Tick Surveillance

2022 Summary

May 2023

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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 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 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* (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 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 passive sampling, but no reproducing populations of ticks have been detected in any areas of the province over several years of active sampling. This means that, at present, there are no known Lyme disease risk areas in the province where blacklegged ticks are known to be established or emerging and people are more at risk of getting Lyme disease. However, the possibility of blacklegged ticks being dropped by migrating birds exists across the province, and approximately 11 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. 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.

2022 Tick surveillance summary

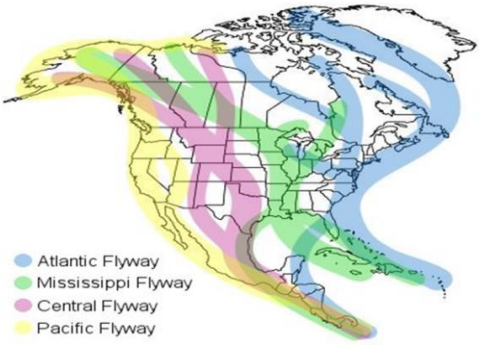
- In Saskatchewan, both passive surveillance (via voluntary submissions) and active surveillance (via tick surveys) are conducted to monitor tick activity in the province.
- The majority of ticks (about 98%) obtained through the surveillance programs are the American dog tick (*Dermacentor variabilis*), winter tick (*Dermacentor albipictus*) or the Rocky Mountain wood tick (*Dermacentor andersoni)*. These species are not known to be competent vectors of Lyme disease.
- In 2022, 1,308 ticks were identified through voluntary submissions and 17 were blacklegged ticks. Seven out of 17 (41%) blacklegged ticks were submitted for pathogen testing; of the ticks tested, zero tested positive for the bacteria that causes Lyme disease. One tick tested positive for *Borrelia miyamotoi*.
- Since 2008, 36,247 ticks have been identified through voluntary submissions and 122 (0.3%) were blacklegged ticks. Of the 122 blacklegged ticks, 101 (83%) were mailed in for testing, and 13 (~13%) tested positive for the bacteria that causes Lyme disease. Eight of the tested ticks (~8%) were positive for the bacteria that causes anaplasmosis. Three ticks (~3%) were co-infected with both agents.
- After the implementation of eTick in 2020, about 50% fewer blacklegged ticks identified through the platform are submitted for pathogen testing.
- Active tick surveys have increased in recent years. Since 2014, over 381 active surveys have been completed in the province; 58 surveys at 53 sites were completed in 2022. Blacklegged ticks have never been detected in Saskatchewan through active surveys.
- Through active surveys in 2022, 1,433 ticks were collected; 798 were American dog ticks, 40 were Rocky Mountain wood ticks, 595 were larvae of the winter or moose tick. No blacklegged ticks were collected.

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. 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[1]. 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. (Figures 1 and 2).

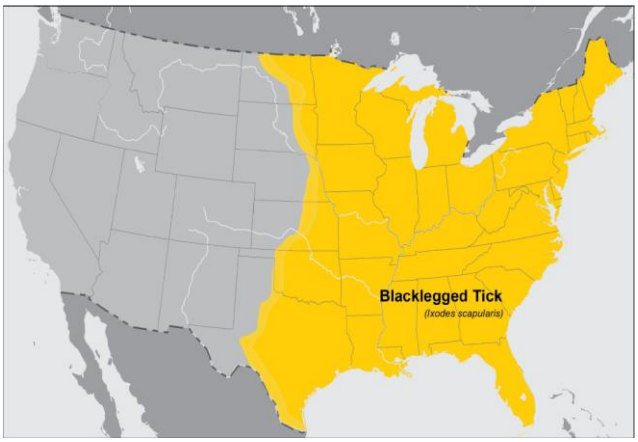
[1] Henry B, Morshed M. Lyme disease in British Columbia: Are we really missing an epidemic? BC Med J. 2011; 53(5): 224-229

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

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 ticks. Since 2008, 122 blacklegged ticks have been detected in the province, and of the 101 ticks mailed in for testing, 13 (~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 (~8%) 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* 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[2] 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[3]; and,
2. field-validated signals from passive tick surveillance[4].

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[5].

[2] Health Canada. Consensus conference on Lyme disease. CMAJ 1991. June; 144(12):1627-32.
[3] 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
[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

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, 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.

