epiREPORT

Manitoba Annual Tick-Borne Disease Report

2018

January 1, 2018 to December 31, 2018

Communicable Disease Control

Population and Public Health Branch

Population Health Division

Manitoba Health, Seniors and Active Living

Released: February 2020

Manitoba

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Abbreviations

BLT	Blacklegged tick (*Ixodes scapularis*)
MHSAL	Manitoba Health, Seniors and Active Living
MIR	Minimum Infection Rate
NML	National Microbiology Laboratory
NNDSS	National Notifiable Disease Surveillance System
PHAC	*the* Public Health Agency of Canada
PPHB	Population and Public Health Branch
RHA	Regional Health Authority
TBD	Tick-borne disease(s)

Regional Health Authorities

Winnipeg RHA	Winnipeg Regional Health Authority[1]
Southern Health – Santé Sud	Southern Health – Santé Sud
Interlake-Eastern RHA	Interlake-Eastern Regional Health Authority
Prairie Mountain Health	Prairie Mountain Health
Northern RHA	Northern Regional Health Authority

[1] Note that reference to the Winnipeg RHA in this report does not include the community of Churchill. Rather reference to the Winnipeg RHA in this report refers only to the City of Winnipeg and the Rural Municipalities of East and West St Paul.

Acknowledgments

The *Manitoba Annual Tick-Borne Disease Report (2018)* is the result of the efforts of dedicated individuals throughout the province of Manitoba, including health care providers, laboratory personnel, central and regional public health employees (i.e. Medical Officers of Health, public health nurses, epidemiology & surveillance staff and seasonal field surveillance staff), external stakeholders (i.e. the Public Health Agency of Canada (PHAC) staff) and members of the public who have submitted blacklegged tick specimens.

The historical passive surveillance program (2008 – 2015) was a collaborative effort between Manitoba Health, Seniors and Active Living (MHSAL), PHAC and researchers and students at the University of Manitoba.

Methodology Note

Detailed information outlining the methodology used herein, as well as surveillance case definitions for the three reportable TBDs and surveillance criteria, can be found by consulting the Manitoba Annual Tick-Borne Disease Report 2016. The report can be found at https://www.gov.mb.ca/health/publichealth/cdc/tickborne/docs/tbd_report2016.pdf

Citation

Government of Manitoba, Manitoba Health, Seniors and Active Living, Population Health Division, Population and Public Health Branch, Communicable Disease Control (2019). *Manitoba Annual Tick-Borne Disease Report 2018.*

Let us know what you think. We appreciate your feedback! If you would like to comment on any aspect of this new report please send an email to: ticks@gov.mb.ca. Include '2018 *TBD report*' in the subject heading.

Executive Summary

The public health burden posed by tick-borne diseases (TBDs) in Manitoba, as seen elsewhere in Canada and the United States, continues to increase. The number of Anaplasmosis and Lyme disease cases reported to Manitoba Health, Seniors and Active Living (MHSAL) in 2018 was the highest recorded to date since they were made reportable in 2015 and 1999 respectively. This increase is likely a function of two primary factors. First, an increasing awareness of TBDs among health care providers that has aided diagnosis and treatment. Second, the continued rapid range expansion of the vector, the blacklegged tick (*Ixodes scapularis*) throughout much of southern Manitoba, wherever suitable habitat is present.

Evidence of BLT establishment, BLT risk areas, now extends across most of southern Manitoba from the Ontario to Saskatchewan borders. Risk areas also extend from the US border to the north of Swan River. Coupled with this rapid range expansion is the subsequent introduction and increasing infection rates of the pathogens of reportable TBDs. For instance, the minimum infection rate (MIR) for *Anaplasma phagocytophilum*, the causative agent of Anaplasmosis, among locally collected BLT specimens rose from 4.0% in 2017 to 6.2% in 2018. Similarly, the MIR for *Borrelia burgdorferi*, the causative agent of Lyme disease, among locally submitted BLTS increased from 16.7% in 2017 to 20.7% in 2018.

Despite the early onset of winter conditions which significantly restricted blacklegged tick activity, 2018 was the most active year to date in terms of Anaplasmosis and Lyme disease human cases. Incidence rates, based on region of residence were highest in the Southern Health – Santé Sud Health Region, while rates based on likely exposure location were highest in the Interlake-Eastern and Southern Health – Santé Sud Health Regions. Areas with the highest incidence rates generally corresponded to areas with a longer history of BLT establishment. Overall, males, particularly those 60 years of age and older accounted for the majority of Anaplasmosis and Lyme disease cases. All Anaplasmosis cases and 93% of Lyme disease cases reported in 2018 were acquired locally. The remaining out of province Lyme disease cases were acquired in Northwestern Ontario. Anaplasmosis and Lyme disease cases were more likely to report either contact with suitable tick habitat and/ or a history of outdoor recreation as key risk factors, while less than 40% of cases recalled a tick bite.

MHSAL continues to monitor the distribution and infection rates of BLTs to identify new risk areas and develop and refine guidance and communications for both health care professionals and the public. Further, MHSAL continues to work with public health colleagues provincially and nationally to assess the human burden of known and emerging TBDs.

Tick Surveillance

Passive Surveillance - 2018

Highlights of 2018 Passive Surveillance

- Received 175 BLT submissions, far fewer than the number received in 2017.
- Most (~ 60%) of BLT specimens were collected between May and June.
- Approximately 99% of the BLT specimens were collected in Manitoba, and 91% were associated with known BLT risk areas.
- Minimum infection rates for the agents of Anaplasmosis and Lyme disease increased to 5.8% and 19.5% in 2018.
- Most infected BLTs were collected from locations within the Interlake-Eastern and Southern Health Regions.

In 2018, MHSAL received 540 submissions via both Cadham Provincial Laboratory (CPL) and the Tick Checker (Table 1 & 2). *Dermacentor variabilis*, the American dog tick (also referred to as the 'wood tick'), was the most common tick, with 289 submissions received (197 from the Tick Checker). Members of the genus *Ixodes* accounted for 176 of the submissions (175 *Ix. scapularis* and 1 *Ix. cookei*)[2]. All *Ixodes* specimens[3] were submitted to PHAC's National Microbiology Laboratory for pathogen testing. The passive surveillance program also detected one *Amblyomma americanum* (Lone Star tick), one *D. andersoni* and three *Rhipicephalus sanguineus* (brown dog tick) submissions. The surveillance program received three submissions determined not to be a tick and 67 that could not be identified, due to poor image quality, lack of image or unavailable specimen.

Overall, the passive surveillance program received 123 fewer submissions in 2018 compared to 2017. BLT submissions declined from 430 and 257 in 2016 and 2017 respectively to 145 in 2018[4]. Similarly the number of BLT specimens[5] received in 2018 was significantly less than that seen in the previous 5 years (Figure 1).

In 2018, 130 of the 145 BLT submissions received for testing at CPL were acquired within Manitoba. BLT specimens were collected between April 19th and November 10th in 2018 (Figure 2). The collection of the first specimen in late April was nearly a month later than in 2016 and 2017, while the last specimen collection in early November was roughly identical to 2017, however nearly month sooner than in 2016. Nearly 60% of BLT specimens were collected in the spring between May and June. In fact less than 25% of BLT specimens were collected during the fall which has historically seen the greatest peak in activity.

[2] Specimens were identified using a number of keys, for a complete list see Appendix C.
[3] An *Ix. scapularis* specimen refers to a single tick. A submission refers to one or more tick specimens that are submitted at once by one individual.
[4] Number of submissions represents only those specimens received and processed at CPL.
[5] A BLT specimen refers to a single tick. A submission refers to one or more tick specimens that are submitted at once by one individual.

Table 1 – Breakdown of submissions to CPL by species and location of acquisition.

	In Province		Out of Province		Unknown	
Species	# Submissions	# Specimens	# Submissions	# Specimens	# Submissions	# Specimens
D. andersoni	0	0	1	1	0	0
D. variabilis	73	89	3	3	16	19
Ix. scapularis	71	73	0	0	15	15
Ix. cookei	1	2	0	0	0	0
R. sanguineus	2	3	0	0	0	0
Not a tick	2	2	0	0	0	0
	149	**169**	**3**	**3**	**31**	**34**

Table 2 – Breakdown of submissions to the Tick Checker by species and location of acquisition.

	In Province		Out of Province		Unknown	
Species	# Submissions	# Specimens	# Submissions	# Specimens	# Submissions	# Specimens
Am. americanum	1	1	0	0	0	0
D. variabilis	195	219	2	2	0	0
Ix. scapularis	88	100	1	1	0	0
R. sanguineus	1	1	0	0	0	0
Not a tick	1	1	0	0	0	0
Unavailable	3	3	0	0	0	0
No image	13	13	0	0	0	0
Unknown	50	51	1	1	0	0
	352	**389**	**4**	**4**	**0**	**0**

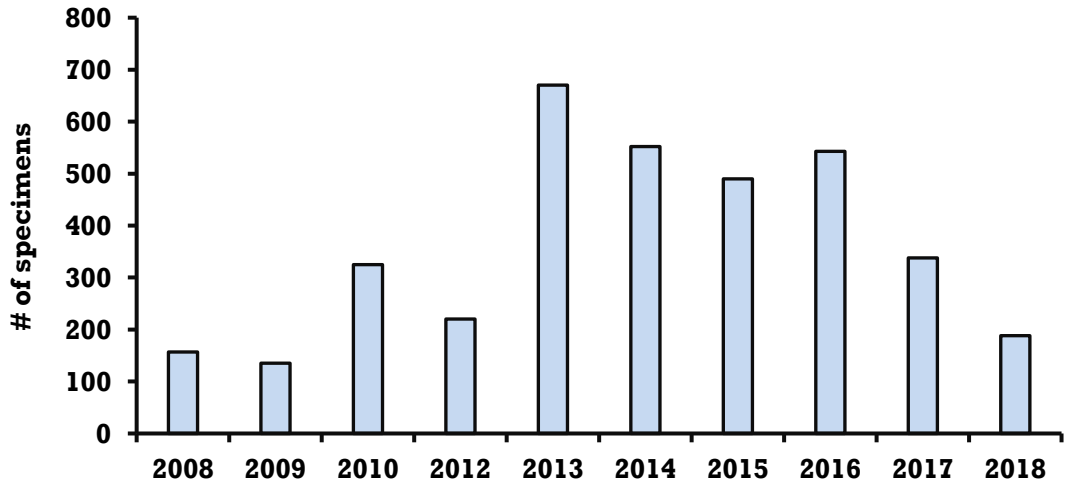

Figure 1 – Number of BLT specimens received annually as part of the passive surveillance program since 2008.

For the first time since surveillance started, the majority of BLTs received were removed from human hosts. The proportion of specimens submitted from human hosts nearly doubled to 56.4%, while the percent received from canines (previously the most common host in the province) decreased to 28.7% from 40.2% in 2017.

