Lyme Disease

A report on Lyme Disease Epidemiology and Surveillance in Nova Scotia

Summary

- Since the first cases reported in 2002, the annual number of reported cases of Lyme disease in Nova Scotia has been increasing. The increase in cases is likely due to a number of factors including an increase in the number of tick populations established in Nova Scotia, increases in the sizes of established tick populations, and an increase in awareness among individuals and physicians leading to increased diagnosis and reporting of Lyme disease.
- To date, there have been 120 cases of Lyme disease reported in Nova Scotia, of which 101 (84%) were likely acquired within the province. A definite tick bite was reported by 25.8% of cases.
- Cases ranged in age from three to 83 years. Cases were 64% male. Five percent of cases (6/120) were hospitalized. No deaths were associated with Lyme disease.
- Ninety percent of cases (108/120) were known to have been treated when follow up was conducted by local public health nurses. The treatment status of the remaining 10% of cases was unknown at the time of follow up.
- The majority of Lyme disease cases in Nova Scotia from 2002 to 2011 presented with symptoms of early Lyme disease, including influenza-like illness (70.0%) and erythema migrans or other rash (81.7%).
- Climate change models predict that Nova Scotia is very close to having a suitable climate for tick establishment across the entire province. Local ecology, including suitable habitat, host availability and other factors, will determine the extent to which tick populations will expand and where new populations will establish.
- Tick field investigation typically leads to knowledge of tick establishment in a discrete geographic location, which is deemed a Lyme disease endemic area. From 2003-2011, endemic areas within Nova Scotia were described by the name of the locality where the endemic tick population was observed. Precise boundaries of identified tick populations are difficult to define and will expand over time as conditions permit.
- Beginning in 2012, endemic areas in Nova Scotia have been given large boundaries encompassing a buffer zone around the previously described endemic localities. Exposure to a suitable habitat for blacklegged ticks (wooded, low shrubs, or grassy areas) within the circled risk areas should be considered an endemic exposure. Of cases likely acquired in the province, 98% had likely exposures within the endemic areas as defined in 2012.
- Nova Scotia has implemented integrated human and tick surveillance for the identification of new endemic areas, whereby cases with exposures outside of known endemic areas are considered for tick surveillance.

Acknowledgements

Provincial Lyme disease surveillance would not be possible without the timely and complete case reporting by health care providers, public health professionals, the Provincial Public Health Laboratory Network, and the National Microbiology Laboratory. Surveillance of Lyme disease endemic areas is made possible through partnerships between the Department of Health and Wellness and the Department of Natural Resources, the Museum of Natural History and The Public Health Agency of Canada. The Nova Scotia Department of Health and Wellness extends its thanks to the Lyme and Tick Surveillance Technical Working Group and to all those whose contributions have helped make this report possible.

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1.0 Introduction

Lyme disease is emerging in Nova Scotia. Lyme disease is a spirochaetal zoonotic disease caused by *Borrelia burgdorferi*, transmitted by the bite of an infected tick. In Nova Scotia, the vector is the blacklegged tick, *Ixodes scapularis*. Illness typically manifests with a characteristic erythema migrans (EM), a rash with a 'bull's eye' appearance. EM presents three to 32 days (mean 7-10 days) after tick exposure in approximately 80% of patients (1). Early systemic symptoms include malaise, fatigue, fever, headache, stiff neck, myalgia, migratory arthralgias and/or lymphadenopathy (1). Dissemination of early Lyme disease may result in multiple EM lesions, cardiovascular symptoms, arthritis, facial palsy, or meningitis (2). If untreated, Lyme disease may lead to the development of symptoms months to years after tick exposure, including arthritis or late neuroborreliosis (2).

Lyme disease can be prevented by avoiding exposure to blacklegged ticks. Blacklegged ticks are most often found in grassy, wooded or shrub covered areas. There is a low but persistent risk of acquiring Lyme disease anywhere in Nova Scotia, because birds can transport blacklegged ticks large distances from established tick populations. Risk of acquiring Lyme disease is typically much higher in areas where there are reproducing populations of blacklegged ticks infected with *B. burgdorferi*. Therefore, primary prevention efforts for Lyme disease include the identification and communication of geographic risk areas associated with populations of blacklegged ticks infected with the bacteria that can cause Lyme disease. These risk areas are known as Lyme disease endemic areas. Nova Scotia Department of Health and Wellness (NS DHW) works with partners in the Department of Natural Resources and the Public Health Agency of Canada (PHAC) to detect and monitor the existence and spread of populations of ticks that transmit *B. burgdorferi*.

Surveillance of Lyme disease, to understand the local epidemiology, and surveillance of ticks, to detect new Lyme disease endemic areas in the province, is ongoing. The first isolation of the agent of Lyme disease was from a blacklegged tick removed from a bird in Nova Scotia in 1999 (3). In 2002, the first human cases of Lyme disease were reported in Nova Scotia. These cases were likely exposed within the province. As a result of increased tick activity and reports of human cases, the surveillance data collection for human cases of Lyme disease and the tick surveillance program have evolved over time. The purpose of this report is to provide descriptive epidemiological information on Lyme disease cases reported in Nova Scotia from 2002-2011, to describe Lyme disease endemic areas that have been identified in the province, and to provide an overview of the outcomes of surveillance for blacklegged tick populations in Nova Scotia.

2.0 Descriptive epidemiology of all reported cases

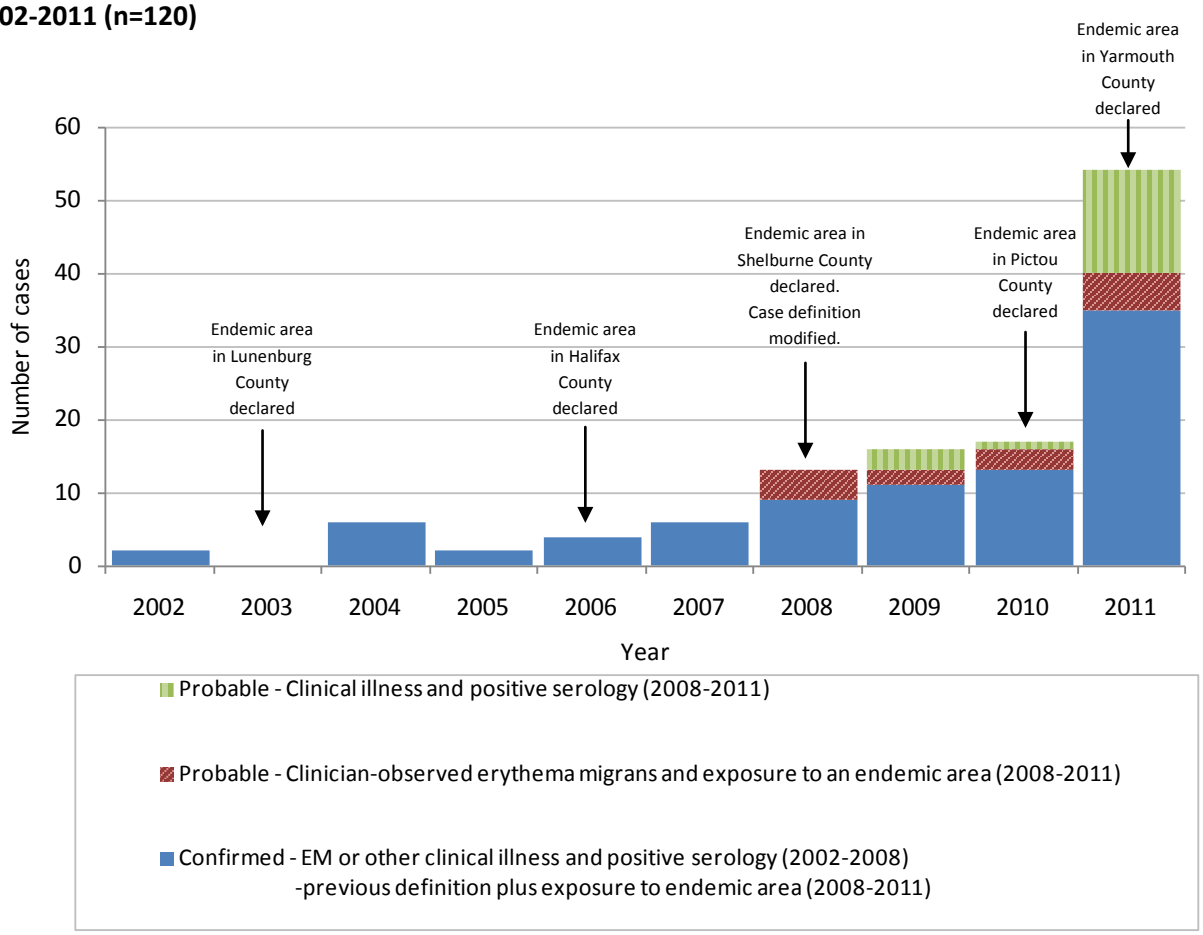
2.1 Disease incidence over time

There have been a total of 120 cases of Lyme disease reported in Nova Scotia with dates of symptom onset (or closest available date) occurring between 2002 and 2011 inclusive (Table 1). The annual number of reported cases remained low from 2002 to 2010, with 18 or less cases reported in any given year. Fifty-four cases of Lyme disease were reported in 2011, which is a marked increase from previous years. Figure 1 presents the number of reported cases by year, showing the increase in cases over time, the years in which new areas were added to the list of known Lyme disease endemic areas, and when the surveillance case definition was modified.