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 former Regina Qu'Appelle Health Region 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 confirms 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 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.

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[6].

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

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 by mail for validation and testing purposes. All mailed-in blacklegged ticks are tested for *B. burgdorferi* at the U of S. Blacklegged ticks are also tested for *B. mayonii*, *B. miyamotoi*, *A. phagocytophilum*, and *B. microti* 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[7]. 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*, 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[8]. Most tick surveys are conducted in high risk areas. Sites of potential high risk have been identified in aspen parkland and boreal transition habitat throughout southeastern and central Saskatchewan (Table 2).

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. 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.

[7] 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

[8] Saskatchewan Ministry of Health, unpublished data

Included among the sites for active sampling in 2022 (n=53) were 10 Canadian Lyme Sentinel Network (CaLSeN) sites in Saskatchewan. Of the 58 active surveys completed in 2022, 10 surveys were in CaLSeN sites. Located near the cities of Saskatoon, Regina and Yorkton, 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 was done by staff from 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 has been provided by the WCVM and Phil Curry, project coordinator contracted with the Ministry of Health.

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 1 m² and is attached to a 1.2 m wooden dowel, with a cord or rope used to pull the drag cloth (Figure 3 and 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 25 m, for a total distance of 2 km. Because the drag cloth is 1 m², the total area sampled per site is 2000 m² or 0.2 hectare. For the fall surveys, the distance travelled was often more than 2 km. 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 1000 m transects (total 2000 m² or 2 km) in suitable tick habitat. Tick samples are collected every 25 m 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/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.

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, counted and discarded. Only adult blacklegged ticks and nymphs, or species that require further identification, would be placed in vials for identification and testing. Any blacklegged ticks, if collected, would be tested for a range of pathogens.

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 2022, 1,308 ticks were identified through the passive surveillance program and 17 (1.3%) were adult blacklegged ticks (Table 1). Four blacklegged ticks were collected from humans, three from cats, and 10 from dogs. Of the 17 blacklegged ticks, seven were mailed in for pathogen testing and of these, zero tested positive for the Lyme disease agent, *B. burgdorferi*. All ticks tested negative for *Anaplasma phagocytophilum* and *Babesia microti.* One tick tested positive for *Borrelia miyamotoi*. Ticks were not tested for *Borrelia mayonii* in 2022.

There was no significant change in blacklegged ticks collected or positive test results from 2008-2016 (average 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 2020-2022. 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. In 2020, ~43% (3 out of 7) blacklegged ticks tested positive for *B. burgdorferi* while in 2021 and 2022, none of the ticks tested positive.

Over the last 15 years (2008-2022), 36,247 ticks were identified and of these 122 (~0.3%) were blacklegged ticks. Of the 101 blacklegged ticks mailed in for pathogen testing, 13 (~13%) were infected with *B. burgdorferi* and eight (~8%) were infected with *A. phagocytophilum.* Three ticks (~3%) 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*, passive surveillance program (2008-2022)

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 for at least one pathogen
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
2020	2,678	12[4]	3	1	0	4
2021	969	15[5]	0	2	0	2
2022	1,308	17[6]	0	0	0	0
Total	**36,247**	**122**	**13**	**8**	**3**	**18**

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.*

[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.

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 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, passive surveillance program, 2008-2022 (N=118)*