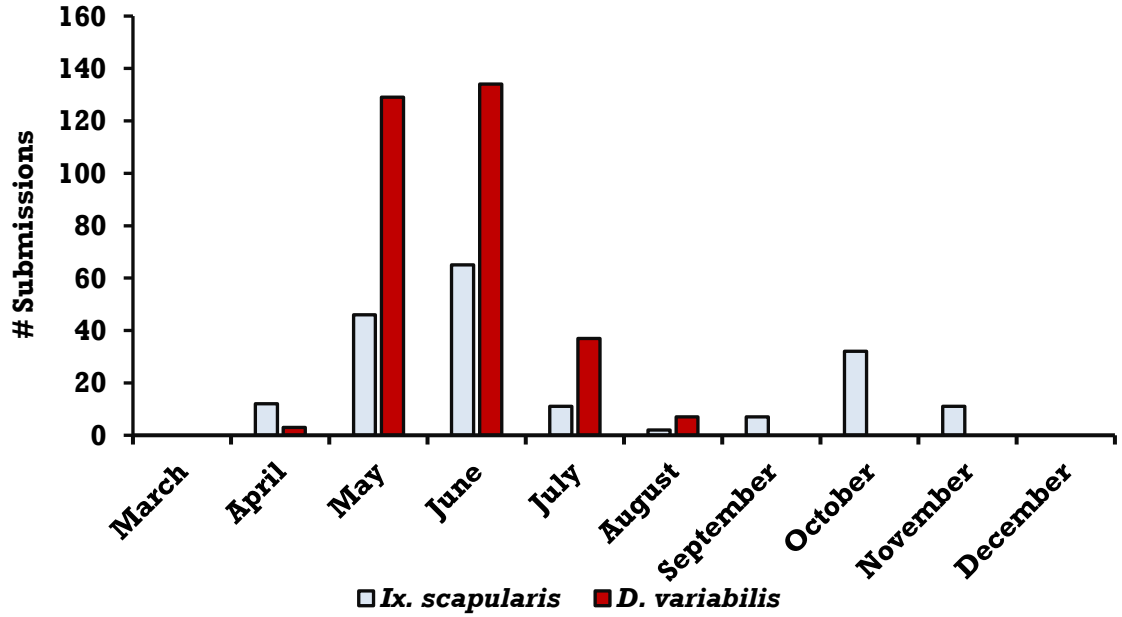

Figure 2: Comparison of seasonal trend in submissions of *Ix. scapularis* and *D. variabilis* based on month of collection.

In 2018, BLT submissions were received from 74 locations distributed across all four southern Manitoba Health Regions (Figure 3). Approximately 91% of the submissions sites from Manitoba were associated with previously identified BLT risk areas. Six of the seven sites (Alonsa (RM), Ashville, Edwin, Gladstone, Hadashville, Rivers and Sandy Lake) where specimens were collected outside of known risk areas were found in western Manitoba. Submission sites again stretched north from the US border to the Bowsman area, and from the Ontario border into western Manitoba.

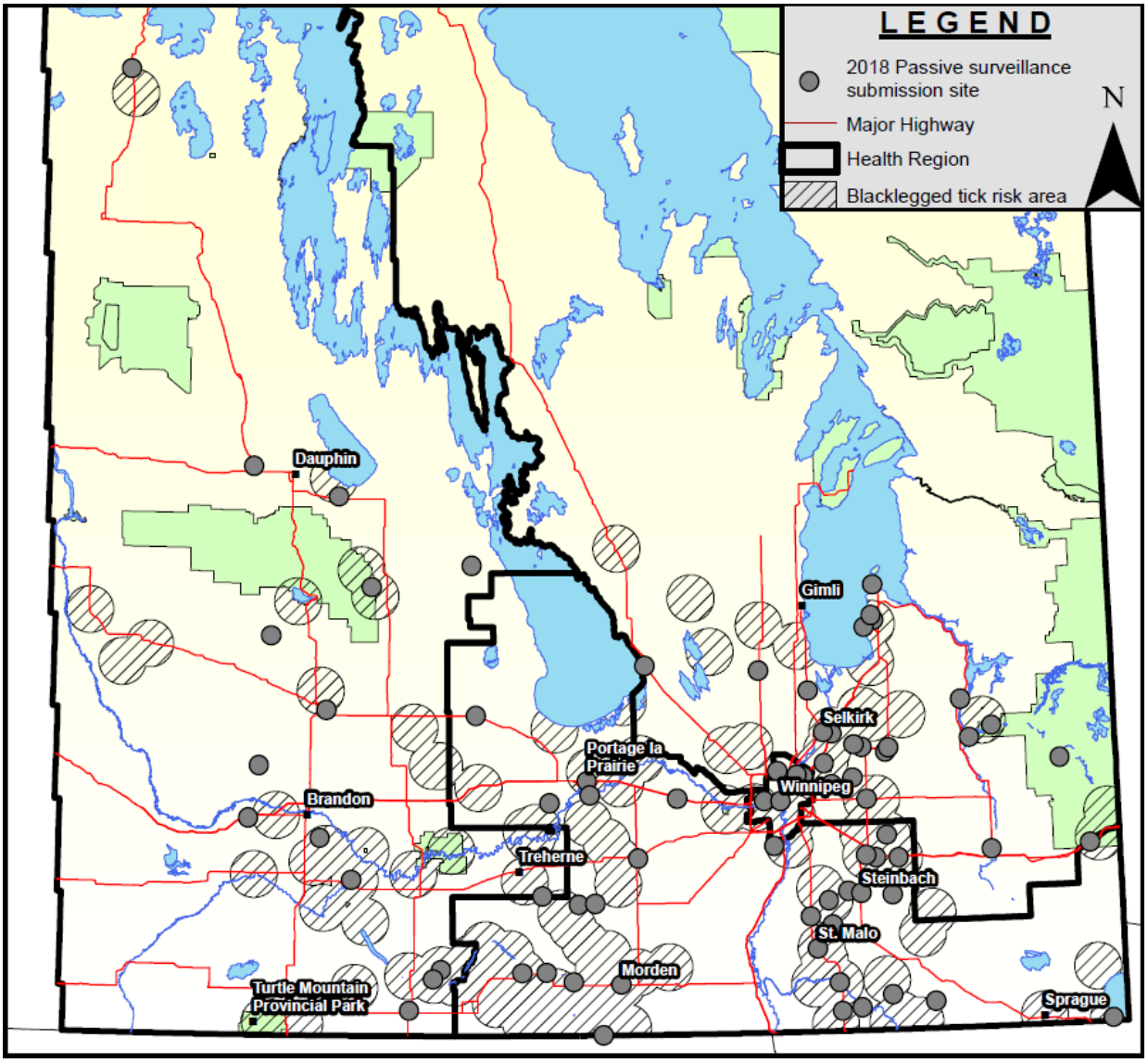

Figure 3: Distribution of BLT passive surveillance submission sites (2018) and known BLT risk areas.

Anaplasma phagocytophilum

As in previous seasons, *A. phagocytophilum* was the second most common pathogen detected among BLTs submitted as part of the passive surveillance program (Table 2). Since 2013 the MIR[6] associated with *A. phagocytophilum* have typically exceeded 5.0%. In 2018 specimens infected with *A. phagocytophilum* were collected from 7 locations across southern Manitoba (Figure 4), all of which were situated within, or in close proximity, to known BLT risk

[6] The data in this report assume that only a single specimen in a pool is positive, so infection rates are presented as a minimum infection rate. Where more than one adult BLT is submitted from a non-human host (i.e. dog, cat, etc.), they are placed in pools of up to five ticks for testing. Any adult ticks that are removed from a human host are tested individually. All nymphs are also tested individually.

areas. The minimum infection rate in 2018 increased compared to 2017, and there was no detection of *A. phagocytophilum* was again detected in nymphs (Table 2).

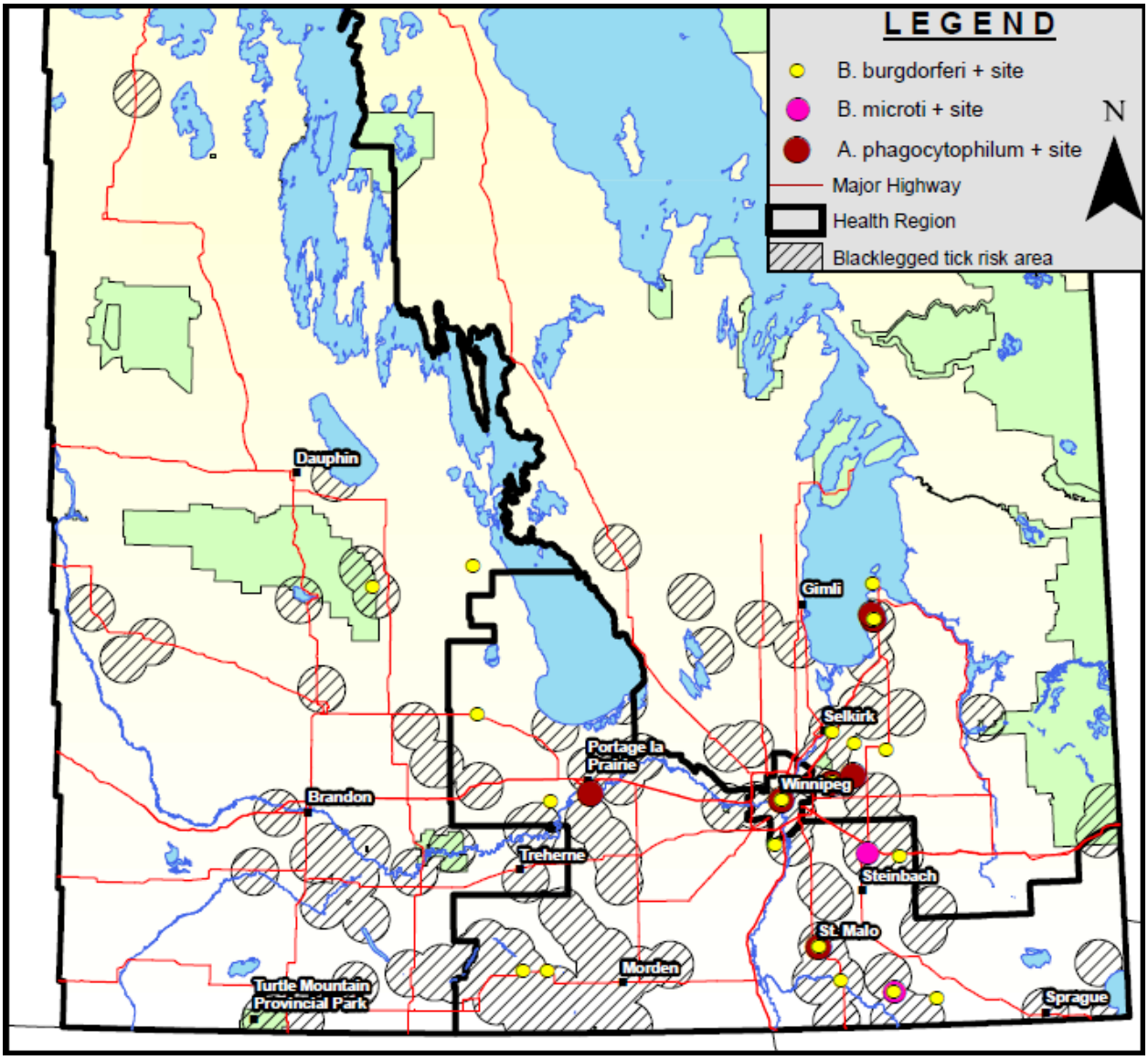

Figure 4: Distribution of collection sites for BLTs submitted as part of the 2018 passive surveillance program that tested positive for one or more of *A. phagocytophilum*, *B. microti* or *B. burgdorferi*.

Table 2: Minimum and maximum prevalence of infection rates for *A. phagocytophilum*, *B. mircroti* and *B. burgdorferi* among BLT specimens collected via passive surveillance in 2018.

