	2023-10-11				0					185	185				
Lakewood Park (Saskatoon)	2023-05-19				0										
Sutherland Dog Park (Saskatoon) – CaLSeN	2023-05-15		9	6	15										
SW Dog Park (Saskatoon)	2023-10-18				0										
Kingsway Ecol. Zone (Moose Jaw –WVA)	2023-05-04	3	182	91	276										
Connor Park (Moose Jaw – WVA)	2023-09-29				0										
Logan Green (Yorkton) - CaLSeN	2023-06-13		21	23	44										
Ravine Ecological Reserve (Yorkton)	2023-10-12				0										
Kiwanis Park – Les Sherman Park (Regina)	2023-05-09		1		1										
Finlayson Island (Battleford)	2023-10-19				0										
Battleford (S-F)	2023-06-22		2	5	7										
Battleford (S-F)	2023-10-19				0										
Mair Park (Prince Albert) - CaLSeN (S-F)	2023-06-01		4	3	7								1		1
Mair Park (Prince Albert) -CaLSeN (S-F)	2023-10-10				0										
Miller's Park (Prince Albert)	2023-10-10				0								1		1
National Historic Sites															
Fort Esperance (S-F)	2023-05-24	10	66	50	126										
Fort Livingstone	2023-10-11				0										
Other:															
Strawberry Hills North	2023-10-16				0										
Strawberry Hills - CaLSeN	2023-06-23		11	17	28										
SW3-9-14-W2 (R.M. Weyburn)	2023-05-30				0										
Total		**27**	**944**	**862**	**1833**		**4**	**4**	**8**	**185**	**185**		**3**		**3**

[1]"S-F" – indicates spring or fall sampling at the same site, Canadian Lyme Sentinel Network (CaLSeN) sites are indicated.

Weather during the spring and fall sampling period – Weather conditions at the start of the 2023 season were cooler than normal during April following a colder and snowier winter. Below-average temperatures in April gave way to above-average temperatures and drier conditions in May and June. Ticks were quite numerous and active at several locations throughout May, where the snow melt and rain showers produced ideal habitat conditions in the grass, shrub, and forest understory. Hotter, drier conditions caused tick activity to slow by the end of May and early June with few ticks collected by the third week of June.

The summer and early fall were warmer and drier than average in western Saskatchewan and near average in eastern Saskatchewan. Regina and Saskatoon recorded mean monthly temperatures in August around 18°C, which is near to slightly above average. Precipitation amounts were slightly below average, with Regina reporting 35 mm and Saskatoon reporting 38 mm. September saw above-normal temperatures in many areas, with highs in the mid 20°C on many of the days. The warm dry conditions continued in October, before cold wintery weather occurred in southern Saskatchewan in late October. The warm weather returned in November and December. In December, Regina and Saskatoon reported mean temperatures of -4.2°C, which was 8° to 9°C warmer than average. The warm temperatures and lack of snow cover allowed tick activity to continue. There were submissions of blacklegged ticks to eTick in November and the winter tick in December. A summary of the mean monthly temperatures for southern and central Saskatchewan during the tick season is provided in Table 3.

Table 3: Mean monthly temperatures - difference from normal – Southern Saskatchewan, 2023

Month	Difference from normal
April	-3°C to -2°C
May	+3°C to +4°C
June	+3°C to +4°C
July	-2°C to 0°C
August	0°C to +2°C
September	+2°C to +3°C
October 23	0°C to +4°C
October 31	-2°C to 0°C
November	+3°C to +4°C
December	>5°C

(Source: Canadian Drought Monitor. Agriculture Canada)

Table 4: Temperature, canopy cover, leaf litter depth and soil moisture at time of collection for blacklegged ticks

Site	Date	Temp	Canopy cover (%)	Litter depth (cm)	Soil moisture (%)
Mair Park (Prince Albert)	2023-06-01	23	25	2.0	100
Miller Hill Park (Prince Albert)	2023-10-17	18	80	3.0	50
Pike Lake Provincial Park	2023-10-10	16	50	6.0	20

***Habitat quality* –** Most survey sites were located in areas with high potential risk for blacklegged tick establishment – classes 3-5 (**Appendix A – Figure 7**). Habitat quality was rated as excellent at most sites and ranged from brushy sites with high grass along walking or game trails to sites in more densely wooded areas of aspen and balsam poplar, Manitoba maple, and elm. Special attention for sampling was focused along hiking and biking trails in or near urban areas. Other areas of focus included game trails, deer bedding areas, and woodpiles which provide good habitat for small rodents. All of these areas tend to have a large number of hosts available in the immediate vicinity for all life-stages of ticks.