Table 1. Number of reported cases of Lyme disease by case classification and year, Nova Scotia, 2002-2011

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Confirmed	2	0	6	2	4	6	9	11	13	35
Probable – EM + endemic	0	0	0	0	0	0	4	2	3	5
Probable – illness + serology	0	0	0	0	0	0	0	3	1	14
TOTAL	**2**	**0**	**6**	**2**	**4**	**6**	**13**	**16**	**17**	**54**

Figure 1. Number of reported cases of Lyme disease by case classification and year, Nova Scotia, 2002-2011 (n=120)



The increase in cases over time between 2002 and 2011 is likely attributable to a number of factors including:

- an increase in the number of tick populations established in Nova Scotia: As shown in Figure 1, the number of known endemic areas in Nova Scotia increased from zero to five from 2002 to 2011. It is very likely that blacklegged tick populations were established in Nova Scotia prior to 2002 but it is

not possible to precisely define when this founding event took place. The Lyme disease endemic areas in the province are described in detail in section 4.0 of this report.

- modification of the surveillance case definition in 2008: Changes made to the national surveillance case definition adopted by Nova Scotia included the addition of a required exposure to a known endemic area to meet the confirmed case definition, and the addition of two probable case definitions: (1) EM with exposure to a known endemic area, or (2) clinical illness with positive serology (4). Complete surveillance case definitions can be found in Appendix B.
- increases in geographic range of the established tick populations, as has been reported by others (5), has been observed in Nova Scotia. Also, increased abundance or density of ticks is also likely, as shown with other tick vectors (6), when conditions permit.
- increases in the infection rate in the established tick populations would also be expected as the density of tick populations grows.
- an increase in awareness among individuals and physicians leading to increased diagnosis and reporting of Lyme disease: With declaration of new endemic areas, public messaging about Lyme disease risk, and clinician educational activities, it is likely that Lyme disease awareness has increased over time. This may have led to increased diagnosis and reporting of cases.

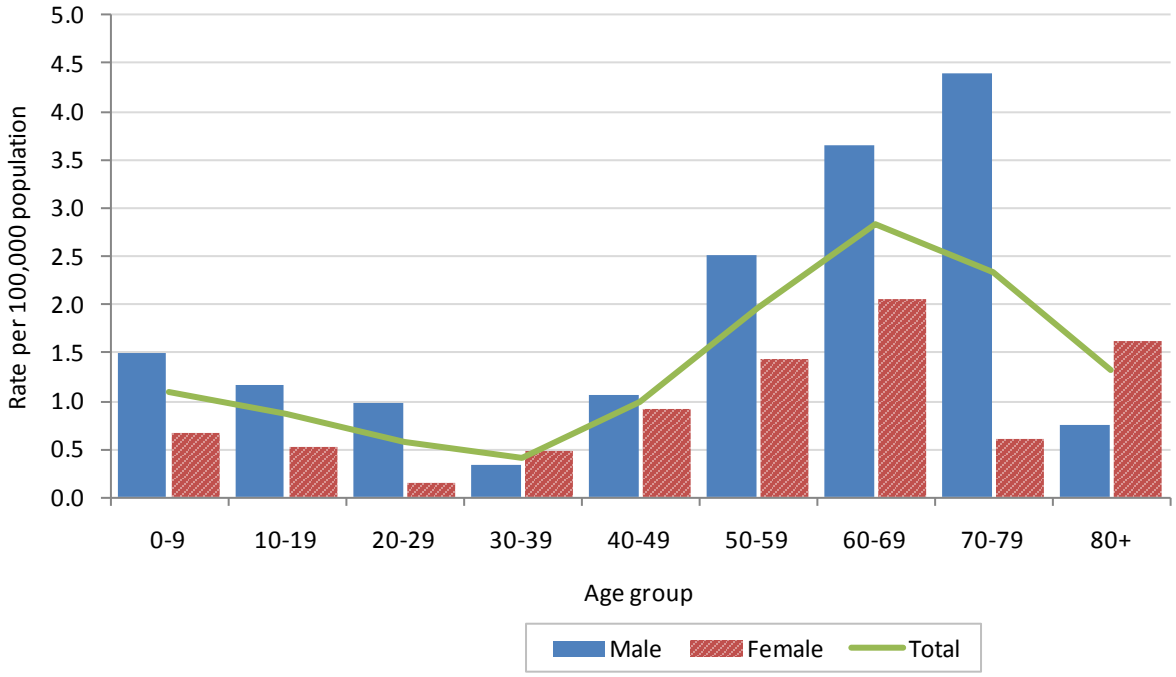
Annual variations in tick activity are also possible. Ticks are active when temperatures are at or above four degrees Celsius (7); however, cases are most often acquired in the summer when nymphs are active and people are enjoying the outdoors. Annual climate could affect the number of days per year during which ticks, as well as people, are active. Annual climate could also affect tick population density each season. A slow start to winter in Nova Scotia was noted in 2011 (8). Further investigation into any relationships between annual weather patterns, tick activity and Lyme disease risk is required to interpret the effect temperature and/or other factors have on the number of reported cases of Lyme disease. Research in this field is ongoing by epidemiologists, medical geographers, entomologists and others at the PHAC and in other institutes.

2.2 Case demographics

Cases ranged in age from three to 83 years old. The average annual rate peaked in the 0-9 year age group and the 60-69 year age group (Figure 2). Considering age group and sex, the average annual rate was highest among males aged 70-79 years of age (4.4 cases per 100,000 population). Overall, males comprised 64% of cases. Although the Centres for Disease Control and Prevention (CDC) used a slightly different case definition than that used in Canada for the compared time periods, the demographics of Nova Scotian cases are similar to those reported in the USA from 1992 to 2006, where 53% of cases were male and average annual rates were highest among children aged 5-9 years and adults aged 55-59 years (9).

Six (5%) of the 120 reported Lyme disease cases were hospitalized. Hospitalization was more likely among young and older cases, with two-thirds of hospitalized cases either under 20 years or over 79 years of age. These age groups accounted for only 21% of all cases. Five of the six hospitalized cases had reported cardiac or neurological symptoms. No deaths were associated with Lyme disease.

Figure 2. Rate of reported cases of Lyme disease per 100,000 population, by sex and age group, Nova Scotia, 2002-2011 (n=120)



2.3 Treatment

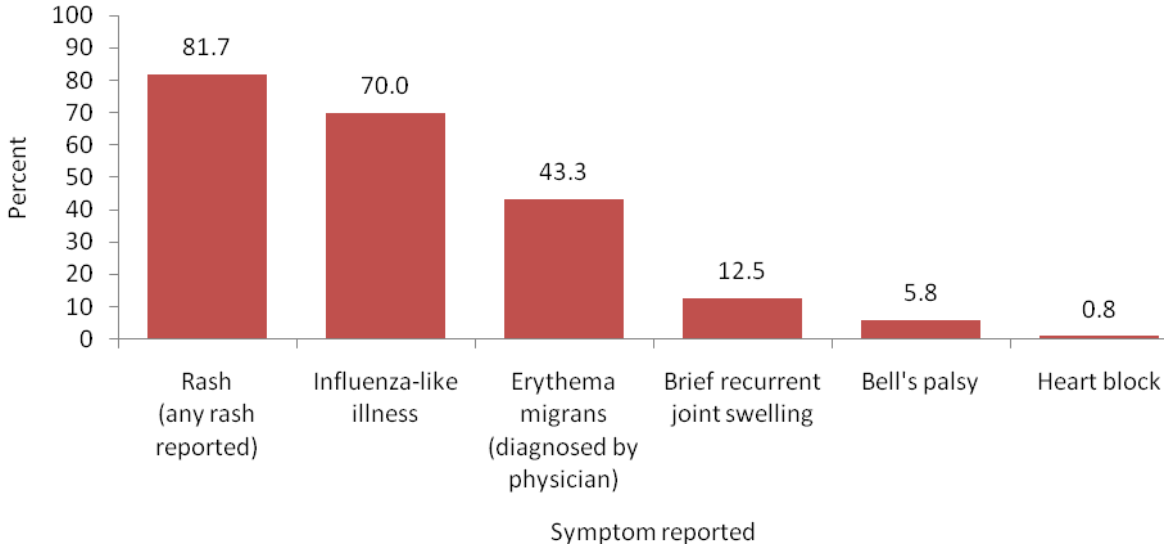
Ninety percent of Lyme disease cases were reported to have received treatment for Lyme disease. Of the remaining ten percent, treatment status was unknown at the time of follow up. One of the three Lyme disease case definitions is based on clinical information alone (with no laboratory component). As with any reportable disease with a case definition based on clinical information alone, under-reporting of cases is likely to occur. While some level of under-reporting is likely, it is unlikely that these cases remained without a clinical diagnosis and treatment. A survey conducted in British Columbia suggested that physicians were comfortable with treating patients empirically, and that more cases had been clinically diagnosed and treated than had been reported to public health (10). Since disease rates in Nova Scotia are higher than in British Columbia, clinician awareness and level of comfort diagnosing and treating Lyme disease is likely to be high in Nova Scotia as well.