	A. phagocytophilum		***B. microti***		***B. burgdorferi***	
	Min IR	**Max IR**	**Min IR**	**Max IR**	**Min IR**	**Max IR**
Adults	8.0%	8.0%	0.9%	0.9%	25.00%	26.5%
Nymphs	0.0%	0.0%	3.1%	3.1%	6.3%	6.3%
Total	**6.2%**	**6.2%**	**1.4%**	**1.4%**	**20.7%**	**22.1%**

Table 3: Minimum infection rates for *A. phagocytophilum* among BLTs collected as part of the 2018 passive surveillance program with comparison to 2017 data

	Negative	Positive	% Positive (2018)	% Positive (2017)
Adults	103	9	8.0%	4.2%
Nymphs	32	0	0.0%	0.0%
Larva	1	0	0.0%	-
Total	**136**	**9**	**6.2%**	**4.0%**

Babesia microti

Babesia microti, the causative agent of Babesiosis, remains the least common pathogen detected among BLTs submitted as part of the passive surveillance program (Table 2). Testing for this pathogen began in 2013 and, with the exception of 2016, the MIR has remained low. In 2018, the MIR was 1.4% (Table 4), a slight decrease from 2017. Specimens infected with *B. microti* were only detected from 2 specimens collected in 2018, though one of these was co-infected with *B. burgdorferi*. Both collection sites were situated in the Southern Health – Santé Sud region, and were associated with long established BLT risk areas (Figure 4).

Table 4: Minimum infection rates for *B. microti* among BLTs collected as part of the 2018 passive surveillance program with comparison to 2017 data.

	Negative	Positive	% Positive (2018)	% Positive (2017)
Adults	111	1	0.9%	1.6%
Nymphs	31	1	3.1%	0.0%
Larva	1	0	0.0%	-
Total	**143**	**2**	**1.4%**	**1.5%**

Borrelia burgdorferi

B. burgdorferi was the most common tick-borne pathogen detected among BLTs collected in Manitoba in 2018 (Table 2). Since 2013, the MIR has hovered around 20%. In 2018, the MIR increased from 16.7% in 2017 to 20.7%. The maximum infection rate (assuming all specimens in a pool were positive) in 2018 was 22.1% (Table 2). In 2018, approximately 1 in 4 adult specimens tested positive for *B. burgdorferi* (Table 5).

In 2018, specimens infected with *B. burgdorferi* were collected from 18 locations across southern Manitoba (Figure 4), all but two of which were within or in close proximity to known BLT risk areas. The number of locales with positive BLTs in 2018 was less than that observed in 2017 (n = 26) and 2016 (n = 48) respectively. Most of these sites were associated with the Southern Health – Santé Sud region.

Table 5: Minimum infection rates for *B. burgdorferi* among BLTs collected as part of the 2018 passive surveillance program with comparison to 2017 data.

	Negative	Positive	% Positive (2018)	% Positive (2017)
Adults	84	28	25.0%	16.9%
Nymphs	30	2	6.3%	12.5%
Larva	1	0	0.0%	-
Total	**115**	**30**	**20.7%**	**16.7%**

The proportion of BLT specimens infected with more than one pathogen remained relatively stable in 2018 (Table 6). Three locally collected specimens were co-infected with both *A. phagocytophilum* and *B. burgdorferi*. The proportion positive (1.95%) was within the range of the results seen over the past three seasons (1.54 – 2.18%). A single locally collected specimen was co-infected with *B. microti* and *B. burgdorferi*. No other co-infected specimens were detected among those received via the passive surveillance program in 2018.

Table 6: Co-infection status of locally collected BLT specimens submitted to the passive surveillance program, 2015 – 2018.

	B. burgdorferi & A. phagocytophilum	*B. burgdorferi & B. microti*	*A. phagocytophilum & B. microti*	*B. microti & B.miyamotoi*
2018	3 (1.95%)	1 (0.65%)	-	-
2017	5 (1.54%)	1 (0.31%)	1 (0.31%)	-
2016	10 (2.18%)	3 (0.65%)	2 (0.44%)	1 (0.22%)
2015	9 (1.85%)	1 (0.21%)	1 (0.21%)	-

Active Surveillance – 2018

Highlights of 2018 Active Surveillance

- Limited active surveillance undertaken in 2018, and no new BLT risk areas identified.
- Approximately 186 km surveyed and only 4 BLT specimens collected.

In 2018 active surveillance was conducted at 93 sites across southern Manitoba, far fewer than the nearly 185 sites visited in both 2016 and 2017 (Table 7). Surveillance was conducted between early June and late August 2018[7]. Active surveillance produced 4 BLT specimens, all of which were collected in previously identified risk areas. There were no additional risk areas identified in 2018.

[7] Staffing constraints prevented early spring and fall surveillance in 2018. In addition, a cool, wet and short fall further limited surveillance opportunities in the fall.

Table 7: Summary of active surveillance conducted in Manitoba, 2015 – 2018.

	Distance covered (km)	Number of sites surveyed	Sites w/ BLT	Total # of BLT Collected
2018	186.0	93	3	4
2017	372.0	186	26	252
2016	376.4	185	16	104
2015	165.4	86	6	12

Tick-Borne Diseases in Humans

Anaplasmosis

Highlights – Anaplasmosis 2018

- Most active year to date, with 21 Anaplasmosis cases reported.
- Males accounted for nearly 2/3rds of the cases, and the median age was 57.
- Burden is highest among Southern Health – Santé Sud residents (2.38 per 100,000).
- Since 2015 incidence rates (1.60/ 100,000) highest among individuals > 60 years of age.
- All 2018 cases reported likely local exposure within Manitoba.
- Non-specific symptoms such as fever, fatigue, sweats/ chills, headache and myalgia are the most common observed among Manitoba Anaplasmosis cases.

In 2018 twenty-one Anaplasmosis cases were reported to MHSAL. Fourteen of the cases met the provincial surveillance case definition for a confirmed case, while seven were classified as probable (provincial surveillance case definitions available here). The case numbers recorded in 2018 were more than double those seen in 2017 (Table 8).

Table 8: Reported Cases of Anaplasmosis in Manitoba, 2015 - 2018.

Case Classification	2018	2017	2016	2015	Total
Confirmed Case	14	6	11	2	**33**
Probable Case	7	4	5	2	**18**
Total Reported	**21**	**10**	**16**	**4**	**51**

The burden of Anaplasmosis is greatest in two segments of the population; notably males and individuals 40 years of age an older (Table 9). Approximately 63% of the Anaplasmosis cases reported since 2015 have been in males. In 2018, males accounted for 62% of all confirmed and probable Anaplasmosis cases. Since 2015, more than 70% of all Anaplasmosis cases reported have been in individuals 40 years of age and older, while in 2018 this group accounted for roughly two-thirds of cases. Based on incidence rates, the burden of Anaplasmosis is highest among individuals 60 years of age and older (1.60/ 100,000) and those between 40 and 59 years of age (1.29/ 100,000) (Figure 5).

Table 9: Number of confirmed and probable Anaplasmosis cases and incidence rates (per 100,000) by sex, with age analysis, in Manitoba, 2015 – 2018.

	2015 - 2017		2018	
	Case Count	**Incidence**	**Case Count**	**Incidence**
Total	30	0.75	21	1.54
Female	11	0.55	8	1.17
Male	19	0.96	13	1.92
	Age Analysis (in years)		**Age Analysis (in years)**	
Average	53.1		49.5	
Median	57.0		57	
St. Dev.	17.0		19.3	
Min. Age	8		5	
Max. Age	73		76	

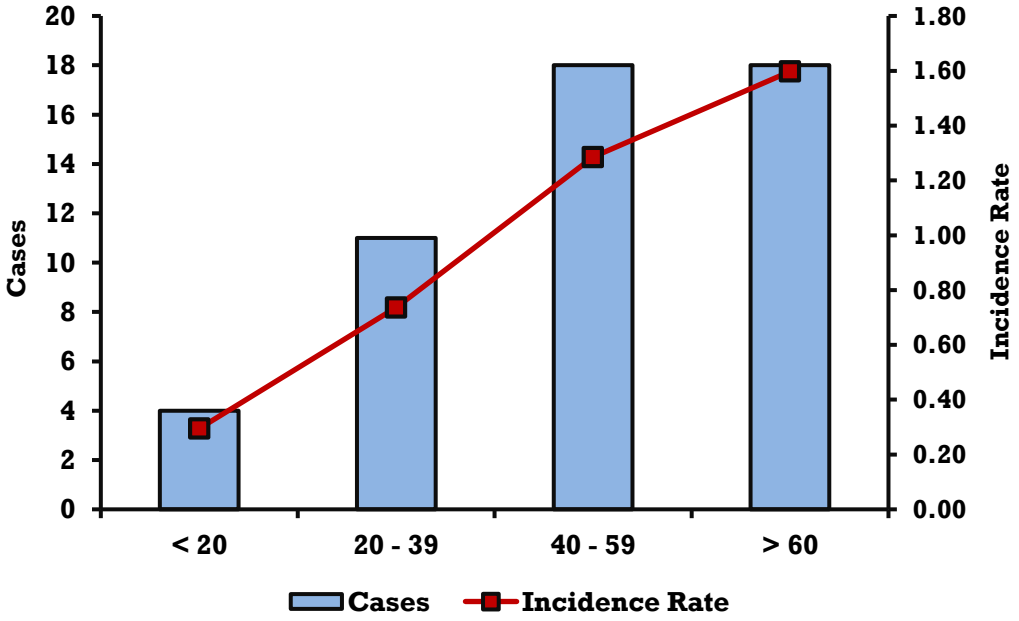

Figure 5: Numbers of confirmed and probable Anaplasmosis cases and incidence rates (per 100,000) by age group recorded in Manitoba since 2015.

At the provincial level the incidence (per 100,000) of Anaplasmosis more than doubled from the 0.66 in 2017 to 1.54 in 2018. At the regional level, the incidence rates increased in the Prairie Mountain (0.74 from 0.20), Southern Health – Santé Sud (2.38 from 1.69) and Winnipeg (0.62 from 0.48) Health Regions (Figure 6). The incidence rate decreased in the Interlake-Eastern Health region (1.55 from 1.82) in 2018. Most Anaplasmosis cases resided in either the Southern Health – Santé Sud or Winnipeg Health Regions.

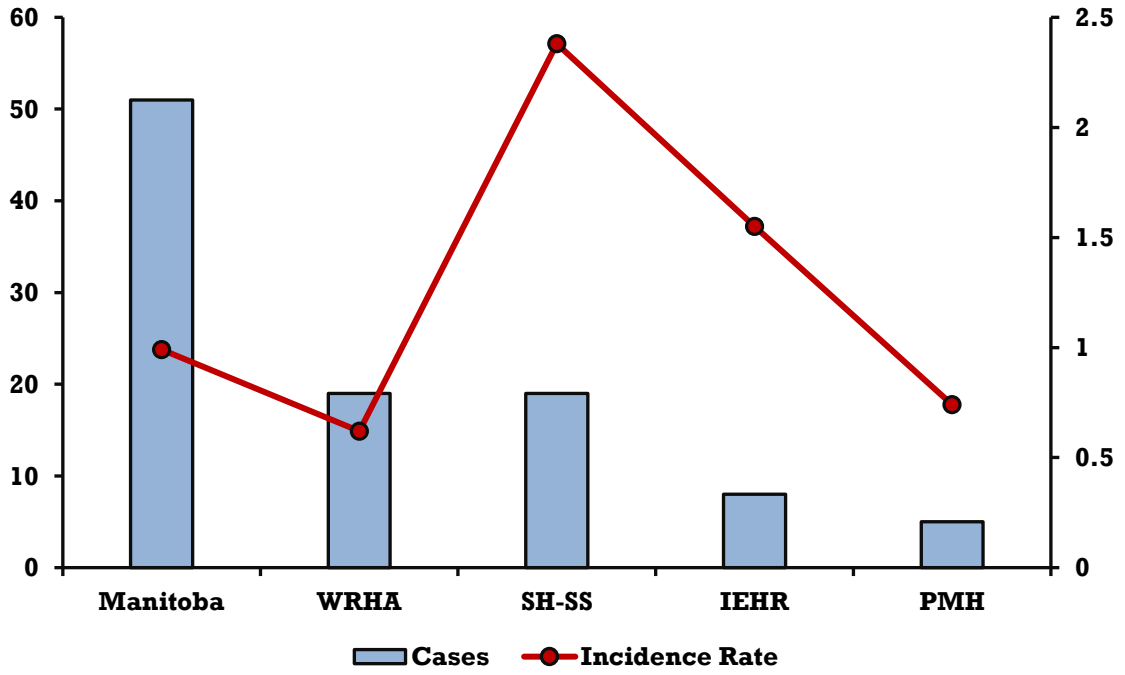

Figure 6: Anaplasmosis incidence rates (per 100,000) and case numbers reported by Health Region of residence since 2018 (n = 51).