Habitat quality and suitability also varied depending on location in the watershed, the temperature and how much precipitation had been received. Blacklegged ticks favour high levels of humidity (>85%) as they are prone to drying out quickly under more arid conditions. Also, tick activity drops off if the temperatures exceed 25°C. In drier years and in lighter soils, soil moisture levels can drop, resulting in low relative humidity levels on the ground and in the surrounding vegetation. These conditions, combined with hotter weather affect tick activity at all active stages (larvae, nymph and adult) and their ability to seek hosts for a blood meal. In addition, the dry conditions can lead to excessive egg desiccation and mortality, which can set back the next couple of generations.

The habitat at the three sites where blacklegged ticks were collected in 2023 were all high-quality woodland sites located in the moist mixed grassland and boreal forest transition ecoregions. All three sites had a variety of trees and an ample understory of shrubs, forbs, and grasses. Miller Hill Park is located on the south bank of the river and faces north. It has wooded, dark gray sandy soils typical of valley complexes (**Appendix B – Figure 8**). Mair Park is located along a level and more sunlit location on the south bank of the North Saskatchewan River. It has a mixture of black silty clay loam to sandy loam alluvial soils closer to the river (**Appendix B - Figure 9**). The dominant tree at both sites is trembling aspen poplar, but there are patches of balsam poplar, Manitoba maple, chokecherry, and pin cherry. Dominant shrubs and forbs include prickly rose, red osier dogwood and highbush cranberry, Canada anemone, golden rod, vetches, field horsetail and a variety of other species. Dominant grasses include smooth brome grass and bluegrasses. Pike Lake Provincial Park is located on an alluvial flood plain on the western edge of the South Saskatchewan River valley. The west bank of the park rises 57m from the river valley bottom, where sand dune complexes are the predominant landform at the top (**Appendix B-Figure 10**). The survey site is located near the top of the bank and faces east. Tree species include trembling aspen, Manitoba maple, balsam poplar and willows in lower, wetter areas. Various species of shrubs include red osier dogwood, rose and highbush cranberry. Wild strawberry, lily-of-the-valley and wild mint are just a few of plants that grow in the understory of the wooded areas. The weather and temperatures at the time of collection were optimum for tick activity (i.e., warm temperatures, low wind, mainly sunny) (Table 4).

Next steps

In 2024, passive surveillance will continue with submissions primarily received through eTick. In terms of active surveillance, the goal is to conduct a minimum of 57 surveys at 50 sites, with a continued focus on deciduous woodlands in several watersheds in southeastern, central, and northwest areas of the province. These include the Upper Assiniboine and Qu'Appelle River watersheds in southeast and east central Saskatchewan near Yorkton and Regina, and the North and South Saskatchewan River watersheds near Saskatoon, Prince Albert, and North Battleford. The eight "sentinel" sites that were sampled in previous years will be resampled in the spring and fall of 2024. Spring surveys at CaLSeN sites will continue at sites near Saskatoon, Regina, Yorkton, and Prince Albert.

Conclusion

Saskatchewan has maintained a robust tick surveillance program, which includes both passive and active surveillance to detect sites with established blacklegged tick populations in the province. Through the passive surveillance system, 150 blacklegged ticks have been detected in the province and a small number of these have been infected with the agents that cause Lyme disease and other disease-causing pathogens. These ticks were likely brought into the province on migrating birds and animals or by travelling people and their pets. In 2023, for the first time since active surveillance started in the province, three male blacklegged ticks were detected in the province through field surveys. Despite this finding, a reproducing population of blacklegged ticks have not yet been detected in Saskatchewan. While the risk of contracting Lyme disease or other tick-borne diseases remains low in the province, precaution should be taken to prevent tick bites.

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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 [13] [14] [15] (Figure 7). These models suggest that areas in southern and central 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, the southeast region of the province is in close proximity to areas of southern Manitoba where established populations of the blacklegged tick have been detected[16]; and,
- suitable habitat sites where there is a high degree of interaction among people, domestic animals, and wildlife. These include provincial parks, ecological reserves, recreation and historic sites, national historic sites, urban parks, regional parks, private campgrounds and resort developments.

Active surveys are also conducted at CaLSeN sites. A project pillar of Canada's National Lyme Disease Strategy, CaLSeN's goal is to establish a national network of sentinel regions allowing a standardized approach to observe the changing Lyme disease risk across Canada. This will serve as a platform to integrate environmental and epidemiological risk data for each region and across Canada.

Key outcomes of the Canadian Lyme Sentinel Network include:

1) the first standardized, national, real-time portrait of Lyme disease risk across Canada;
2) new capacity to detect/monitor Lyme disease risk factors; and
3) a novel integrated structure to assess how risk and risk factors are changing along the continuum of disease emergence across the country.

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)[17] and at additional sites identified through a pilot project for surveys in the southeast and east central regions conducted yearly from 2016 – 2021.