2.4 Reported disease symptoms

The majority of Lyme disease cases in Nova Scotia from 2002 to 2011 presented with symptoms of early Lyme disease, including influenza-like illness and EM or other rash not specifically identified as EM (Figure 3). Compared to American cases for which data were available for the 1992-2006 time period, Nova Scotian cases were less likely to have reported EM (69.2 versus 43.3%) and brief attacks of joint swelling (32.0 versus 12.5%) (9). Heart block was reported in the same proportion of cases in Nova Scotia as in the USA (0.8%) (9).

The sensitivity of the surveillance system in Nova Scotia for capturing EM is unknown. Current public health practice involves case management of all reported cases of Lyme disease. One component of case management includes determining symptoms through consultation with both the health care provider and the individual patient. Physician-diagnosed EM is one clinical component recognized in the surveillance case definition, and must be specifically reported by the physician. If a public health nurse receives information from a chart review of a case and EM is not clearly stated on the chart, then the case will not be reported as having physician-diagnosed EM. Collection of data on reports of 'Other skin rashes' has ensured all rash presentations are captured. The extent to which reports of 'Other skin rashes' are in fact EM is difficult to assess. Furthermore, single EM (early localized disease) versus multiple EM (early disseminated disease) may not be specified, making it difficult to assess proportions of cases presenting with localized versus disseminated disease. With a large number of reports of 'Other skin rashes', further investigation is required to understand whether fewer patients are presenting with typical EM or clinicians are not recognizing and/or recording or reporting EM in Nova Scotia.

Figure 3. Percent of reported cases of Lyme disease by symptoms reported*, Nova Scotia, 2002-2011 (n=120)



*More than one symptom may be reported per case. Rash (any rash reported) includes EM.

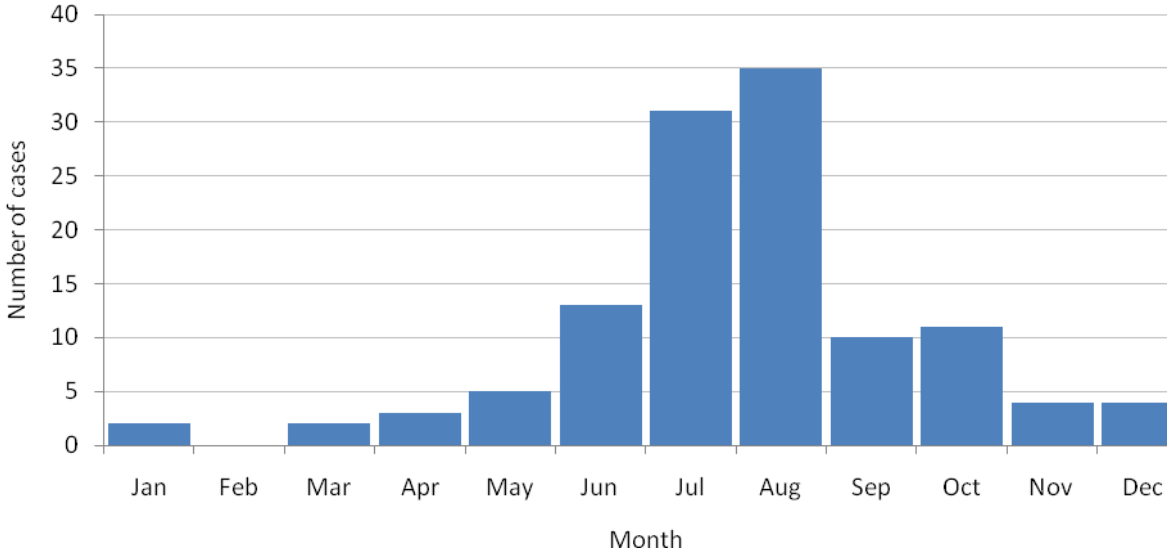
2.5 Seasonality of cases

The majority of cases had reported symptom onset dates (or closest available date) within the summer months (Figure 4), reflecting the seasonal risk of tick exposure. A definite tick bite was reported by 25.8% of cases. The highest risk of Lyme disease is in the late spring and summer months, when the nymphal stage of the blacklegged tick is active (11). However, risk for Lyme disease exists anytime ticks are active which occurs when temperatures are at or above four degrees Celsius (7). Since nymphs are smaller and more difficult to see than adult females, they are less likely to be noticed and removed before transmission of infection can occur (i.e., within 24 to 36 hours after tick attachment (11)).

Some cases were noted to work or recreate outdoors; however, information on occupation, recreational activities, landscape of yard, number/type of pet(s), or use of repellants or other protective measures is

not systematically collected in Nova Scotia. This information would be useful in understanding risks associated with acquiring Lyme disease in the province, and possibly help direct messages about Lyme disease prevention. Revisions to the Lyme disease case report form are planned to enable future collection and analysis of such information.

Figure 4. Number of reported cases of Lyme disease by month of symptom onset*, Nova Scotia, 2002-2011 (n=120)



*If date of symptom onset unavailable, date of specimen collection or clinical diagnosis applied.

2.6 Testing for Lyme disease

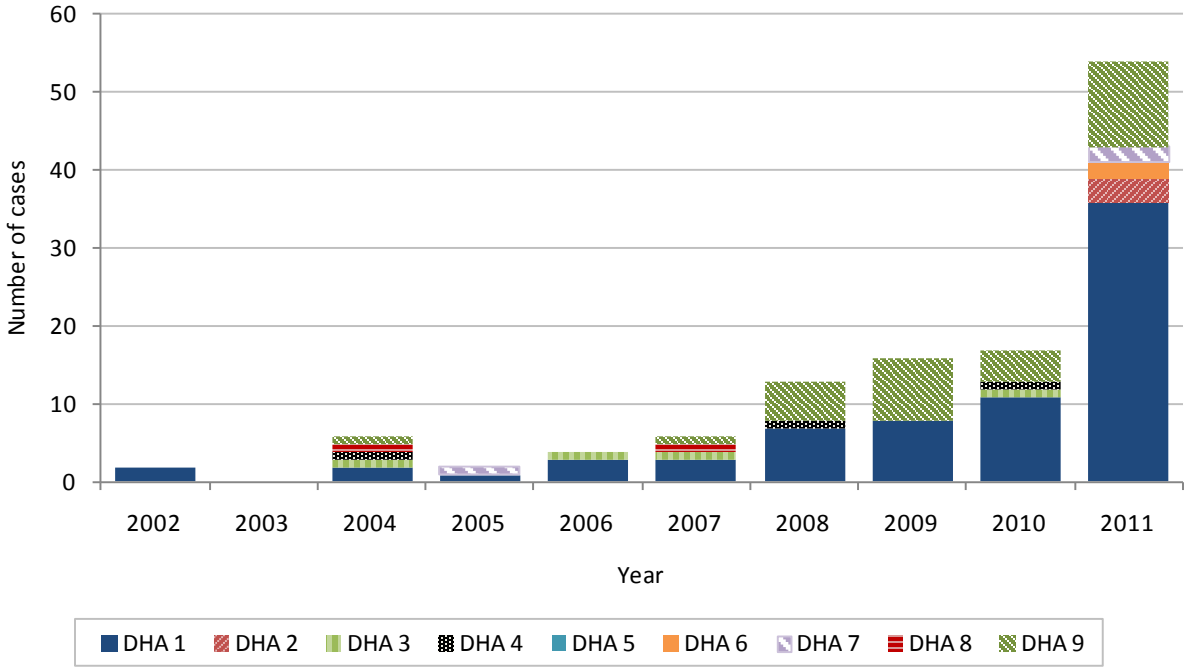
In recent years, over 1000 screening tests have been conducted on Nova Scotia residents per year by the Provincial Public Health Laboratory (PPHLN) (PPHLN communication). The number of tests completed has increased over time, from less than 500 tests in the 2001/02 and 2002/03 fiscal years. Tests have been ordered by physicians within every District Health Authority (DHA) across the province. An understanding of the number of laboratory requisitions for Lyme disease serology and percent positive by location, month, and over time would aid in the interpretation of the numbers of reported cases. This information is not routinely accessed by public health, but could be obtained from the PPHLN for research purposes. Further to numbers and demographics of tests requisitioned, knowledge of reason for testing (or not testing) as well as reporting practices of clinicians would be of interest to understand testing practices and the extent of under-reporting of probable cases that do not require positive serology. This is beyond the scope of routine public health surveillance and would require a research study on the knowledge, attitudes, and behaviours of clinicians across the province.

2.7 Reports by District Health Authority of residence

Figures 5 and 6 present the numbers and rates, respectively, of reported cases of Lyme disease by DHA of residence (See Appendix A for DHA names). The majority of cases (61%) were from DHA 1 (Figure 5). DHA 9 had the second highest number of cases, accounting for 25% of cases. Overall, Lyme disease rates were highest, and displayed the greatest increasing trend, in DHA 1 (Figure 6, Table 2). Reported Lyme disease cases have reported residence in eight of nine DHAs in the province. To date, no cases have been reported from DHA 5.