Since Anaplasmosis became provincially reportable in 2015, only three cases indicated likely exposure outside of Manitoba. In 2018, follow up investigations determined that all 21 confirmed and probable cases were exposed locally. All exposure locations from 2018 were associated with well-known BLT risk areas, primarily in southern and eastern Manitoba (Figure 7). Similarly, when known exposure locales were plotted on a map, the corresponding Health Districts[8] with the highest incidence rates were situated in areas of the province where surveillance has demonstrated a longer history of BLT establishment.

[8] Health Districts are groupings of populations with approximately 10,000 to allow for analysis to be conducted at a smaller scale than possible when using the larger Regional Health Authority or Health Zone level.

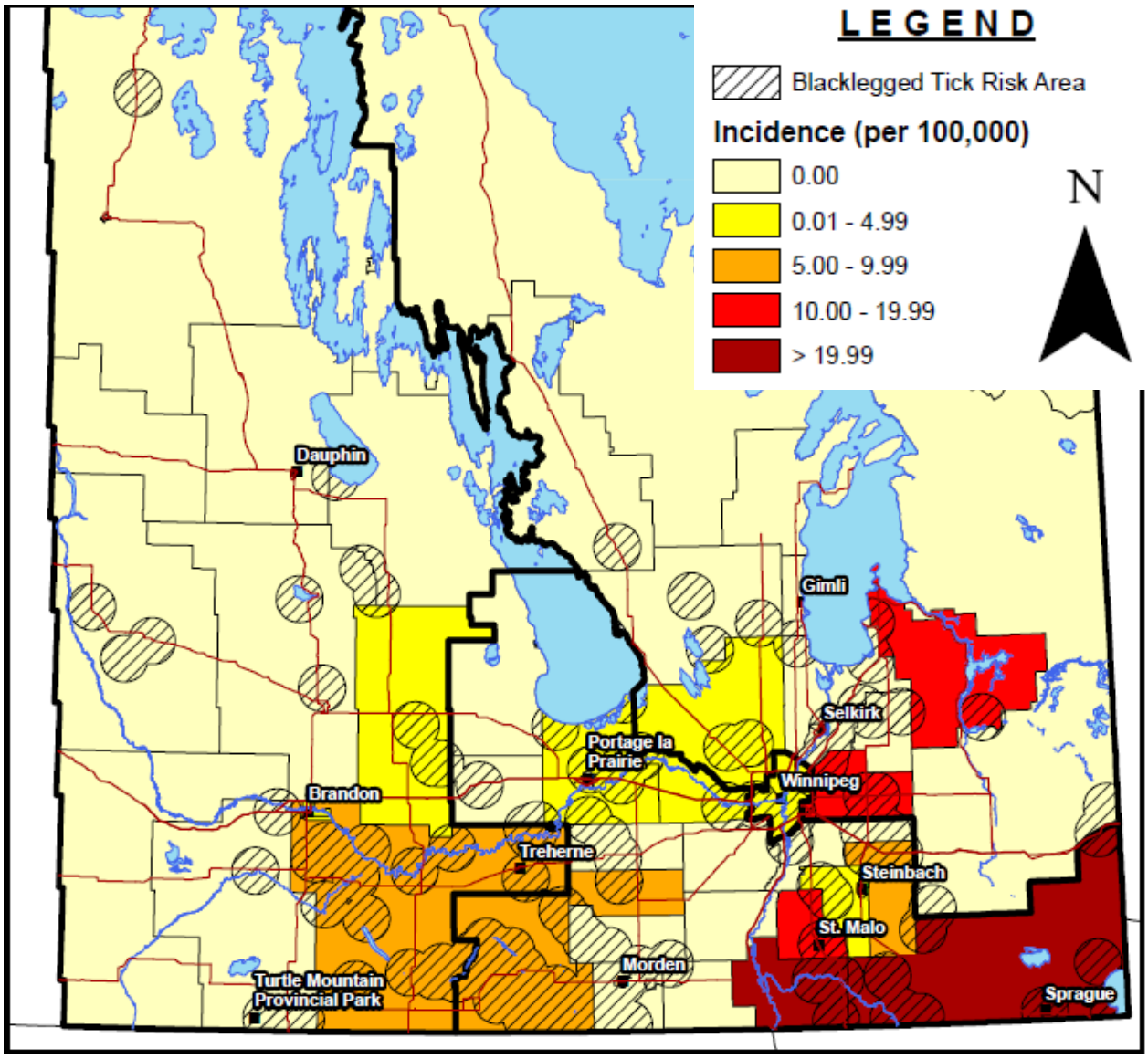

Figure 7: Incidence, per 100,000, of all confirmed and probable Anaplasmosis cases reported in Manitoba since 2015 based on Health District of likely exposure (n = 48).

Fever is a requirement for a confirmed and probable Anaplasmosis case, and as such all 51 cases reported this symptom. Other common symptoms associated with Anaplasmosis cases in Manitoba were non-specific (Table 10). Common symptoms (those observed in more than 50% of the cases) included: fatigue, sweats/ chills, headache, myalgia, malaise, weakness and nausea. Less common symptoms (observed in < 50% of cases, but > 20%) included: stiff neck, anorexia, arthralgia, recurrent brief joint swelling (arthritis), thrombocytopenia and anemia. Uncommon symptoms included (< 20% of cases): cardiac symptoms, elevated liver function tests, cough, Bell's palsy and lymphadenopathy.

Table 11 – Clinical symptoms associated with confirmed and probable Anaplasmosis cases reported to MHSAL since 2015

	Symptom	Frequency observed	Cases w/ symptom	Total Cases
Common	Fever	100.0%	51	51
	Fatigue	91.7%	44	48
	Sweats/ Chills	83.7%	41	49
	Headache	78.0%	39	50
	Myalgia	70.2%	33	47
	Malaise	62.5%	25	40
	Generalized Weakness	60.0%	24	40
	Nausea	58.3%	28	48
Less Common	Stiff Neck	46.8%	22	47
	Anorexia	44.7%	21	47
	Arthralgia	42.6%	20	47
	Recurrent Brief Joint Swelling	25.5%	12	47
	Thrombocytopenia	24.2%	8	33
	Anemia	21.2%	7	33
Uncommon	Cardiac Sx	19.1%	9	47
	LFT Elevation	18.2%	6	33
	Cough	17.0%	8	47
	Bell's Palsy	8.5%	4	47
	Lymphodenopathy	6.4%	3	47

Lyme disease

Highlights - 2018

- 2018 was the most active year to date in terms of confirmed and probable Lyme disease cases.
- At the provincial level incidence rates increased from 3.17/ 100,000 to 3.97/ 100,000. Regionally rates were highest in the Southern Health – Santé Sud RHA (10.77/ 100,000).
- Males accounted for more than 60% of all confirmed and probable Lyme disease cases.
- Incidence rates were highest among males 60 years of age an older (8.07/ 100,000).
- Approximately 83% of the cases reported likely exposure between May and July, and 93% of reported cases indicated likely exposure within Manitoba.
- Only 35.2% of confirmed and probable Lyme disease cases had a history of tick-bite.
- Proportion of Lyme disease cases with physician observed Erythema migrans increased from 60% in 2017 to 68.5% in 2018.

The number of confirmed and probable Lyme disease cases reported in 2018 was the highest recorded to date (Table 12). A total of 54 confirmed or probable Lyme disease cases were reported in Manitoba in 2018, an increase of 11 cases compared to 2017 and two more

than the previous high of 52 reported in 2016. More than 72% of all confirmed and probable Lyme disease cases reported in Manitoba since 2009 have come in the past five year (2014 – 2018), while nearly half of the total cases have been reported in the past three.

Table 12: Reported cases of Lyme disease in Manitoba, 2013 – 2018

	2018	2017	2016	2015	2014	2013	Total
Confirmed Case *	28	29	24	12	23	16	**132**
Probable Case *	26	14	28	20	15	15	**118**
Other Case **	16	14	12	9	11	8	**70**
Total Reported ***	**70**	**57**	**64**	**41**	**49**	**39**	**320**

* National surveillance case definitions are available at:
https://www.canada.ca/en/public-health/services/diseases/lyme-disease/surveillance-lyme-disease/case-definition.htm
** Cases listed as 'other' are reported by either physician or lab but fail to meet the classification criteria for 'confirmed' or 'probable'
*** Total cases reported and classified as of January 28, 2019.

At the provincial level the incidence rate for confirmed and probable Lyme disease cases[9] (per 100,000) rose to 3.97 compared to 3.17 in 2017 and the five year average of 3.01 (Table 13). Males accounted for approximately 63% of the confirmed and probable cases in 2018 a slight increase compared to the five year average of 60%. Likewise the 2018 incidence rates (per 100,000) in males was significantly higher when compared to females and the five year average. For instance the incidence rate in males in 2018 was 5.03 compared to 2.92 for females, while the five year average was only 3.63. Similar observations were recorded for Lyme disease cases reported provincially as 'other'. In 2018 the total number of 'other' cases, as well as incidence rates, increased in comparison to the five year average (Table 14). Further, males accounted for 69% of the 'other' cases reported in 2018 an increase from the 59% of cases associated with males in the previous five year period.

Table 13: Number of confirmed and probable Lyme disease cases and incidence rates (per 100,000) by sex, with age analysis, in Manitoba, 2018 and 5 year average (2013 – 2017)

	2018		2013-2017 Average	
	Case Count	**Incidence**	**Case Count**	**Incidence**
Total	54	3.97	39.8	3.01
Female	20	2.92	16.0	2.40
Male	34	5.03	23.8	3.63
	Age Analysis (in years)		**Age Analysis (in years)**	
Average	44.3		41.8	
Median	49.5		44.0	
St. Dev.	22.9		22.5	
Min. Age	3		1	
Max. Age	82		86	

[9] National surveillance case definitions (https://www.canada.ca/en/public-health/services/diseases/lyme-disease/surveillance-lyme-disease/case-definition.html. Accessed August 28, 2018)

Table 14: Number of '*other*' Lyme disease cases[10] and incidence rates (per 100,000) by sex, with age analysis, in Manitoba, 2018 and 5 year average (2013 – 2017)

	2018		2013 - 2017 Average	
	Case Count	**Incidence**	**Case Count**	**Incidence**
Total	16	1.18	11.0	0.83
Female	5	0.73	4.6	0.69
Male	11	1.63	6.4	0.98
	Age Analysis (in years)		**Age Analysis (in years)**	
Average	52.7		48.4	
Median	48.5		53.0	
St. Dev.	16.0		22.1	
Min. Age	30		2	
Max. Age	84		85	

Both the average and median age ranges of confirmed and probable Lyme disease cases increased in 2018, compared to the previous five year average (Table 13). The 2018 median was approximately 5 years older than that seen between 2013 and 2017. The same was true for Lyme disease cases classified as 'other'.