Active surveillance is important as established or reproducing blacklegged tick populations have not yet 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.

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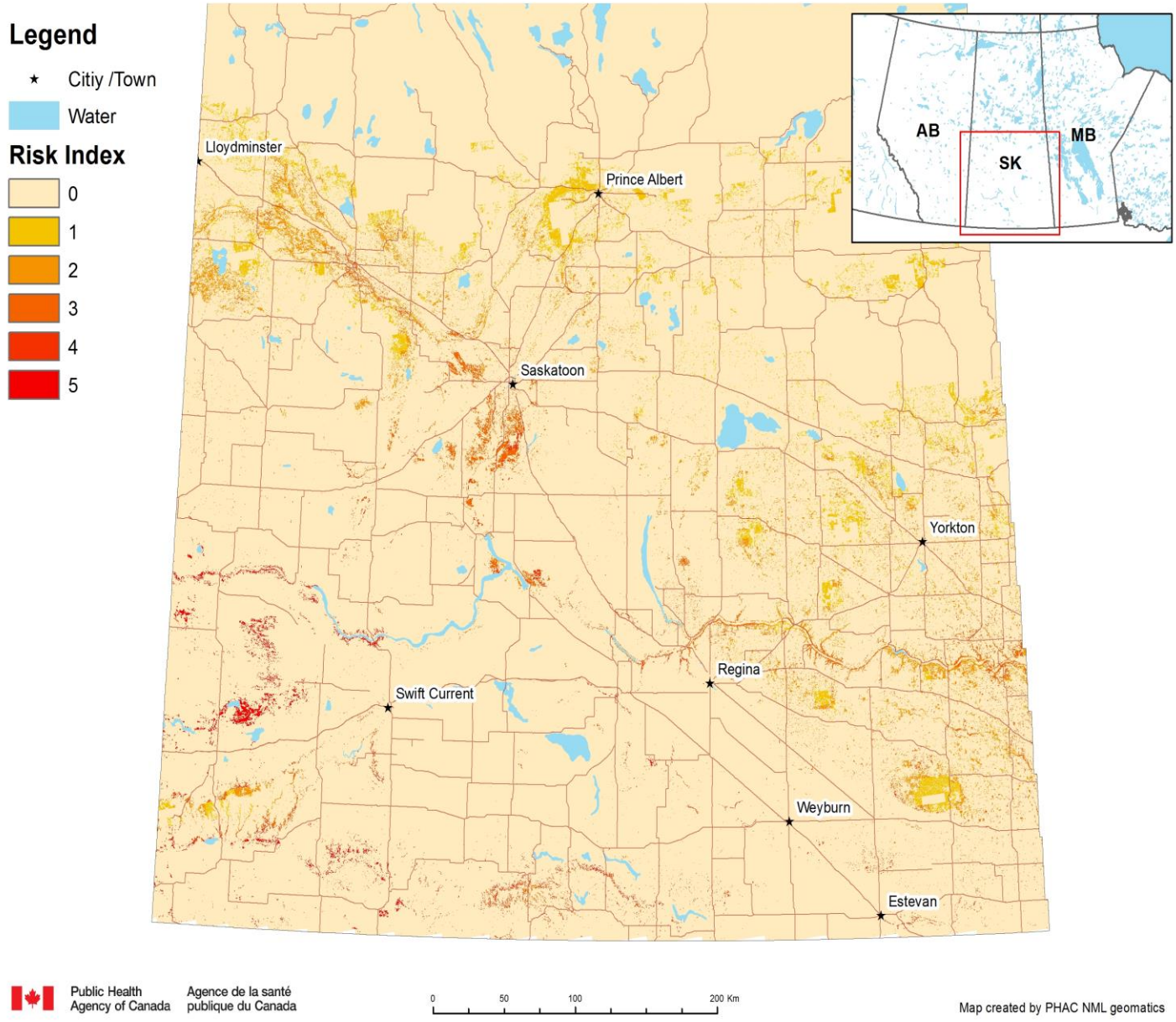
[17] Chilton NB, Curry PS, Lindsay LR, Rochon K, Lysyk TJ, Dergousoff. Passive and active surveillance for Ixodes scapularis (Acari: Ixodidae) in Saskatchewan, Canada. J Med Entomol. 2020. 57(1): 156-163

Figure 7: Habitat suitability for Blacklegged tick establishment in Saskatchewan - low to high potential risk (Risk Index 0 – 5)



Appendix B – Habitat quality

Figure 8: Miller Hill Park - Prince Albert
(Photos courtesy of Phil Curry)

Figure 9: Mair Park - Prince Albert
(Photos courtesy of Phil Curry)

Figure 10: Pike Lake Provincial Park

(Photos courtesy of Phil Curry)