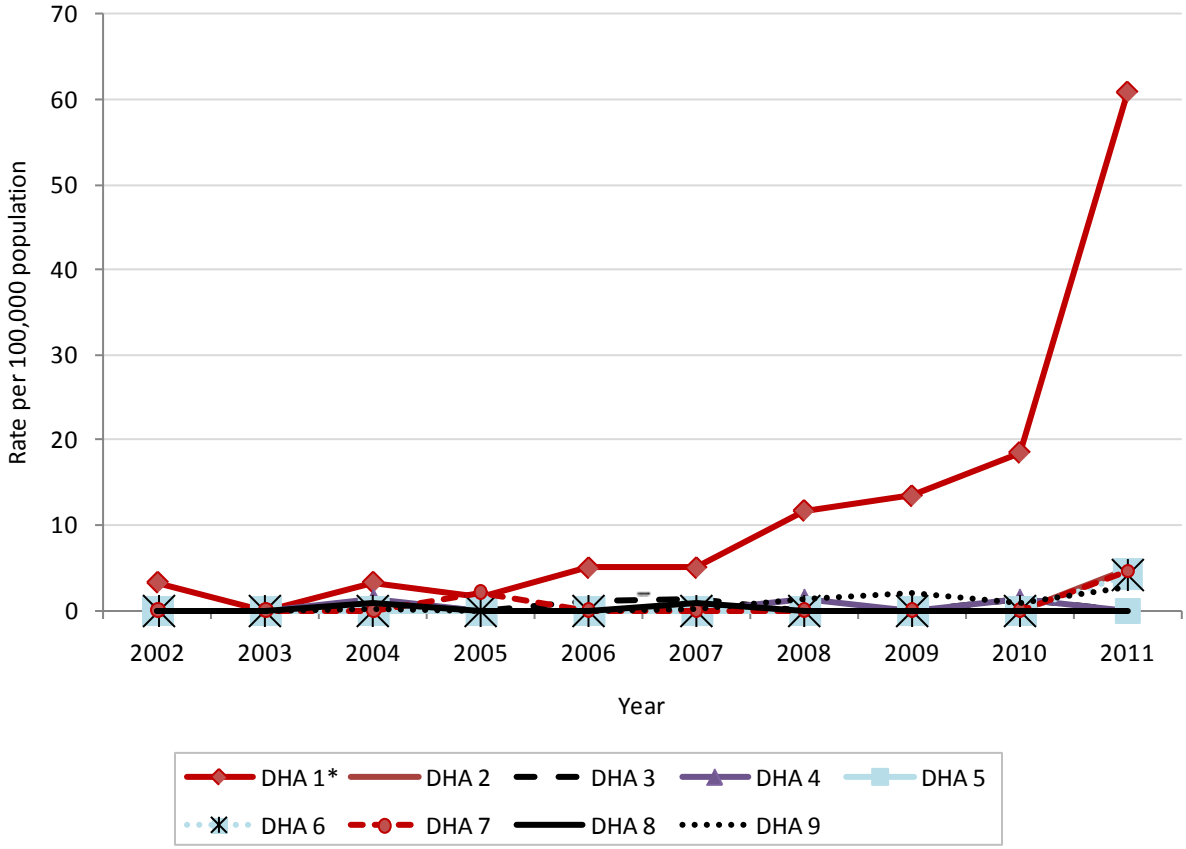
Most Nova Scotian cases have been exposed to infected ticks either by living in or traveling to one of the growing number of endemic areas within the province. To date, endemic areas have been declared in DHA 1 (in 2003), DHA 9 (in 2006), DHA 2 (in 2008 and 2011), and DHA 6 (in 2010). Analysis of location of likely exposure (Figure 7 and 12), however, is required to attribute cases to exposure locations and further understand Lyme disease epidemiology in Nova Scotia.

Figure 5. Number of reported cases of Lyme disease by DHA of residence*, Nova Scotia, 2002-2011 (n=120)



*Over time (see Figure 1), endemic areas have been identified in four of the nine DHAs. DHA of residence may differ from location of likely exposure. See Figure 11 for cases by location of likely exposure.

Figure 6. Rate of reported cases of Lyme disease per 100,000 population by DHA of residence* and year, Nova Scotia, 2002-2011 (n=120)



*Over time (see Figure 1), endemic areas have been identified in DHAs 1, 9, 2, and 6. DHA of residence may differ from location of likely exposure. See Figure 11 for cases by location of likely exposure.

Table 2. Rate of reported cases of Lyme disease per 100,000 population by DHA of residence* and year, Nova Scotia, 2002-2011

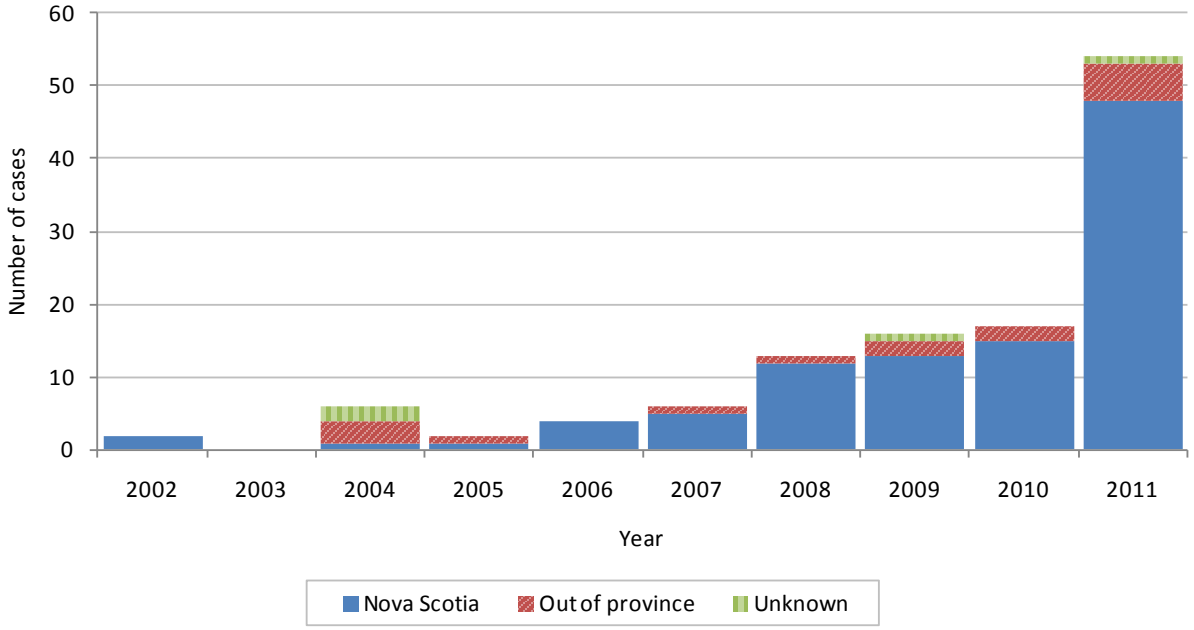
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
DHA 1	3.3	0.0	3.3	1.7	5.0	5.0	11.7	13.4	18.5	60.9
DHA 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9
DHA 3	0.0	0.0	1.2	0.0	1.2	1.2	0.0	0.0	1.2	0.0
DHA 4	0.0	0.0	1.4	0.0	0.0	0.0	1.4	0.0	1.4	0.0
DHA 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DHA 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4
DHA 7	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	4.6
DHA 8	0.0	0.0	0.8	0.0	0.0	0.8	0.0	0.0	0.0	0.0
DHA 9	0.0	0.0	0.3	0.0	0.0	0.2	1.2	2.0	1.0	2.7
NS TOTAL	**0.2**	**0.0**	**0.6**	**0.2**	**0.4**	**0.6**	**1.4**	**1.7**	**1.8**	**5.8**

*Over time (see Figure 1), endemic areas have been identified in DHAs 1, 9, 2, and 6. DHA of residence may differ from location of likely exposure. See Figure 11 for cases by location of likely exposure.

2.8 Reports by location of likely exposure

Eighty-four percent of Nova Scotian cases of Lyme disease were likely acquired in the province (Figure 7). Of the remaining cases, 13% were likely acquired outside of the province, and for 3% of cases the likely exposure location was unknown. Exposures for cases likely acquired outside of Nova Scotia included exposures in the USA and Europe (mainly Germany). The increase in cases in the province is even more striking when considering only the cases likely acquired in the province, reflecting the emergence of Lyme disease and its vector in Nova Scotia (Figure 7), as discussed in Section 2.1.