Males aged 40 years of age and older had the highest incidence rates among cases reported in 2018 (Figure 12). For instance, males aged 40 to 59 had an incidence rate of 7.42/ 100,000, nearly 2.6 times higher than that for females of the same age range. In addition, the incidence rate in males 60 years of age and older was 8.07/ 100,000, nearly 2.5 times higher than females. Little difference was observed among case numbers or incidence rates between males and females younger than 40 years of age. When compared to the previous five year period, incidence rates increased in all but two age/ gender categories. Males less than 40 years of age saw slight decreases in incidence rates (Figure 13). However, the increase was most pronounced among males aged 40 – 59, where the 2018 rate was approximately 2.3 times that observed in the 2013 to 2017 period. The highest increase among females was seen in the 20 – 39 year age range, where the rate rose roughly 1.9 times. Overall, incidence rates were highest among males 60 years of age and older both in 2018, and in the previous five years.

[10] Manitoba records 'other' Lyme disease cases where the data is suggestive of infection, but is not sufficient, more often incomplete, to meet the more stringent requirements of the National surveillance case definition.

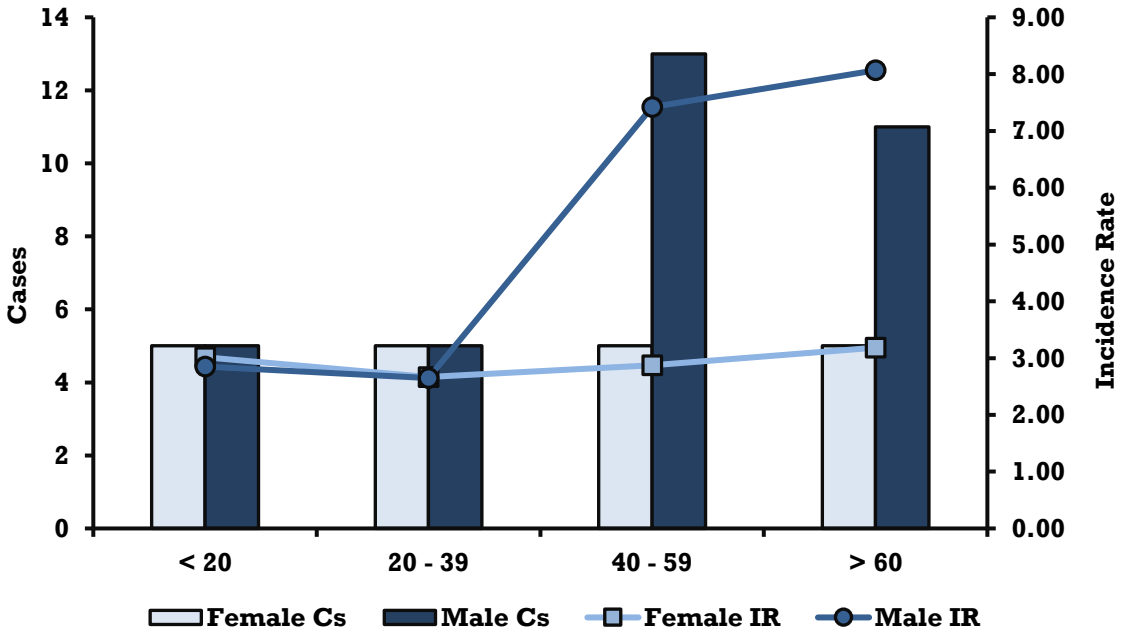

Figure 12: Number and incidence rate (per 100,000) of confirmed and probable Lyme disease cases by gender and age group in Manitoba for 2018 (n = 54).

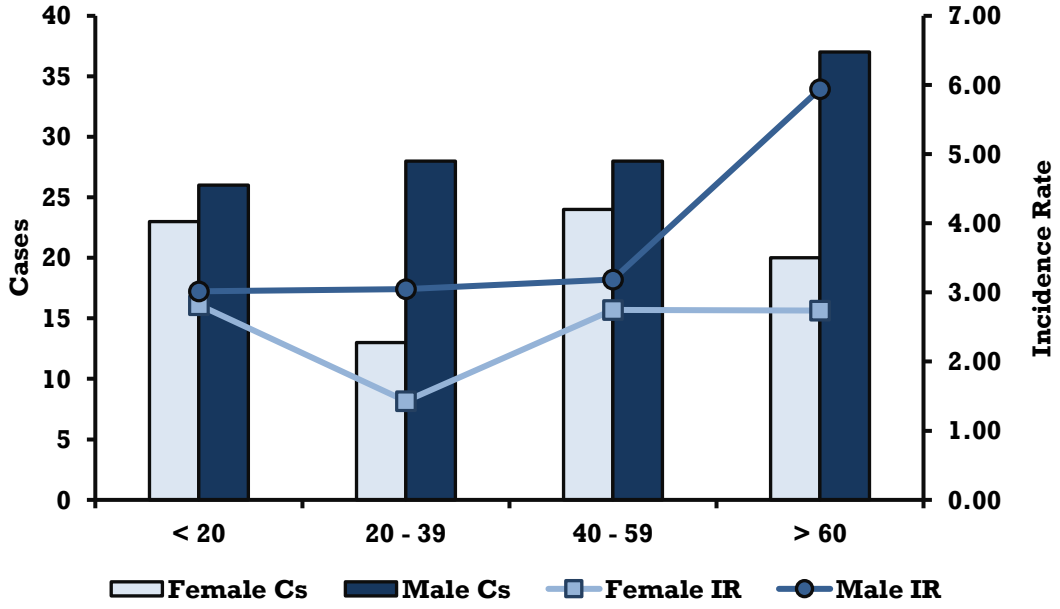

Figure 13: Number and incidence rate (per 100,000) of confirmed and probable Lyme disease cases by gender and aged group in Manitoba, 2013 – 2017 (n = 199).

Between 2013 and 2016 the proportion of confirmed and probable Lyme disease cases with likely exposure within the province has exceeded 80% (Figure 14). In 2017 this rose to 98%, slightly higher than the 93% (n = 50) recorded in 2018. The increasing trend of local acquisition mirrors that seen at the National level, albeit at a lower magnitude. For example,

between 2009 and 2015 the proportion of cases acquired locally in Canada increased from 54.7% to 72.7%[11]. In 2018, all four cases with history of out of province exposure were linked with travel to northwestern Ontario. Similarly between 2013 and 2018, half of the 40 cases with out of province exposure were associated with travel to NW Ontario.

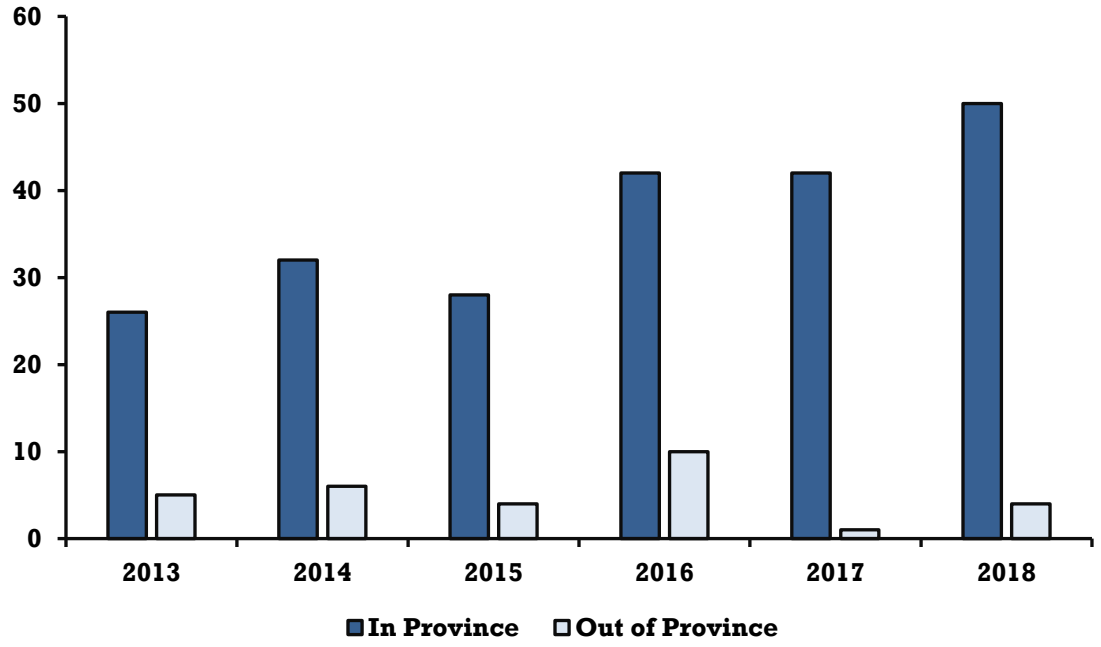

Figure 14: Confirmed and probable Lyme disease cases reported between 2013 and 2018 based on likely exposure, within or outside of the province (n = 253).

Based on month of likely exposure the highest risk period for Anaplasmosis and Lyme disease falls between May and July (Figure 15). Approximately 81% of all Anaplasmosis (n = 39) and Lyme disease (n = 196) cases indicated likely exposure during these months since 2013. In 2018, 80% and 83% of Anaplasmosis and Lyme disease cases respectively were exposed during this late spring/ early summer period. The timing of exposure corresponds to the peak activity period for BLT nymphs, which when compared to adults are smaller to see and subsequently remove. In 2018, roughly 97% of the nymphs (n = 28) received via the passive surveillance program were collected between May and July.

[11] Gasmi, S., Ogden, N. H., Lindsay, L. R. et al. **2017**. Surveillance for Lyme disease in Canada, 2009 to 2015. *Canadian Communicable Disease Report*, 43 (https://www.canada.ca/en/public-health/services/reports-publications/canada-communicable-disease-report-ccdr/monthly-issue/2017-43/ccdr-volume-43-10-october-5-2017/surveillance-surveillance-lyme-disease-canada-2009-2015.html).

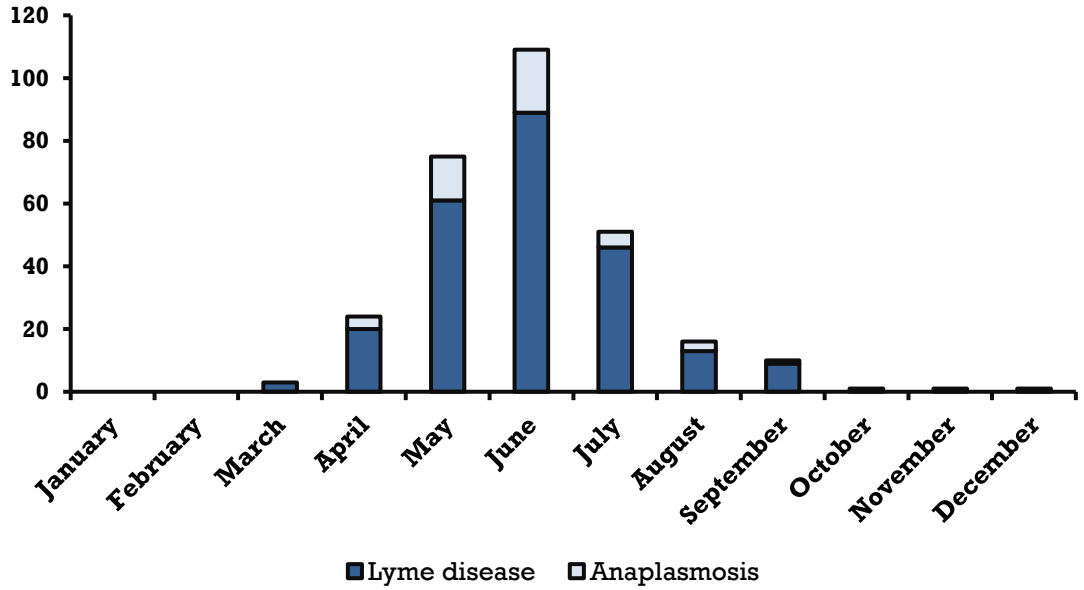

Figure 15: Likely exposure month for confirmed and probable Anaplasmosis cases 2015 – 2018; n = 48) and Lyme disease cases (2013 – 2018; n = 243)[12]

Among the 250 confirmed and probable Lyme disease cases, reported since 2013 with relevant exposure information, only 39.6% (n = 99) recalled a tick-bite. The recall among Anaplasmosis cases was even lower, at approximately 28.6% (n = 14/ 49). Taken together since, 2015, only 37.8% of all Anaplasmosis and Lyme disease cases have a recollection of a tick-bite upon follow-up investigation. When broken down by health region level, the proportion of Anaplasmosis and Lyme disease cases with a history of tick bite was highest among residents of the Interlake-Eastern Health Region (~ 47.4%) and lowest among those residing in the WRHA (~ 33.0%) (Table 15). Other risk factors, notably exposure to suitable habitat, were more likely to be associated with tick-borne diseases. For instance, nearly 90% of Anaplasmosis and Lyme disease cases indicated exposure to suitable tick habitat, with a range between 87.5% (Prairie Mountain) and 91.8% (WRHA) (Table 16).