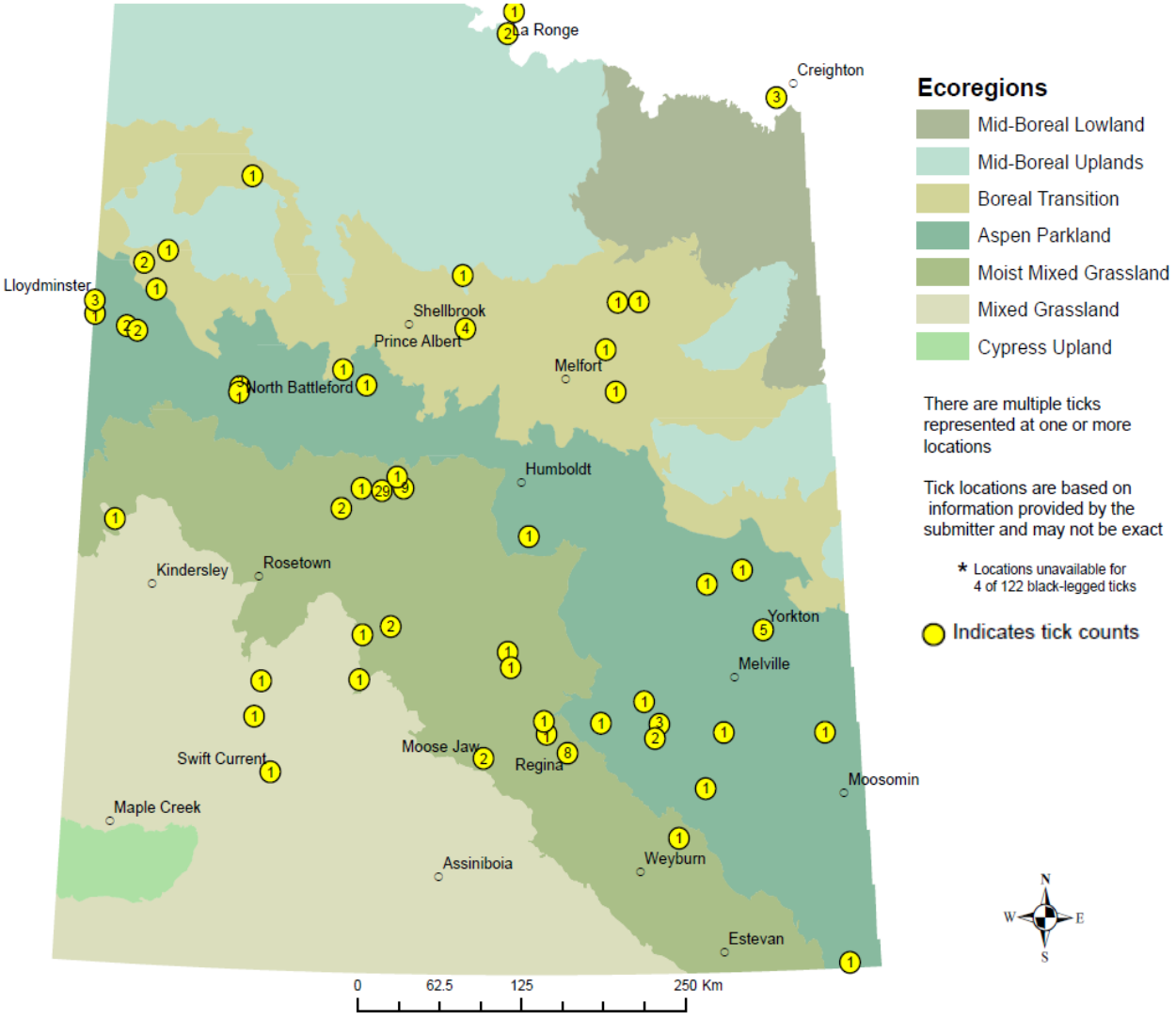
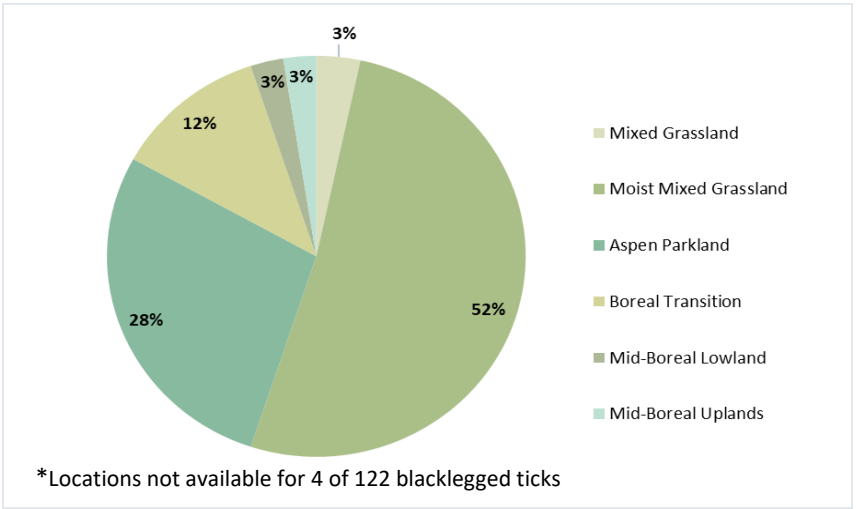


Figure 6: Percent Blacklegged ticks by ecoregion in Saskatchewan, passive surveillance program, 2008-2022 (N=118)*



*Locations not available for 4 of 122 blacklegged ticks

Active surveillance

Results

Fifty-eight surveys at 53 sites were completed during the spring, summer and fall periods in 2022. Twenty-two surveys were completed during the spring and early summer period, and 36 surveys were completed during the fall period (Table 2).