Figure 7. Number of reported cases of Lyme disease by place of likely acquisition, Nova Scotia, 2002-2011 (n=120)



3.0 Descriptive epidemiology of cases most likely acquired in Nova Scotia

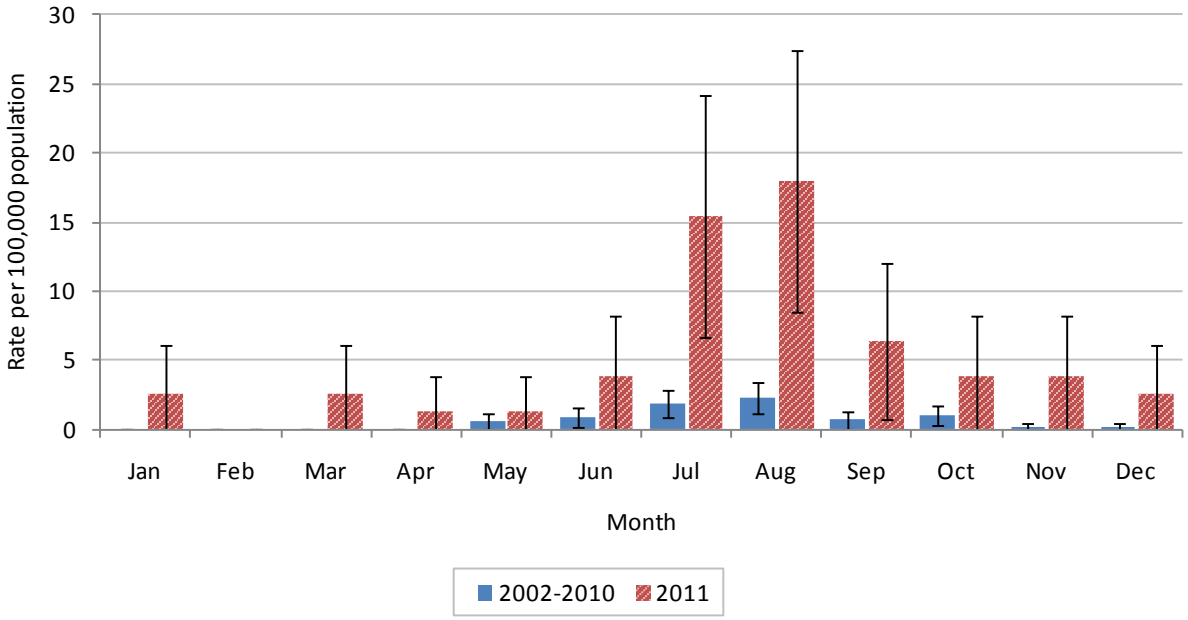
3.1 Case demographics and seasonality of cases

Cases with most likely acquisition in Nova Scotia displayed similar symptoms and demographics, and followed the same trend in seasonality as all reported cases (Figures 1-3). Cases ranged from three to 83 years of age and were 63% male.

3.2 Comparison of 2011 cases with those reported in 2002-2010

The increase over time in Lyme disease cases likely acquired in Nova Scotia is displayed in Figure 7. The number of reported cases with likely acquisition in Nova Scotia was 2.5 times higher in 2011 compared to 2010 (37 cases versus 15 cases). Figures 8 and 9 compare 2011 cases to those reported between 2002 and 2010. Rates of Lyme disease were higher in all age groups in 2011 compared to the average annual rate from 2002 to 2010 (Figure 8). Rates were significantly higher in 2011 compared to the average annual 2002-2010 rate in the 50-59 and 60-69 year age groups. The rate in the zero to nine years age group was much higher in 2011 compared to the average 2002-2010 annual rate; however, this difference was not statistically significant.

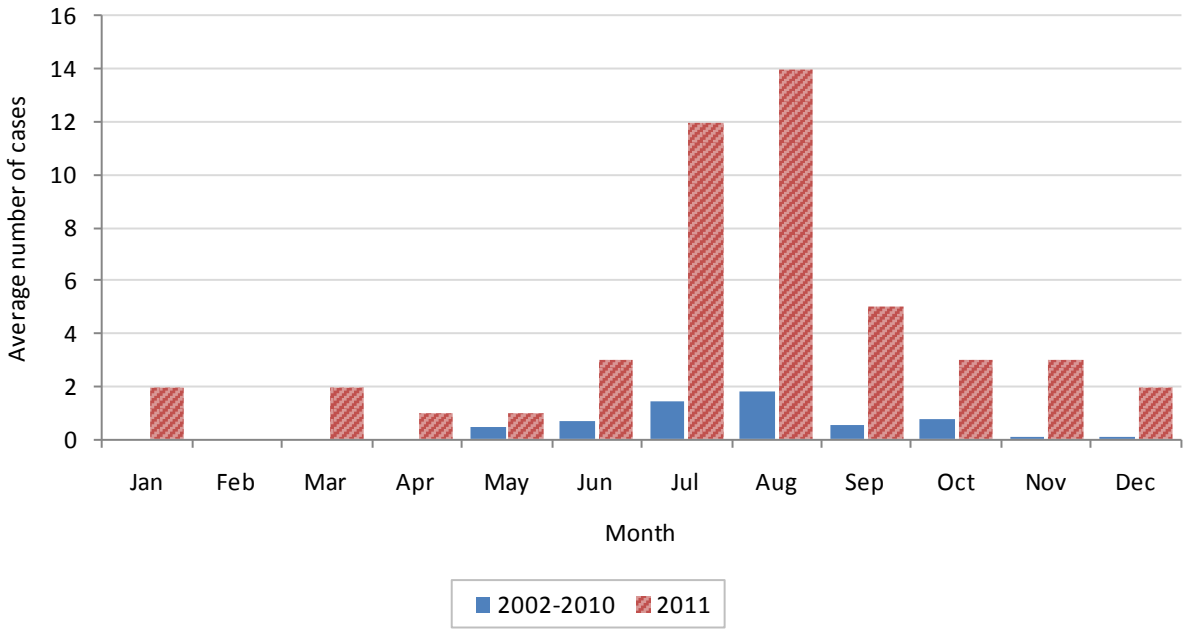
Figure 8. Average annual rate* by age group for 2002-2010 compared to 2011 rates, Lyme disease likely acquired in Nova Scotia (n=101)



*Error bars represent 95% confidence interval of rate

In 2011, cases reported symptom onset (or closest available date) in every month other than February (Figure 9). From 2002 to 2010, only one case had been reported in both November and December, and no cases were reported in January, February, March, or April. As previously mentioned, research focused on the relationships between annual weather patterns, tick activity and Lyme disease risk is ongoing by epidemiologists, medical geographers, entomologists and others at the PHAC and in other institutes. The findings of such studies can aid in the interpretation of any effect temperature or other factors may have had on the number of reported cases in Nova Scotia in 2011.

Figure 9. Average annual number of reported cases by month of onset* for 2002-2010 compared to cases by month of onset* for 2011, Lyme disease likely acquired in Nova Scotia (n=101)



*If date of symptom onset unavailable, date of specimen collection or clinical diagnosis applied.

4.0 Lyme disease endemic areas in Nova Scotia

Lyme endemic areas are defined nationally as those areas in which the risk of transmission of Lyme disease to humans is supported by the presence of an established vector population known to be infected with *Borrelia burgdorferi,* or the occurrence of a cluster of human cases for which there is no history of exposure in previously identified endemic areas (12). The Canadian definition for Lyme disease endemic areas states that 'the limits of the endemic area will be defined by the provincial or territorial health authorities'(12). This national definition is used in Nova Scotia. The first endemic tick populations in Nova Scotia were identified in Lunenburg County in 2003, in the localities of Garden Lots, Blue Rocks, First Peninsula, and Heckman's Island. The second endemic area, Admiral's Cove Park in Bedford, Halifax County, was identified in 2006. In 2008, Gunning Cove, Shelburne County, was declared an endemic area. In August 2010, areas around Melmerby Beach, Egerton, Kings Head, and Pine Tree within Pictou County were declared endemic. The fifth endemic area to be named in Nova Scotia was Gavelton, Yarmouth County, in December 2011. To date, no endemic area has been declared in Nova Scotia based on the human case cluster criteria (12).