Table 15: Proportion of confirmed and probable Anaplasmosis (n = 49) and Lyme disease (n = 250) cases with a history of tick bite prior to symptom onset, 2013 – 2018.

Health Region	Proportion	Total # Cases	# with Hx of tick bite
WRHA	33.0%	109	36
SH-SS	38.8%	134	52
IEHR	47.4%	38	18
PMH	38.9%	18	7
TOTAL	**37.8%**	**299**	**113**

[12] Data presented in Figure 15 includes data from cases with exposure histories within and outside of the province. Exposure information was unavailable for three Anaplasmosis and ten Lyme disease cases.

Table 16: Proportion of confirmed and probable Anaplasmosis (n = 49) and Lyme disease (n = 162) cases with a history of contact with suitable tick habitat, 2015 – 2018.

Heatlh Region	Proportion	Total # Cases	Contact with Suitable Habitat
WRHA	91.8%	85	78
SH-SS	87.8%	82	72
IEHR	89.7%	29	26
PMH	87.5%	16	14
TOTAL	**89.6%**	**212**	**190**

Based on region of residence Lyme disease incidence rates increased in two of four southern Manitoba Health Regions in 2018 compared to the previous five year average (Figure 16; Table 17). The incidence rate (per 100,000) rose from 1.80 to 3.21 in the WRHA, while it increased from 9.58 to 10.77 in the Southern Health – Santé Sud. At the provincial level the incidence rate increased from a fiver year average of 3.01 to 3.97 in 2018. Case numbers were highest in the WRHA (n = 25) followed by Southern Health – Santé Sud (n = 22). Overall the burden of Lyme disease, based on region of residence, is highest in the Southern Health – Santé Sud (10.77/ 100,000) and Interlake-Eastern Health Region (3.84/ 100,000). The higher incidence rates in these regions reflect both the abundance of BLT risk areas and the longer history of BLT establishment.

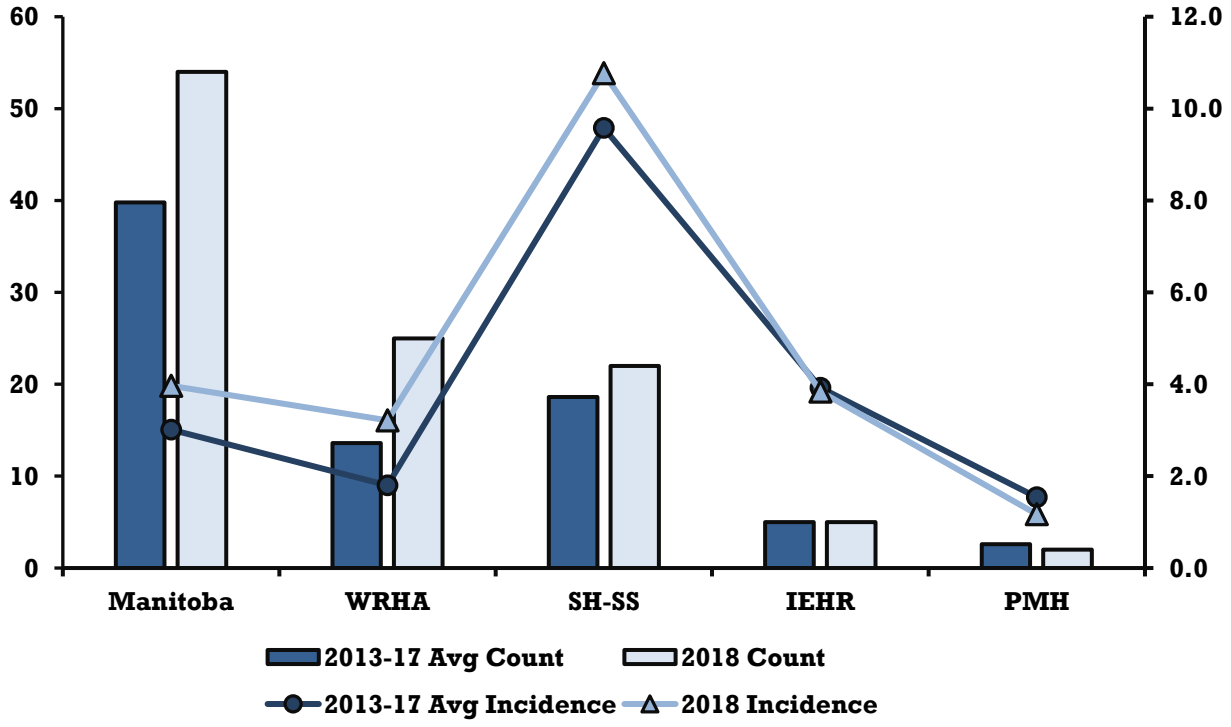

Figure 16: Lyme disease incidence (per 100,000) rates and cases numbers for confirmed and probable cases reported by Health Region of residence between 2013 and 2018.

Table 17: Lyme disease incidence rates (per 100,000) for confirmed and probable cases, reported by Health Region of residence between 2013 and 2018.

	Manitoba	WRHA	SH-SS	IEHR	PMH
2018 Count	54	25	22	5	2
2013 – 2017 Avg. Count	39.8	13.6	18.6	5.0	2.6
2018 Incidence	3.97	3.21	10.77	3.84	1.17
2013 – 2017 Avg. Incidence	3.01	1.80	9.58	3.93	1.54

When the incidence rates (per 100,000) were examined based on likely exposure location at the health district[13] level two distinct observations are apparent (Figure 17). All health districts with a minimum of one confirmed or probable Lyme disease case contain a BLT risk area. Second, health districts with the highest incidence rates based on likely exposure locations (i.e. greater than 19.99) correspond to regions with a longer history of BLT establishment. Districts with the highest incidence rates, based on likely exposure location, included the Rural East (101.19/ 100,000), Whiteshell (64.6/ 100,000) and Red River South (34.91/ 100,000). All three districts are located in the southeast corner of the province and have some of the oldest established populations, the first of which dates back to 2006. In general, the incidence rates, based on likely exposure location have corresponded with the continued BLT range expansion north and west in the province.

[13] Health Districts are groupings of populations with approximately 10,000 to allow for analysis to be conducted at a smaller scale than possible when using the larger Regional Health Authority or Health Zone level.

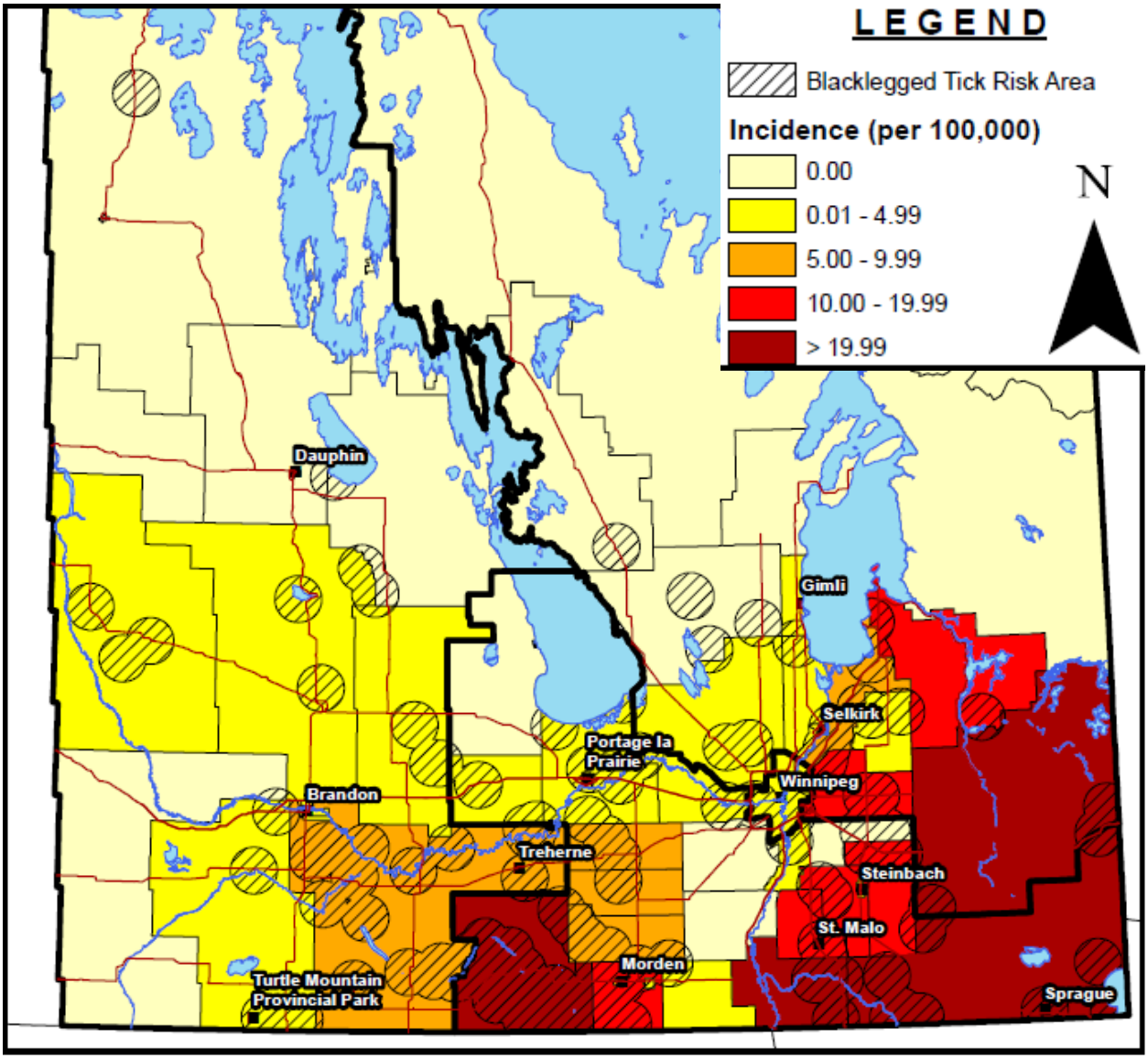

Figure 17: Incidence, per 100,000, of all confirmed and probable Lyme disease cases reported in Manitoba between 2009 and 2018 based on Health District of likely exposure (n = 194).