The survey sites included nine Provincial Parks (two individual sites were done at Pike Lake), six Regional Parks, six provincial ecological reserves/historic sites, three national historic sites, one community pasture, 18 urban parks, ecological reserves and recreation areas, and seven 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, Lakewood Park (Saskatoon), and Fort Esperance National Historic Site. Additional surveys were completed at some urban park locations where there was a large amount of suitable habitat (i.e. Wakamow Valley Authority, Meewasin Valley Authority).

An increased number of surveys were conducted in urban parks, ecological reserves and recreation areas close to larger urban areas in response to submissions of blacklegged ticks by the public. The surveys, conducted at sites where blacklegged ticks had been detected through passive surveillance, included: Wascana Trails, Strawberry Hills and Strawberry Hills North, Finlayson Island, Wakamow Valley, Pike Lake Provincial Park and several parks in or near Saskatoon – Lakewood, Cosmopolitan, Gabriel Dumont, southwest dog park, Chief Whitecap, and Restoring 71 nature area.

Spring surveys – Twenty-two surveys were completed during the spring and early summer period, all in suitable tick habitat (Table 2). Ten CaLSeN sites were surveyed in the spring in cooperation with staff and students from the WCVM. Conditions were dry and mainly sunny at all sites. The spring survey program began on May 16, 2022 and ended on July 3, 2022. Scattered rain from thunderstorms occurred throughout June which delayed surveys in some areas.

All surveys were a minimum of 2 km in length with a total of 68.2 hours of sampling completed during the spring period, with an average of 3.1 hours of survey effort at the sites.

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 12 – 28°C (mean 21.2°C). Temperatures were less than ideal at one survey site, Tatagwa Park – Weyburn, where it was very hot and windy in more open areas.

There were 798 American dog ticks (*Dermacentor variabilis*) (10 nymphs, 388 males, 400 females) and 40 Rocky Mountain wood ticks (*Dermacentor andersoni*) (22 males, 18 females) collected during the spring surveys (total = 838). Numbers have rebounded from 2021 (total = 556) where cool dry conditions in the spring followed by hot dry weather substantially impacted tick activity.

Fall surveys – Thirty-six surveys were completed in the fall of 2022 in southern and central Saskatchewan (Table 2). The fall survey program began on September 22, 2022 and the last survey was completed on November 2, 2022.

Conditions were dry and mainly sunny at most sites. Surveys were not completed at two sites (Lady Lake and Sturgis Regional Parks) due to unexpected snow/rain squalls. Sampling was done during the early afternoon period when temperatures warmed up enough to stimulate tick activity. Temperatures, particularly in September and October, were warm and generally dry throughout the fall period (average 14.4°C; range 5 - 23°C). Surveys continued into early November and ceased when cool, wet weather occurred throughout southern and central Saskatchewan.

Most surveys were a minimum of 2 km in length with the exception of one small site in the R.M. of Eldon. A total of 84.5 hours of sampling effort were completed during the fall period, with an average of 2.4 hours of survey effort at the sites.

Field evaluations were completed at four sites (Prince Albert (2) and R.M. Aberdeen (2)) to determine their habitat potential and suitability for surveys in 2023. A potential CaLSeN site was surveyed in the Yorkton Area (Leflay Trail – Saltcoats). This site will be surveyed again in the spring of 2023.

595 larvae of the winter or moose tick (*Dermacentor albipictus*) were collected at two sites during the fall period (Wanuskewin Heritage Park and Fort Esperance National Historic Site). This tick is a one-host tick that is commonly found on moose, deer, elk and bison. Horses and cattle can also become infested. The winter tick is not known to transmit agents that may cause disease in humans.

There were no blacklegged ticks collected in any of the spring or fall surveys.