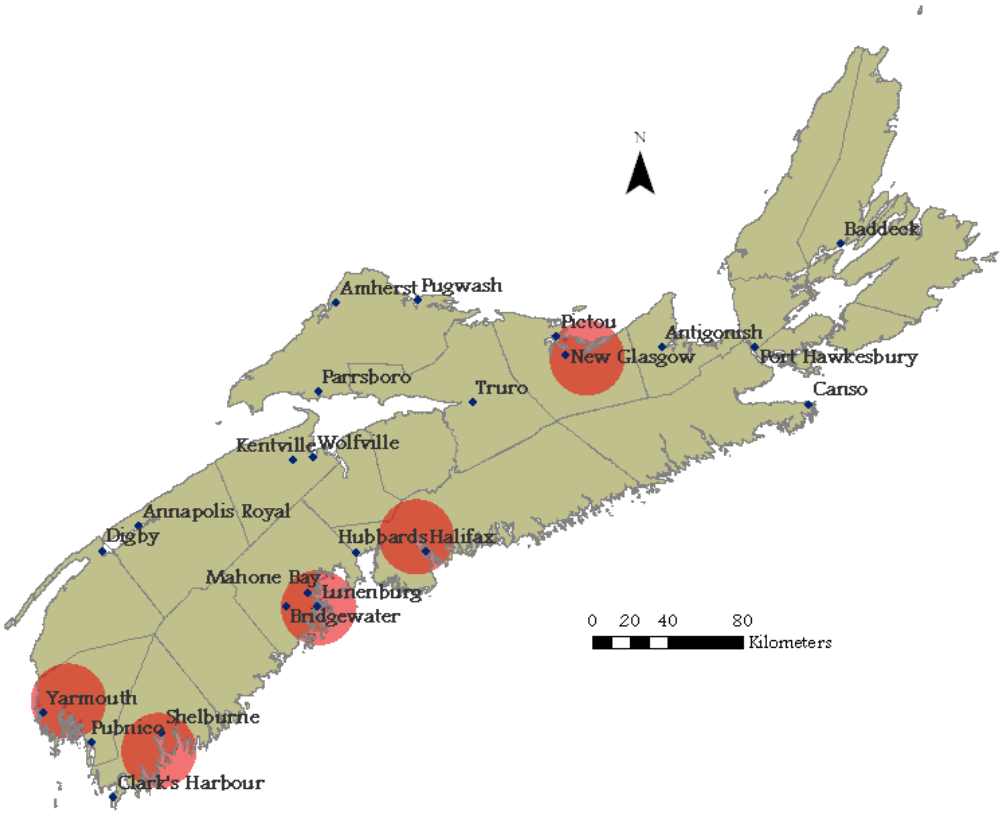
Until 2012, endemic areas within Nova Scotia were described by the name of the locality where the endemic tick population was observed. No formal boundaries were defined for Lyme endemic areas from 2002 to 2011. Localities were listed on the NS DHW website for access by the public and health professionals. The language used to describe the endemic area in Lunenburg and Pictou counties was broader than the named localities, and included the wording 'areas around' and 'as well as areas immediately surrounding them'. Precise boundaries of identified tick populations are difficult to define and will expand over time as conditions permit.

Due to the difficulty in defining exact boundaries and the need to provide a definition in order to classify cases using the surveillance case definition and for clinical care, beginning in 2012, endemic areas in Nova Scotia were given large boundaries encompassing a buffer zone around the previously described endemic localities. Communication of Lyme disease endemic areas changed to the presentation of large circular Lyme disease endemic areas on a map available to the public and to clinicians. Exposure to a suitable habitat for blacklegged ticks (wooded, low shrubs, or grassy areas) within the circled risk areas should be considered an endemic exposure. The map of known endemic areas in Nova Scotia in 2012 is presented in Figure 10. Enlarged maps of the endemic areas are available in Appendix D.

The new circular Lyme endemic areas will be used:

- to communicate areas of known higher risk to the public,
- for endemic exposure criteria when assessing the public health surveillance case definition,
- for clinicians to consult when making decisions on diagnosis and treatment.

Figure 10. Map of Lyme disease endemic areas in Nova Scotia in 2012



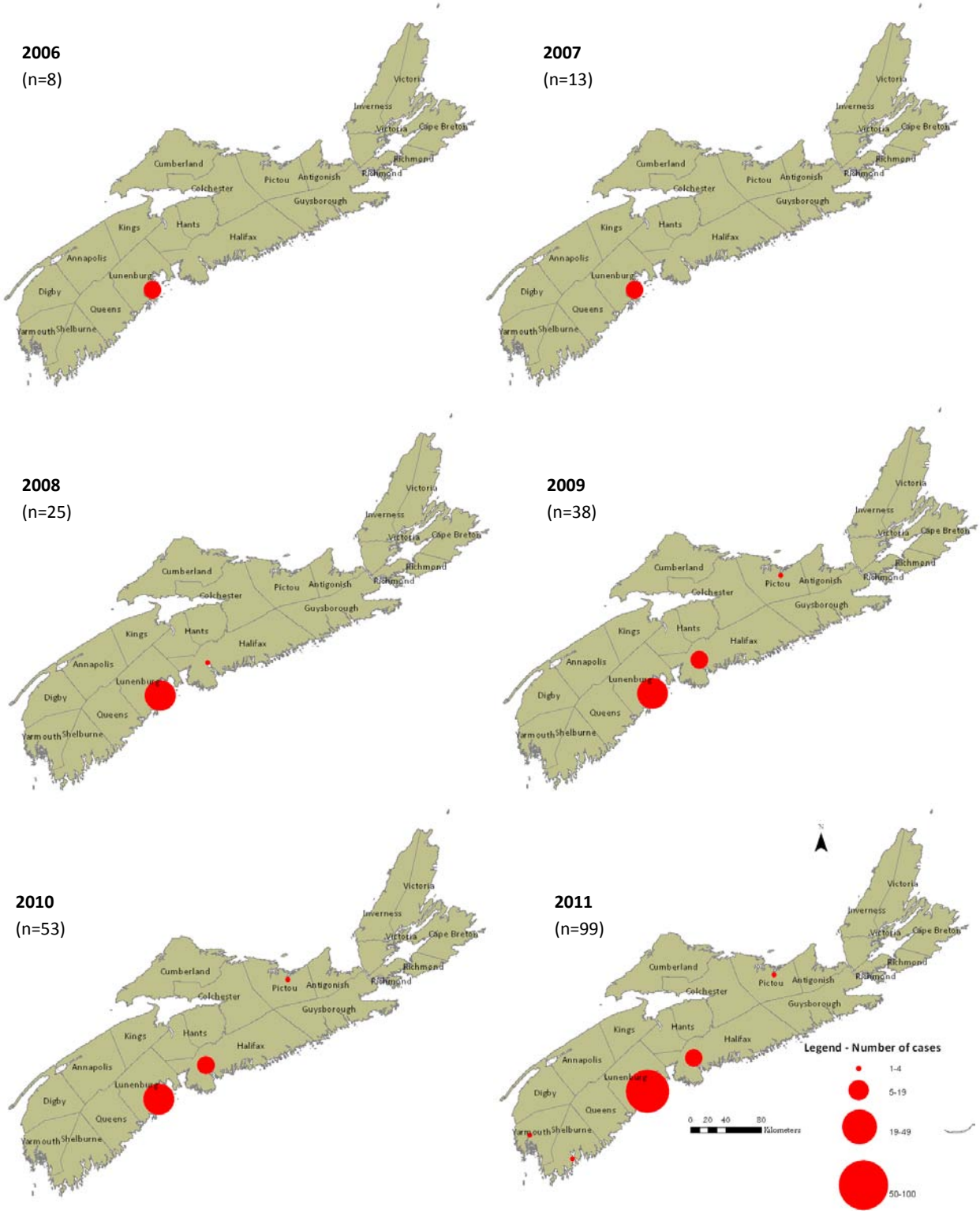
See inset maps in Appendix D

Ninety-eight percent of cases with likely exposure in Nova Scotia between 2002 and 2011 were associated with the endemic areas presented in Figure 10 above. Figure 11 depicts the cumulative numbers of cases associated with each endemic area by year of onset, for 2006 to 2011. Prior to 2008,

all cases were associated with exposures in the endemic area in Lunenburg County. Between 2008 and 2010, cases were also associated with exposures in the endemic areas in Halifax and Pictou counties. In 2011, the first cases associated with the endemic areas in Shelburne and Yarmouth counties were reported.

Prior to placing large boundaries around known endemic areas (pre-2012), a number of cases were reported from outside the then strictly defined, locality based Lyme endemic areas. The majority of these cases reported exposures within 10km of the known endemic localities, and these exposures fall within the new boundaries around the Lyme disease endemic areas. Although heightened awareness of the risk of Lyme disease may be associated with the known endemic areas, requisitions for Lyme disease serology have come from physicians across the province (PPHLN communication). This suggests that clinicians across Nova Scotia are both aware of, and testing for, Lyme disease. There have been two cases with likely exposures within the province that are not associated with the known endemic areas as defined in 2012. The locations of likely exposures for these cases will be considered when prioritizing sites for field investigations of tick populations through the province's tick surveillance algorithm (Appendix C).

Figure 11. Lyme disease cases with likely exposure associated with known endemic areas (2012), cumulative over time, 2006-2011



5.0 Tick Surveillance Program

Informal surveillance efforts to detect blacklegged ticks in Nova Scotia began in the late 1990s as part of a broader study on determining the range of American dog ticks in the province. A passive tick surveillance program was formalized and advertised after the first established blacklegged tick population was reported in Lunenburg county in 2003. The passive surveillance program was operated mainly through the Department of Natural Resources in collaboration with the Public Health Agency of Canada and was a system that allowed the general public, veterinarians, medical health professionals and others to submit ticks collected from across Nova Scotia. The passive surveillance program was supplemented by active surveillance, which is field work that can confirm the establishment of a tick population when evidence of possible tick establishment was discovered through passive surveillance. On September 30, 2011, the passive tick surveillance program was suspended. This allowed for a refocus of tick surveillance activities on active field work to investigate the 'hot spots' identified through the surveillance algorithm, based on 10 years of tick submission data and human case information.