Physician observed Erythema migrans (EM) was observed in 68.5% of confirmed and probable Lyme disease cases reported in 2018. Though this value reflected a slight increase, compared to the proportion of physician observed EM since 2015 (Table 18), it was still less than the approximate 74% reported in confirmed and probable cases elsewhere in Canada[14]. Most common symptoms reported over the past four years, such as Fatigue, Headache and Fever, were non-specific and typically associated with early Lyme disease. Less common symptoms included a mixture of non-specific manifestations of early Lyme disease, such as

[14] Gasmi, S., Ogden, N. H., Lindsay, L. R. et al. **2017**. Surveillance for Lyme disease in Canada, 2009 to 2015. *Canadian Communicable Disease Report*, 43.

arthralgia (35.1%), and late disseminated Lyme disease, such as recurrent brief joint swelling (24.3%). The proportion of cases with recurrent brief joint swelling has decreased over the past three years from 38.5% in 2016 to 18.5% in 2018, potentially suggesting an increase in awareness and earlier treatment and diagnosis. Symptoms associated with early disseminated Lyme disease remain relatively uncommon among Manitoba cases, with Bell's Palsy and cardiac symptoms observed in only 8.6% and 7.0% of cases respectively.

Table 19: Clinical symptoms associated with confirmed and probable Lyme disease cases reported to MHSAL since 2015[15]

	Symptom	Frequency observed	Cases w/ symptom	Total Cases
Common	Physician observed Erythema migrans	62.3%	114	183
	Fatigue	61.6%	114	185
	Headache	54.1%	100	185
	Fever	51.9%	96	185
Less Common	Myalgia	44.9%	83	185
	Sweats/ Chills	42.2%	78	185
	Malaise	41.5%	71	171
	Arthralgia	35.1%	65	185
	Stiff Neck	30.8%	57	185
	Anorexia	24.9%	46	185
	Recurrent Brief Joint Swelling	24.3%	45	185
Uncommon	Nausea	17.3%	32	185
	Cough	11.4%	21	185
	Bell's Palsy	8.6%	16	185
	Cardiac Symptoms	7.0%	13	185
	Lymphodenopathy	6.5%	12	185
	LFT Elevation	4.5%	8	176
	Anemia	3.4%	6	176
	Thrombocytopenia	2.3%	4	176

[15] The clinical case report form changed in 2016 to query specific symptoms, and again in 2017 to include additional symptoms (i.e. anemia, thrombocytopenia and LFT elevation). Where queries were absent on the forms, the interpretation was treated as 'unknown' and not included in the denominator.

Discussion

The burden of TBDs continues to increase in North America. A recent analysis of reportable diseases in the United States showed that between 2004 and 2016 approximately 77% of all vector-borne diseases were associated with ticks[16]. Further, roughly 82% of the TBDs reported during this period were associated with Lyme disease. In fact, the number of annual Lyme disease cases reported increased from approximately 10,000 in the early 1990s to 36,249 by 2016[17]. The number of Lyme disease cases reported is also estimated to be 8 - 10 times lower than the actual number of cases diagnosed. This increasing burden is not limited solely to Lyme disease. Annual numbers of Anaplasmosis cases have increased nearly 12 fold between 2000 (n = 351) and 2016 (n = 4,151)[18]. Similarly, Babesiosis case numbers have increased from roughly 1,100 in 2011 to approximately 1,900 in 2016.

A similar increase has been seen among TBDs in Canada. For instance, since Lyme disease became nationally notifiable in 2009 the number of confirmed and probable cases have increased nearly 14-fold. In 2009, there were 144 confirmed and probable Lyme disease cases reported, compared to 2,025 in 2017[19]. In addition, the increasing evidence of *A. phagocytophilum*, *B. microti* and Powassan virus (Deer tick lineage) circulation in locally collected BLTs and sporadic human cases have led to the creation of a task group to develop national surveillance case definitions and reporting procedures.

Much of the increasing burden of TBDs can be associated with the continued range expansion of BLTs into Canada. In the early 1990s, Long Point, Ontario was the only Lyme disease endemic site in the country[20]. However, the continued northward expansion of BLT populations in the northeastern and Midwest US into southern Canada has increased considerably over the previous few years. For instance, in 2006 there were 7 endemic areas[21], and by 2014 this had more than tripled to 22[22]. The key driver of this rapid range expansion and subsequent establishment of BLT populations is climate change. In particular, warming temperatures have allowed for increasing BLT abundance in established areas, expansion to more northern reaches and increased seasonal activity and hence opportunities for contact with human populations[23].

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[16] Rosenberg, R., Lindsey, N. P., Fischer, M. P., et al. **2018**. Vital Signs: Trends in reported vectorborne disease cases – United States and Territories, 2004 – 2016. *Morbidity and Mortality Weekly Report*, 67 (17): 496 – 501.
[17] Eisen, R. J. Kugeler, K. J., Eisen, L., et al. **2017**. Tick-borne zoonoses in the United States: Persistent and emerging threats to human health. *ILAR Journal*, 58 (3); 319 – 335.
[18] Eisen, R. J. and Eisen, L. **2018**. The blacklegged tick, *Ixodes scapularis*: An increasing public health concern. *Trends in Parasitology*, 34 (4); 295 – 309.
[19] Public Health Agency of Canada 'Surveillance of Lyme disease' https://www.canada.ca/en/public-health/services/diseases/lyme-disease/surveillance-lyme-disease.html (accessed November 20, 2019)
[20] Ogden, N. H., Lindsay, L. R., Morshed, et al. **2009**. The Emergence of Lyme disease in Canada. *CMAJ*, 180 (12); 1221 – 1224.
[21] Ogden, N. H., Trudel, L., Artsob, H., et al. **2006**. *Ixodes scapularis* ticks collected by passive surveillance in Canada: Analysis of geographic distribution and infection with Lyme borreliosis agent *Borrelia burgdorferi*. *Journal of Medical Entomology*, 43 (3); 600 – 609.
[22] Ogden, N. H., Koffi, J. K., Pelcat, Y., and Lindsay, L. R. **2014**. Environmental risk from Lyme disease in central and eastern Canada: a summary of recent surveillance information. *Canada Communicable Diseases Report*, 40 (5); 74 – 82.
[23] Bochard, C., Dibernardo, A., Koffi, J., et al. **2019**. Increased risk of tick-borne diseases with climate and environmental changes. *Canada Communicable Disease Report*, 45 (4): 81 – 89.

The situation in Manitoba has mirrored that seen more broadly at the National level. The first locally collected BLT specimen was received in 1989 from the southern Interlake community of Gunton[24]. Given the potential public health implications, an extensive active surveillance project was undertaken in the early 1990s. Despite surveying 150 locations in southern Manitoba no evidence of BLT establishment was found[25]. Subsequent passive surveillance monitoring between 1990 and 2003 yielded a total of 394 BLTs, of which approximately 9.7% were infected with *B. burgdorferi*[26]. An investigation into a cluster of human Lyme disease cases with common exposure history identified the first established BLT population in 2006. In the years since, the number of BLT risk areas in Manitoba has increased considerably and they can now be found stretching from the Ontario border to the Saskatchewan border and north from the US border to the Swan River area (Figure 18).

The number of submissions received as part of Manitoba's passive BLT surveillance program in 2018 decreased significantly from the previous two seasons. However, from the 145 specimens received at Cadham Provincial Laboratory approximately 90% were collected in Manitoba. In addition, roughly 90% of the submission sites in Manitoba were associated with previously identified BLT risk areas. The low overall submission numbers may be accounted for by two observations. First, dry conditions in 2018 may have limited BLT activity and hence human and/or domestic animal exposure. Previous studies have noted both a negative correlation between densities of BLT nymphs and hot and dry summer days[27], and a positive correlation between tick survival and high humidity[28]. Second, the wet and cool conditions served to curtail both human and tick activity between September and November when BLT activity is normally at its peak. For instance, in 2017 approximately 53% of the BLT specimens were collected in the autumn, compared to 26.5% in 2018.

Unlike in previous seasons the majority of BLT specimens received in 2018 were collected from human hosts (~ 56.4%) as opposed to canines (~ 28.7%). This marks the first time in Manitoba that humans have accounted for the majority of hosts. As recently as 2015 the number of BLTs collected from human hosts was only 23%. Further, early passive surveillance efforts in Canada in the 1990s and 2000s showed that nearly 75% of BLTs collected were associated with domestic animals, primarily dogs[29]. Recent surveillance in Saskatchewan has also showed that dogs accounted for 75% of all BLT hosts[30]. The observation lends weight to the continued establishment of BLT populations throughout much of southern Manitoba.

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[24] Galloway, T. D. **1989**. Lyme disease vector, *Ixodes dammini*, identified in Manitoba. *Canada Diseases Weekly Report*, 15 (37): 185.

[25] Galloway, T. D., Christie, J. E., Sekla, L. and Stackiw, W. **1991**. Current status of the Lyme borreliosis vector, *Ixodes dammini*, in Manitoba. *Canada Diseases Weekly Report*, 17 (47): 259-260.

[26] Ogden, N. H., Trudel, L., Artsob, H., et al. **2006**. *Ixodes scapularis* ticks collected by passive surveillance in Canada: Analysis of geographic distribution and infection with Lyme borreliosis agent *Borrelia burgdorferi*. *Journal of Medical Entomology*, 43 (3); 600 – 609.

[27] Burtis et al 2016 (see Edwards et al 2019)

[28] Eisen et al 2016 (see Edwards et al 2019).

[29] Ogden, N. H., Trudel, L., Artsob, H., et al. **2006**. *Ixodes scapularis* ticks collected by passive surveillance in Canada: Analysis of geographic distribution and infection with Lyme borreliosis agent *Borrelia burgdorferi*. *Journal of Medical Entomology*, 43 (3); 600 – 609.

[30] Chilton, N. B., Curry, P. S., Lindsay, L. R. **2019**. Passive and active surveillance for Ixodes scapularis (Acari: Ixodidae) in Saskatchewan, Canada. *Journal of Medical Entomology*, https://doi.org/10.1093/jme/tjz155

Since the passive surveillance program's relaunch the MIRs for *B. burgdorferi* have fluctuated between 10.5% and 24.7%. In 2018 the MIR for *B. burgdorferi* increased from 16.7% in 2017 to 20.7%. Prevalence rates were higher than those observed in neighbouring jurisdictions of Northwestern Ontario (~ 13.5% (n = 251))[31], North Dakota (~ 8.5% (n = 91))[32] and Saskatchewan (~ 12.3% (n = 65))[33]. However, the rates were considerably lower than those from areas with longer histories of BLT establishment; New Hampshire (~ 52.3% (n = 509)), Maine (~ 49.1% (n = 10,004)) and Minnesota (~ 47.2% (n = 803))[34].

Active surveillance efforts have historically yielded higher *B. burgdorferi* MIRs, likely a reflection of surveillance in areas with longer established BLT populations. These surveillance efforts have also illustrated fluctuations in MIR, and hence risk, at a smaller spatial scale. For instance, in 2017 active surveillance in southwestern Manitoba revealed MIRs of 51.7% (n = 149) compared to 23.9% elsewhere in the province (n = 113). Similarly in Northwestern Ontario, two studies showed elevated MIRs of 68.8%[35] and 60%[36] respectively, far in excess of the 21.4% infection rate detected through passive surveillance. Results from all of these more surveillance efforts illustrate the non-uniform risk of Lyme disease within areas with established BLT populations.

A. phagocytophilum was the second most common tick-borne pathogen detected among locally collected BLT specimens in Manitoba. The MIRs detected through passive surveillance were 6.2% an increase from 2017. Prevalence rates were higher than those seen elsewhere in Canada, such as Northwestern Ontario (2.8%), Ottawa (0.9%) and the Thousand Islands region (3.2%)[37] suggesting a greater risk of Anaplasmosis in Manitoba compared to elsewhere in the country. The MIR observed in Manitoba were lower than those recorded in more hyper-endemic regions in the US such as New York (12.3%)[38] and Wisconsin (3 – 9%)[39]. Interestingly, the MIR was higher in Saskatchewan samples (7.7%)[40] however, the overall

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[31] Schillberg, E., Lunny, D., Lindsay, L. R., et al. **2018**. Distribution of *Ixodes scapularis* in Northwestern Ontario: Results from active and passive surveillance activities in the Northwestern Health Unit Catchment Area. *International Journal of Environmental Research and Public Health*, 15; 2225 – 2235

[32] Russart, N. M., Dougherty, M. W. and Vaughan, J. A. **2014**. Survey of ticks (Acari: Ixodidae) and tick-borne pathogens in North Dakota. *Journal of Medical Entomology*, 51 (5): 1087 – 1090.