Table 2: Active surveys completed in Saskatchewan (2022)[1]

Tick Sampling Locations and Sites 2022	Date	*Dermacentor variabilis* (American Dog Ticks)				*Dermacentor andersoni* (Rocky Mountain Wood Ticks)			*Dermacentor albipictus* (Winter or Moose Tick)	
		Nymph	Male	Female	Total	Male	Female	Total	Larvae	Total
Provincial Parks										
Buffalo Pound	2022-06-21		18	21	39	1		1		
Crooked Lake (S)	2022-06-23	3	17	18	38					
Crooked Lake (F)	2022-10-07									
Duck Mountain	2022-10-13									
Echo Valley (S) - CaLSeN	2022-07-03		1	6	7					
Echo Valley (F)	2022-10-05									
Good Spirit – CaLSeN	2022-06-11		32	33	65					
Greenwater Lake	2022-10-04									
Moose Mountain (S)	2022-06-17	1	18	25	44					
Moose Mountain (F)	2022-09-27									
Fort Carlton	2022-10-11									
Pike Lake (East) S - CaLSeN	2022-05-26		32	27	59					
Pike Lake (West) F	2022-10-13									
Recreation/Historic Sites and Ecological Reserves										
Wascana Trails – CaLSeN	2022-06-01		5	2	7					
White Butte Trails – CaLSeN	2022-06-03		1	2	3	1		1		
Fairy Hill Trail (north of Regina)	2022-10-06									
Bird's Point (Round Lake)	2022-06-22		9	16	25					
Petrofka	2022-10-11									
Roche Percee	2022-11-02									
Regional Parks										
Saltcoats – Leflay Trail - CaLSeN	2022-09-28									
Whitesand	2022-10-14									
Outlook and District	2022-06-28		1		1					
Woodlawn (Estevan)	2022-11-02									
Carlton Trail	2022-09-27									
Esterhazy	2022-09-27									
Melville	2022-09-28									
Silver Lake (Maidstone)	2022-10-12									
Urban Parks										
Beaver Creek Cons. Area (Saskatoon -MVA) – CaLSeN	2022-05-16		28	12	40	20	18	38		
Chief Whitecap Park (Saskatoon- MVA) - CaLSeN	2022-05-25		6	6	12					
Chief Whitecap Park – South (Saskatoon – MVA)	2022-06-07		3	5	8					
Gabriel Dumont Park (Saskatoon - MVA)	2022-09-28									
Cosmopolitan Park (Saskatoon - MVA)	2022-09-29									
Wanuskewin Heritage Park (Saskatoon)	2022-10-19								455	455
Lakewood Park (Saskatoon) (S)	2022-06-07			1	1					
Lakewood Park (Saskatoon) (F)	2022-09-29									
Sutherland Dog Park (Saskatoon) – CaLSeN	2022-05-24		1	4	5					
SW Dog Park (Saskatoon)	2022-10-04									
Kingsway Ecol. Zone (Moose Jaw –WVA)	2022-09-30									
Paashkow Park (Moose Jaw – WVA)	2022-05-25		39	58	97					
Connor Park (Moose Jaw – WVA)	2022-05-23	1	22	21	44					
Logan Green (Yorkton) - CaLSeN	2022-06-11	1	29	26	56					
Ravine Ecological Reserve (Yorkton)	2022-10-12									
Kiwanis Park – Les Sherman Park (Regina)	2022-06-24									
Tatagwa Park – Weyburn	2022-06-17									
Finlayson Island (Battleford)	2022-10-12									
Wastewater Off-leash Dog Park (Prince Albert)	2022-10-05									
National Historic Sites										
Fort Esperance (S)	2022-06-26	3	30	36	69					
Fort Esperance (F)	2022-10-20								140	140
Fort Livingstone	2022-10-13									
Batoche	2022-09-28									
Community Pastures										
Spy Hill-Ellice-Archie South	2022-10-20									
Other:										
Strawberry Hills North	2022-10-13									
Strawberry Hills - CaLSeN	2022-05-27	1	96	81	178					
Restoring 71 (Grandora)	2022-10-04									
Stushnoff West	2022-10-05									
NE13-18-27-W2 (R.M. Moose Jaw)	2022-10-01									
NE3-51-23-W3 (R.M. Eldon)	2022-10-12									
Imhoff (Paradise Hill)	2022-10-12									
Total		**10**	**388**	**400**	**798**	**22**	**18**	**40**	**595**	**595**