The Nova Scotia tick surveillance algorithm (Appendix C) describes the process by which sites are selected for field work and which types of field work are undertaken at each stage of investigation. Briefly, sites are selected based on indicators from past passive tick surveillance, results from past active tick surveillance, and likely exposures from human case investigations. This evidence is reviewed and sites are prioritized. Once a site is selected for field work, either drag sampling (to detect host seeking ticks) or collection and examination of small mammals (to detect the immature stages of blacklegged ticks and to detect evidence of endemicity of the agent of Lyme disease) is performed. Drag sampling is usually recommended if the site was selected without existing evidence of tick presence (i.e. likely human case exposure only). Drag sampling can provide relatively specific information about the possible establishment of ticks in a new area and is reasonably inexpensive to undertake and can be done in a timely manner. Collection and examination of small mammals is usually recommended if the site was selected based on past tick surveillance, including either passive tick submissions or active tick surveillance through which ticks were found to be present. Because it is much more laborious and expensive to undertake, it is usually not performed unless some evidence of tick establishment has already been obtained. The algorithm then flows through the steps required for an area to be declared endemic (Appendix C). The tick surveillance algorithm also notes other information sources that may contribute to the identification and prioritization of sites for field work in the future (e.g. PHAC risk maps, seroprevalence study, etc.).

The map of endemic areas in Nova Scotia (Figure 10), the Guidelines for Clinical Practice by the Infectious Disease Society of America (13), the laboratory testing guidelines by the Canadian Public Health Laboratory Network (14), and the tick surveillance algorithm (Appendix C) are complementary documents. The application of these documents results in an integrated human and tick surveillance program in Nova Scotia, whereby all cases that meet a surveillance case definition are reported to public health and all locations of likely exposures outside of known endemic areas are considered for tick surveillance.

NS DHW collaborates with partners within the NS Department of Natural Resources and the Public Health Agency of Canada to coordinate field work and data collection for tick surveillance activities. While climate change models predict that Nova Scotia is very close to having a climate that is suitable for tick establishment across the entire province (15), local ecology including suitable habitat, host availability and other factors will determine the extent to which tick populations will expand and where new populations will establish. Active surveillance for tick populations provides the information required to educate the public about disease risk and prevention and to assist doctors when they are making clinical evaluations of people who present with symptoms consistent with Lyme disease. The tick

surveillance algorithm is used to prioritize field work each year. Field work plans should be reviewed annually and activities revised as appropriate, according to the results of field work conducted and other sources of information about potential risk areas (from research work or other). Long term planning for investigation of tick populations within the province may include ecological niche modeling, reinstating a modified passive tick surveillance program, or other activities. The need to continue to include surveillance for tick-borne diseases other than Lyme disease (such as human granulocytic anaplasmosis and babesiosis) should be seen as a priority.

6.0 Summary

As populations of blacklegged ticks and the bacteria that causes Lyme disease emerge in Nova Scotia, the risk of acquiring Lyme disease is increasing in the province. Currently, the majority of the province's population lives in or near a known Lyme disease endemic area (Figure 10). The proportion of the population in eastern Canada inhabiting areas with established tick populations is expected to increase to over 80% within the next decade (15).

To date, there have been 120 cases of Lyme disease reported in Nova Scotia from 2002 to the end of 2011. Reports of Lyme disease display an increasing trend over time, with a large increase in the number of reported cases in 2011 compared to 2010. The majority (98%) of cases likely acquired in the province were associated with the endemic areas shown on the map in Figure 10. Further investigation is required to understand the relative contributions of various factors, such as increases in the number and size of established tick populations and public and physician awareness of Lyme disease, to the increase.

Through an integrated human and tick surveillance program, evidence will be used to prioritize sites for field investigation to identify new Lyme endemic areas. These areas, associated with an increased risk of exposure to ticks that can transmit Lyme disease, are communicated to the public and physicians in order for appropriate prevention, diagnosis, and treatment to occur.

7.0 Data sources

In Nova Scotia, reporting of cases of Lyme disease to Public Health Services is mandated by the Health Protection Act (16). Through public health case management of Lyme disease, public health staff document demographic, clinical, exposure, treatment, and laboratory information about the case. This information is reported to the Nova Scotia Department of Health and Wellness for provincial surveillance purposes. Further information on the Lyme disease case definitions, reporting procedures, and forms can be found in the Nova Scotia Surveillance Guidelines for Notifiable Diseases and Conditions (4). Information on Lyme disease public health case management and control measures in Nova Scotia can be found in the Nova Scotia Communicable Disease Control Manual (17).

All case data are current as of March 21, 2012.

All population counts were obtained from Statistics Canada, and are estimates based on the 2006 census.

8.0 Limitations

There are limitations to disease and vector surveillance. The following list describes known limitations.

1. Under-reporting and misclassification of cases is common in all surveillance systems. Not every case of Lyme disease in the province is reported to NS DHW, and some cases that are reported may not be true cases of Lyme disease. Rates of under-reporting and/or misclassification of cases may vary across the province.
2. Public and physician awareness of the signs, symptoms and current epidemiology of Lyme disease may influence the surveillance program's ability to capture and classify cases. Consequently, a sudden or marked change in reported cases does not necessarily represent a true change in disease incidence, and may reflect a change in surveillance practices of reporting physicians.
3. Surveillance data are provisional and may change as new information is received. The time lag between symptom onset and case reporting to the provincial level can be months. While efforts have been made to complete all management for cases with onset up to December 31 2011 in this report, cases with symptom onset in this time period may arise post-publication.
4. The surveillance case definition for Lyme disease was modified in 2008. These changes must be considered when attempting to interpret trends.
5. Episode date is collected for each reported case. The episode date assigned to a case is the earliest known date. In this report, symptom onset refers to episode date. When symptom onset was unavailable, the closest available date (either specimen collection date or clinical diagnosis date) was assigned.
6. Defining the borders of endemic areas is difficult and artificial. The range of blacklegged ticks likely varies from season to season and is unlikely to be completely congruent with the large circular endemic areas depicted on the map of Lyme endemic areas. With limited resources, field work has been directed to the identification of new endemic areas rather than characterizing the exact size, location, number of discrete populations, rate of expansion, or infection prevalence in ticks from areas where Lyme disease is known to be endemic.

9.0 References

1. D. L. Heymann, *Control of Communicable Diseases Manual* (American Public Health Association), pp. 315-320 (2004). [18th Edition]
2. M. E. Aguero-Rosenfeld, G. Wang, I Schwartz, G.P. Wormser, Diagnosis of Lyme Borreliosis. *Clin Micro Rev*. **18**, 484-509 (2005).
3. M. G. Morshed, J.D. Scott, S. N. Banerjee, et al. First isolation of Lyme disease spirochete, *Borrelia burgdorferi*, from blacklegged tick, *Ixodes scapularis*, removed from a bird in Nova Scotia, Canada. *CCDR*. **25**, 153-154 (1999).
4. Nova Scotia Department of Health and Wellness Surveillance Guidelines for Notifiable Diseases and Conditions. http://www.gov.ns.ca/hpp/populationhealth/surveillanceguidelines/
5. N. K. Madhav, J. S. Brownstein, J. I. Tsao, D. Fish. A dispersal model for the range expansion of blacklegged tick (*Acari: Ixodidae*). *J Med Entomol*. **41**, 842-852(2004).
6. T. G. T. Jaenson, D.G. E. Jaenson, L. Eisen, et al. Changes in the geographical distribution and abundance of tick *Ixodes ricinus* during the past 30 years in Sweden. *Parasites and Vectors*. **5**, doi:10.1186/1756-3305-5-8 (2012).

7. D. C. Duffy, S. R. Campbell. Ambient air temperature as a predictor of activity of adult *Ixodes scapularis*(*Acari: Ixodidae*). *J Med Entomol*. **31**, 178-180 (1994).

8. The Weather Network. March 5, 2012, *accessed March 14 2012*. www.theweathernetwork.com/news/storm_watch_stories3&stormfile=Winter_s_impact_on_the_2012_spring_season_in_Atlantic_Canada_and_Quebec_05_03_2012

9. R. M. Bacon, K. J. Kugeler, P. S. Mead. Surveillance for Lyme disease – United States, 1992-2006. *MMWR*. **57(SS10)**, 1-9 (2008).

10. B. Henry, M. Morshed. Lyme disease in British Columbia: Are we really missing an epidemic? *BC Med Jour*. **53**, 224-229 (2011).

11. Centres for Disease Control and Prevention. April 12, 2011, *accessed March 19 2012*. http://www.cdc.gov/lyme/transmission/index.html

12. Consensus Conference on Lyme Disease. *Can Med Assoc J*. **144**, 1627-1632 (1991).

13. G. P. Wormser, R. J. Dattwyler, E. D. Shapiro, et al. The clinical assessment, treatment, and prevention of Lyme disease, human granulocytic anaplasmosis, and babesiosis: Clinical practice guidelines by the Infectious Diseases Society of America. *Clin Infect Dis*. **43**, 1089-1134 (2006).

14. Canadian Public Health Laboratory Network. The laboratory diagnosis of Lyme borreliosis: Guidelines from the Canadian Public Health Laboratory Network. *Can J Infect Dis Med Microbiol*. **18**, 145-148 (2007).