[33] Chilton, N. B., Curry, P. S., Lindsay, L. R. et al. **2019**. Passive and Active Surveillance for *Ixodes scapularis* (Acari: Ixodidae) in Sasktachewan, Canada. *Journal of Medical Entomology*, https://doi.org/10.1093/jme/tjz155

[34] Neldar, M. P., Russell, C. B., Sheehan, N. J., et al. **2016**. Human pathogens associated with the blacklegged tick *Ixodes scapularis*: a systematic review. *Parasites and Vectors*, 9; 265 – 278.

[35] Scott, J. D., Foley, J. E., Clark, K. L., et al. **2016**. Established population of blacklegged ticks with high infection prevalence for the Lyme disease bacterium, *Borrelia burgdorferi* Sensu Lato, on Corkscrew Island, Kenora District, Ontario. *International Journal of Medical Sciences*, 13 (11); 881 – 891.

[36] Schillberg, E., Lunny, D., Lindsay, L. R., et al. **2018**. Distribution of *Ixodes scapularis* in Northwestern Ontario: Results from active and passive surveillance activities in the Northwestern Health Unit Catchment Area. *International Journal of Environmental Research and Public Health*, 15; 2225 – 2235.

[37] Werden, L., Lindsay, L. R., Barker, I. K., et al. **2015**. Prevalence of *Anaplasma phagocytophilum* and *Babesia microti* in *Ixodes scapularis* from a newly established Lyme disease endemic area, the Thousand Islands Region of Ontario, Canada. *Vector Borne Zoonotic Diseases*, 15: 627 – 629.

[38] Prusinski, M. A., Kokas, J. E., Hukey, K. T., et al. **2014**. Prevalence of *Borrelia burgdorferi*, *Anaplasma phagocytophilum*, and *Babesia microti* in *Ixodes scapularis* Collected from Recreational Lands in the Hudson Valley Region, New York State. *Journal of Medical Entomology*, 51 (1): 226-236.

[39] Lee, X., Coyle, D. R., Hoang Johnson, D. K., et al. **2014**. Prevalence of *Borrelia burgdorferi* and *Anaplasma phagocytophilum* in *Ixodes scapularis* Nymphs collected in Managed Red Pine Forests in Wisconsin. *Journal of Medical Entomology*, 51 (3): 694-701.

[40] Chilton, N. B., Curry, P. S., Lindsay, L. R. et al. **2019**. Passive and Active Surveillance for *Ixodes scapularis* (Acari: Ixodidae) in Sasktachewan, Canada. *Journal of Medical Entomology*, https://doi.org/10.1093/jme/tjz155

sample size was lower (n = 65 vs. 145). The MIR for *B. microti* was relatively low, well below rates seen in the northeast US (5.3 – 6.7%)[41]. Passive surveillance efforts in neighbouring provinces of Saskatchewan and Ontario (Northwest) failed to detect *B. microti* again suggesting that the risk, the lower in magnitude compared to Lyme disease and Anaplasmosis, is again greater in Manitoba.

Based on human case data, 2018 was the most active year to date in terms of both Anaplasmosis and Lyme disease. For instance, the 21 Anaplasmosis cases reported to MHSAL accounted more than 40% of the total numbers reported since 2015. Further, unlike previous seasons, all cases reported likely local exposure. In 2018, approximately 62% of Anaplasmosis cases were among males. Since 2015 the ratio of male to female cases has been 1.7:1, slightly higher than the 1.4:1 ratio observed in US cases between 2008 and 2012[42]. In addition, nearly two-thirds of cases reported in 2018 were among individuals aged 40 and older, while the incidence rates were highest in individuals 60 years of age and older (1.60/ 100,000), again similar to US observations. Two-thirds of the cases reported symptom onset in June or July, corresponding to likely exposure when nymph activity is at its peak[43].

Despite more than doubling to 1.5/ 100,000 between 2017 and 2018, the incidence rate of Anaplasmosis in Manitoba was well below those of Minnesota and Wisconsin where the disease was first reported in 1994. By 2012 annual Anaplasmosis incidence rates in the upper Midwest were 9.7 and 7.9 in Minnesota and Wisconsin respectively[44]. Aside from Manitoba where Anaplasmsois became provincially reportable in 2015, reports of human cases in Canada are limited to date[45] [46]. Thus, while Manitoba may be less impacted than other jurisdictions, such as Nova Scotia, Ontario and Quebec, in terms of Lyme disease, the risk posed by other TBDs such as Anaplasmosis is uniquely high.

It should be cautioned that the number of Anaplasmosis cases likely only represents a fraction of the total number. A recent sero-prevalence study of serum specimens collected between 2011 and 2014 showed higher numbers of cases than the numbers reported[47]. These observations were also seen in a summary of US data[48]. In both studies, the underreporting was attributed to less severe symptomology not necessitating visits to health care providers

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[41] Neldar, M. P., Russell, C. B., Sheehan, N. J. et al. **2016**. Human pathogens associated with the blacklegged tick *Ixodes scapularis*: a systematic review. *Parasites and Vectors*, 9; 265 – 278.

[42] Dahlgren, F. S., Heitman, K. N., Drexler, N. A., et al. **2015**. Human Granulocytic Anaplasmosis in the United States from 2008 to 2012: A Summary of National Surveillance Data. *American Journal of Tropical Medicine and Hygiene*, 93 (1); 66 – 72.

[43] Uminski, K., Kadkhoda, K., Houston, B. L., et al. **2018**. Anaplasmosis: An emerging tick-borne disease of importance in Canada. *ID Cases*, https://doi.org/10.1016/j.idcr.2018.e00472

[44] Dahlgren, F. S., Heitman, K. N., Drexler, N. A., et al. **2015**. Human Granulocytic Anaplasmosis in the United States from 2008 to 2012: A Summary of National Surveillance Data. *American Journal of Tropical Medicine and Hygiene*, 93 (1); 66 – 72.

[45] Edginton, S., Guan, T. H., Evans, G., and Srivastava, S. **2018**. Human granulocytic anaplasmosis acquired from a blacklegged tick in Ontario. *CMAJ*, March 26; 190: 363 – 366

[46] Parkins, M. D., Church, D. L., Jiang, X. Y., and Gregson, D. B. **2009**. Human granulocytic anaplasmosis: First reported case in Canada. *Canadian Journal of Infectious Diseases and Medical Microbiology*, 20 (3): 100 – 102.

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and lower physician awareness. In Manitoba, these findings have precipitated increased communications efforts focused on the consideration of TBDs, such as Anaplasmosis, when patients present with a febrile illness and suitable exposure history (with or without evidence of a tick-bite)[49].

Nearly half of all confirmed and probable Lyme disease cases reported since 2009 have been reported in the past there years. Moreover, 2018 was the most active year to date in terms of Lyme disease in Manitoba. Since becoming nationally reportable in 2009 the case numbers and incidence rates have increased from 5 and 0.4/ 100,000 to 52 and 4.0/ 100,000 by 2018. The Manitoba situation mirrors that seen elsewhere. For example at the national level, case numbers have increased more than 14-fold between 2009 and 2017 and incidence rates have risen from 0.4/ 100,000 in 2009 to 2.7/ 100,000 in 2016[50]. While the incidence in Manitoba continues to increase, it is far less than the 34.4/ 100,000 recorded in Nova Scotia (2016) or the 23.6/ 100,000 recorded in Minnesota (2016), two regions with longer histories of BLT establishment.

Approximately 93% of the Lyme disease cases reported in 2018 indicated likely exposure history within Manitoba. As with Anaplasmosis, males accounted for more than 60% of all confirmed and probable case. Incidence rates were highest among males 60 years of age and older (8.07/ 100,000). High rates among older individuals were similar to previous observations in Ontario and Nova Scotia[51] [52]. Similarly the majority of cases (~ 83%) had likely exposure between May and July which aligns with the peak in nymph activity and corresponds to observations elsewhere in Canada.

Despite continued efforts to raise awareness, recollection of tick-bite among Anaplasmosis and Lyme disease cases remains low. In 2018, only 35% and 20% of Lyme disease and Anaplasmosis cases had a history of tick-bite. Further, since 2013, roughly 39% and 30% of Lyme disease and Anaplasmosis cases have indicated a recollection of tick-bite upon follow-up investigation. These low rates correspond to exposure histories that coincide with peak nymph activity. However, when considering TBDs in their differential, physicians should be mindful of low recall rates when assessing patients and tease out other notable risk factors. For instance, exposure to suitable BLT habitat was identified as the most common risk factor, with nearly 90% of Anaplasmosis and Lyme disease cases reporting since 2013. In addition, nearly 70% of all locally acquired cases indicated a history of outdoor recreation with common examples including; golfing, hiking and gardening.

Upon examination the most common symptoms associated with Anaplasmosis and Lyme disease were non-specific. For instance, fever, headache and fatigue were noted in more than 50% of the cases reported. Laboratory findings such as elevated liver function tests

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[51] Johnson, K. O., Nelder, M. P., Russell, C., et al. **2018**. Clinical manifestations of reported Lyme disease cases in Ontario, Canada: 2005-2014. *PLoS One*, June 1, 2018 (https://doi.org/10.1371/journal.pone.0198509)

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and thrombocytopenia, were specific to Anaplasmsois. Additional non-specific symptoms have also been reported including sweats, chills, myalgia, malaise and nausea. In the case of Lyme disease, physician observe Erythema migrans was the most common clinical finding. While typically an indication of early localized infection this symptom was recorded in 68.5% of cases reported in 2018. The proportion of Erythema migrans observed has increased in Manitoba from 51.7% in 2013, and is now closer to the approximately 70% recorded in Ontario. The change with which physicians are recognizing this clinical feature may indicate raising awareness among practitioners.

Cardiac and neurological (Bell's Palsy only) involvement with Lyme disease, symptoms associated with early disseminated Lyme disease, were recorded in only 7.0 and 8.6% of cases respectively reported since 2015. Arthritis was observed in nearly a quarter of all Lyme disease cases. While the proportion of cases with late disseminated Lyme disease was similar to the 23.4% observed in Nova Scotia, it was less than the 41.9% recorded among Ontario cases[53]. The proportion of cases with arthritis have declined from 39.2% in 2016 to 18.5% in 2018 suggesting earlier diagnosis. However, there is still room to improve awareness among health care providers to increase awareness and diagnose more cases in the early localized stage.

Since their initial detection in 1989, BLT populations, aided largely by climate change in recent years, have expanded to occupy much of southern Manitoba. With the proliferation of BLT risk areas, a corresponding increase in infection rates among local tick populations has also been seen. This has resulted in an increasing risk of TBDs, most notably Anaplasmosis and Lyme disease in Manitoba. As the burden posed by TBDs continues to increase MHSAL continues to monitor BLT infection rates for known pathogens of public health importance and newly emerging ones (i.e. *Bo. miyamotoi*, *Bo. mayonii* and deer tick virus (Powassan lineage II). In addition, MHSAL continues to analyze human disease to assess risk and develop targeted messaging to the public and health care providers to raise awareness. As BLT populations continue to expand and establish, prevention and awareness are keys to minimizing the burden and hence public health impact.

[53] Johnson, K. O., Nelder, M. P., Russell, C., et al. **2018**. Clinical manifestations of reported Lyme disease cases in Ontario, Canada: 2005-2014. *PLoS One*, June 1, 2018 (https://doi.org/10.1371/journal.pone.0198509)