[1] "S-F" indicates spring or fall sampling at the same site, CaLSeN sites are indicated

Weather during the spring and fall sampling period – Weather conditions at the start of the 2022 season were cooler than normal during April and May following a colder and snowier winter. Several intense late-season snowstorms occurred in southeastern and central areas in April and again in mid-May. While the excess snow did end the drought conditions in eastern areas, dry conditions persisted throughout much of the western portions of the province. Heavy and frequent showers in June, particularly in central aspen parkland regions, replenished soil moisture levels. This produced a lush growth of grass, shrub and forest understory resulting in higher relative humidity and ideal conditions for ticks. There were reports of ticks remaining active in early to mid-July. Late summer and early fall were marked by hot, dry weather. September saw record high temperatures in many areas, with highs above 30°C on some days. The warm dry conditions continued in October, before an early winter storm arrived in southern Saskatchewan in late October. 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 2022

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

(Source: Canadian Drought Monitor. Agriculture Canada)

Table 4: Total *Dermacentor variabilis* (American dog tick) numbers from spring surveys at three provincial parks
2014-15 and 2017-22

Location	2014	2015	2017	2018	2019	2020	2021	2022
Echo Valley Prov. Park	214	509	42	67	35	79	81	7
Moose Mountain Prov. Park	121	57	38	53	137	110	28	44
Buffalo Pound Prov. Park	106	242	57	-	14	107	49	39

Habitat quality – Most survey sites were located in areas with high potential risk for blacklegged tick establishment – classes 4-5 (**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, picnic sites in wooded areas to wooded understory vegetation in undisturbed poplar, Manitoba maple, ash and oak bluffs. 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 quantity was more limited at one smaller site in an abandoned farmstead in the RM of Eldon in northwest Saskatchewan.

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.

Sites further south and west along the upper Qu'Appelle River and its tributaries, Wascana Creek and the Moose Jaw River, and in southwest parts of the province are frequently warmer and drier, and are dominated by mixed grass and shrub vegetation. Some of these areas, including the Great Sand Hills in southwest Saskatchewan and the sand dune areas south of Saskatoon are generally dry and do not have sufficient litter layers to support blacklegged tick populations (**Appendix B – Figure 8**). Although these areas contain pockets of suitable habitat, shrub and treed areas are characteristically shorter and confined to narrower strips along river and creek areas.

Conversely, sites along the eastern sections of Qu'Appelle River valley and in the aspen parkland and boreal transition areas are moister with larger tracts of aspen and balsam poplar, Manitoba maple, ash, and bur oak predominating. They have a dense understory of shrubs and forbs, and deeper litter layers. These sites tend to have lower temperatures and higher relative humidity levels which are conducive to sustaining black-legged tick populations (**Appendix B – Figure 9**).

Next steps

In 2023, passive surveillance will continue with submissions primarily received through eTick. In terms of active surveillance, the goal is to conduct a minimum of 55 surveys at 50 sites, with a continued focus on wooded, aspen parkland habitat 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 five "sentinel" sites that were sampled in previous years will be resampled in the spring and fall of 2023. The sixth sentinel site at Lakewood Park in Saskatoon, established in 2022, will be moved to Chief Whitecap Park south unit, where there is more suitable habitat. Spring surveys at CaLSeN sites will continue at sites near Saskatoon, Regina, and Yorkton with additional sited evaluated and surveyed near Yorkton, Regina, and Prince Albert.

Conclusion

The Saskatchewan Tick Surveillance Program has been expanded in recent years. The implementation of eTick resulted in increased voluntary submissions from veterinarians, health care workers and the general public. Through active surveillance, over 381 active surveys have been completed in the province since 2014. In spite of this increased effort, no known blacklegged tick populations have been detected in Saskatchewan. However, 122 blacklegged ticks have been collected through the passive surveillance system since 2008 and a small number (n=18) have been infected with the agents that cause Lyme disease and human granulocytic anaplasmosis. These ticks have most likely been brought into the province through human travels and from migratory birds. The risk of contracting Lyme disease or other tick-borne diseases remains low in the province.

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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 [9] [10] [11] (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[12]; 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.

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)[13] 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.

[9] 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

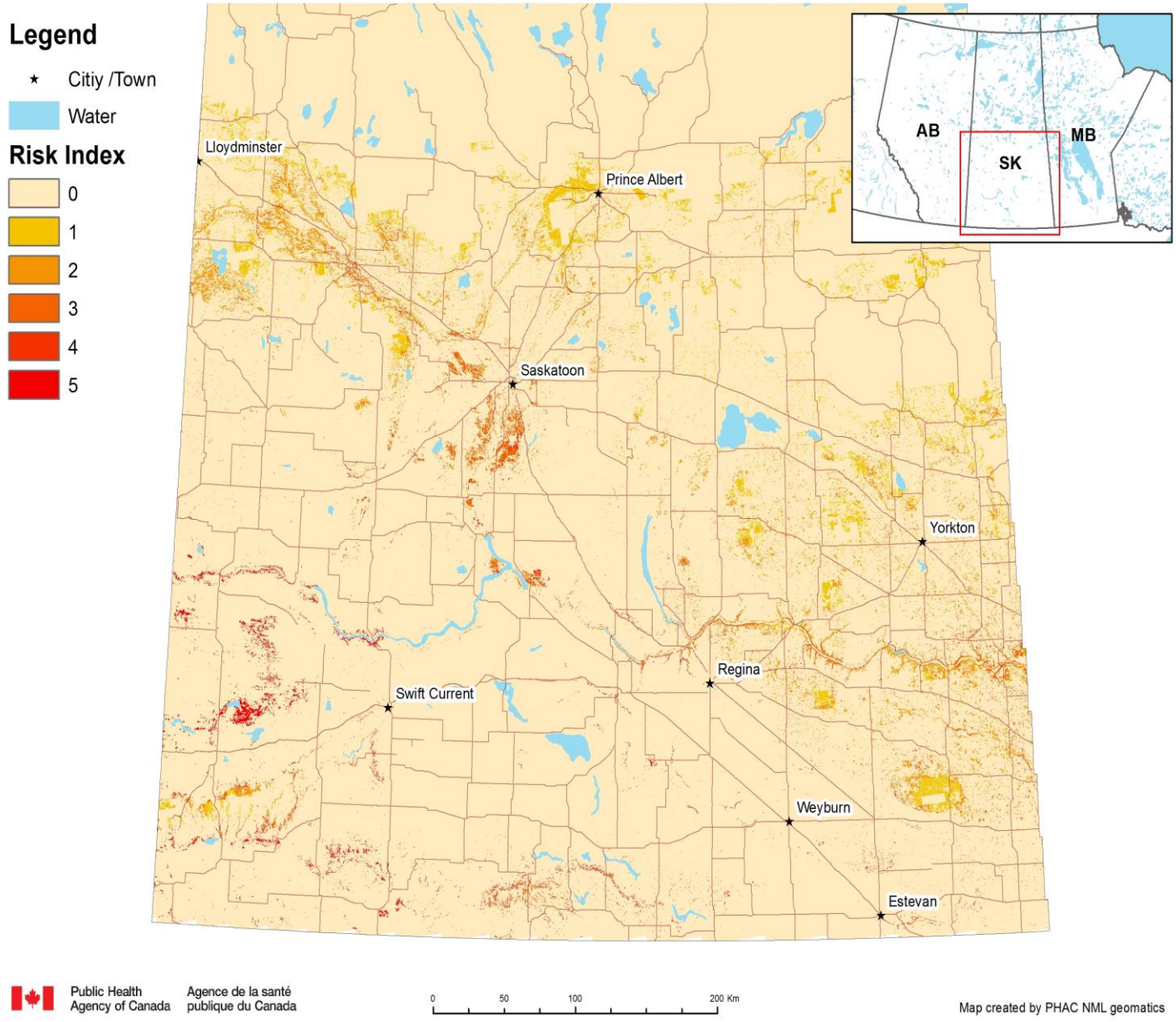
[10] Gabriele-Rivet V, Koffi J, Pelcat Y et al. A risk model for the Lyme disease vector *Ixodes scapularis* (Acari: Ixodidae) in the Prairie Provinces of Canada. 2017. J. of Med. Ent. (in press)

[11] 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

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

[13] 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: Sand dune areas – Pike Lake Provincial Park

(*Photos courtesy of Phil Curry*)

Figure 9: Mink and Ermine Trails – Echo Valley Provincial Park

(*Photos courtesy of Phil Curry*)