15. P. A. Leighton, J. K. Koffi, Y. Pelcat, et al. Predicting the speed of tick invasion: an empirical model of range expansion for the Lyme disease vector *Ixodes scapularis* in Canada. J Appl Ecol: doi: 10.1111/j.1365-2664.2012.02112.x (2012).

16. Nova Scotia Health Protection Act. 2004. http://nslegislature.ca/legc/statutes/healthpr.htm

17. Nova Scotia Communicable Disease Control Manual. http://www.gov.ns.ca/hpp/cdpc/cdcmanual/

APPENDIX A: DISTRICT HEALTH AUTHORITIES IN NOVA SCOTIA

DHA 1 – South Shore Health

DHA 2 – South West Health

DHA 3 – Annapolis Valley Health

DHA 4 – Colchester East Hants Health

DHA 5 – Cumberland Health

DHA 6 – Pictou County Health

DHA 7 – Guysborough Antigonish Strait Health

DHA 8 – Cape Breton District Health

DHA 9 – Capital Health

APPENDIX B: CASE DEFINITIONS

Case definition 2002-2007

Confirmed case:

Erythema migrans or at least one late manifestation with laboratory confirmation of infection

Case definition: 2008-present

Confirmed case:

Clinical evidence of illness with a history of residence in, or visit to, an endemic area and laboratory evidence of infection

Probable case:

Clinical evidence of illness without a history of residence in, or visit to, an endemic area and with laboratory evidence of infection

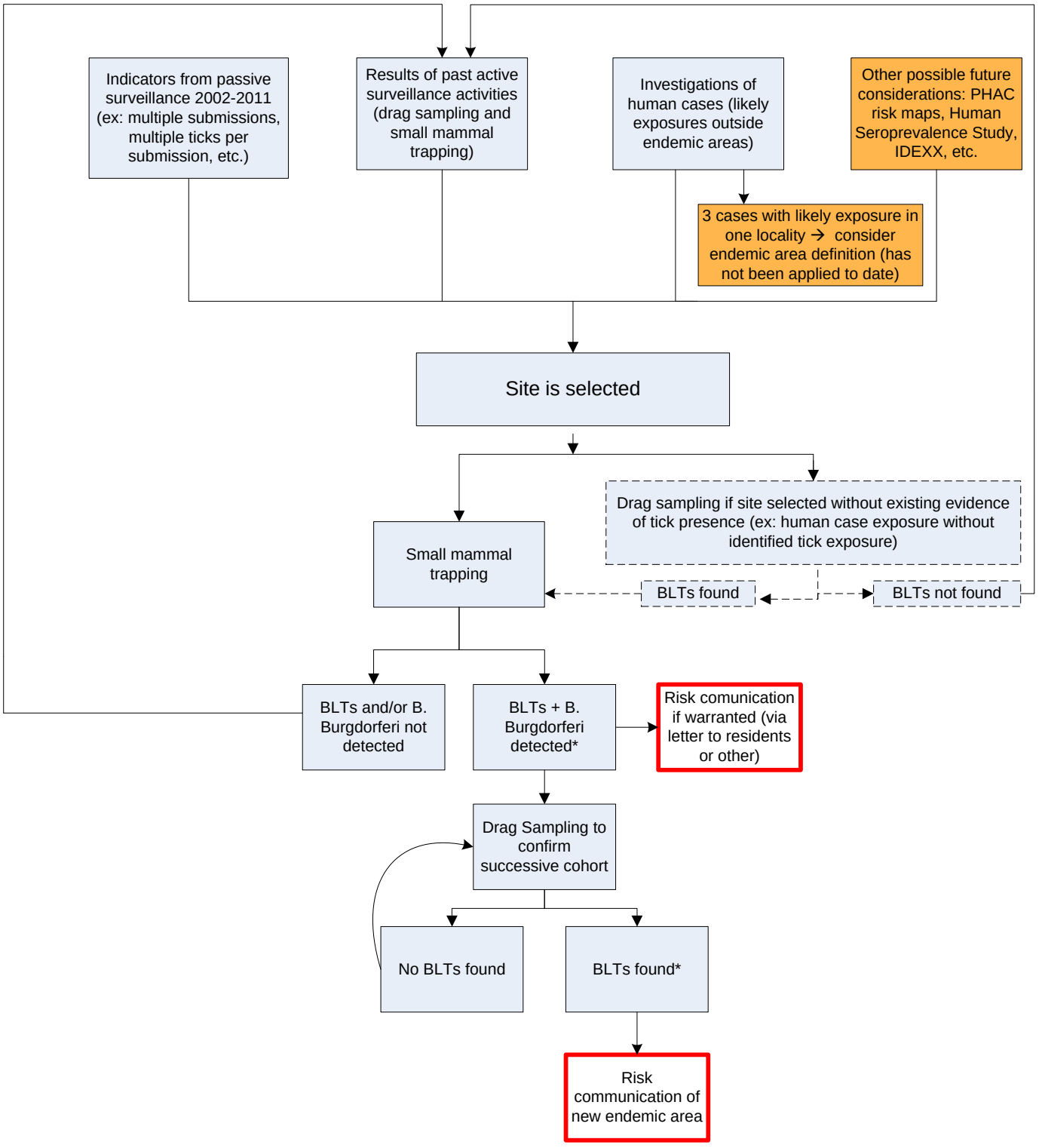
OR

Clinician-observed EM without laboratory evidence but with history of residence in, or visit to, an endemic area

-An endemic area is one in which the risk or transmission of Lyme disease to humans is supported by either (a) the presence of an established vector population known to be infected with *Borrelia Burgdorferi*, or (b) the occurrence of at least three confirmed human cases, with adequate histories, in which there is no history of exposure in previously identified endemic areas (three confirmed cases must be based on the pre-2008 case definition). The geographic limits of the endemic area will be defined by the provincial or territorial health authorities.

-Laboratory evidence of infection is a positive serologic test using the two step approach, namely ELISA screening followed by Western Blot assays on all ELISA positive or equivocal samples (14)

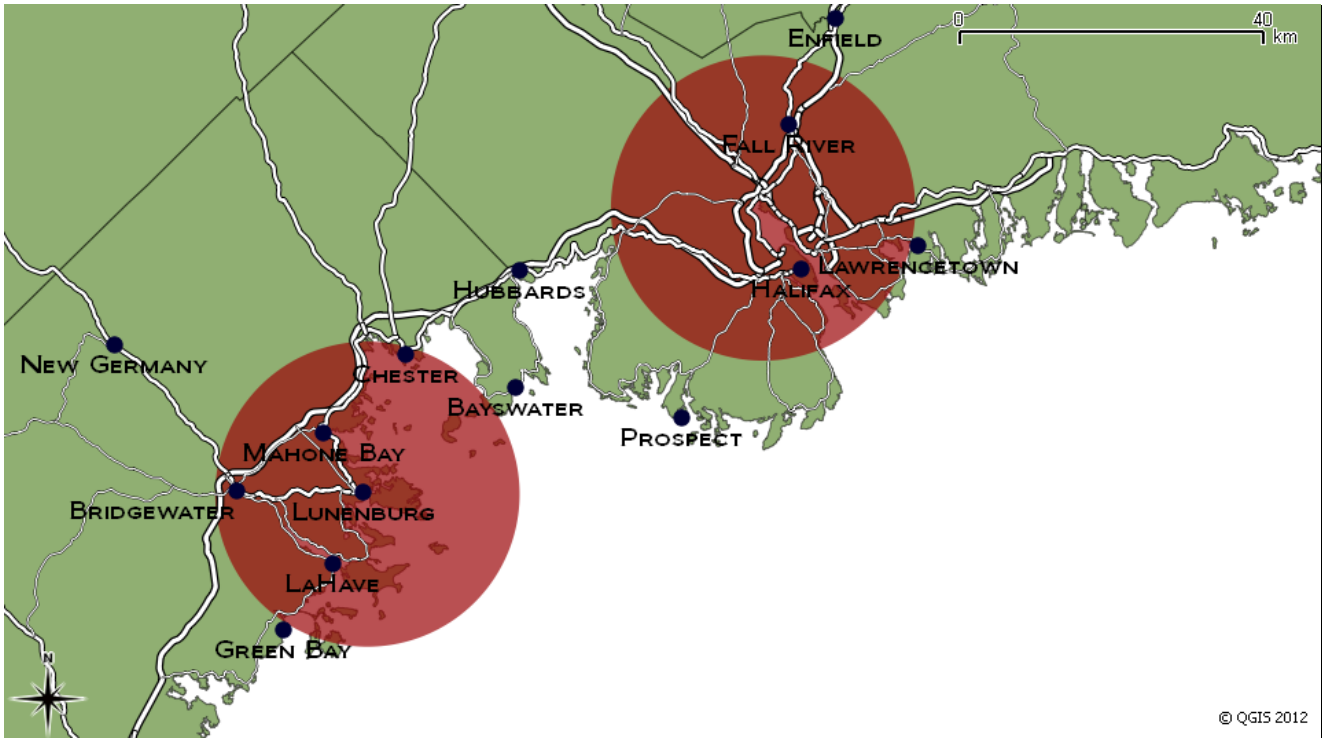
APPENDIX C: TICK SURVEILLANCE ALGORITHM



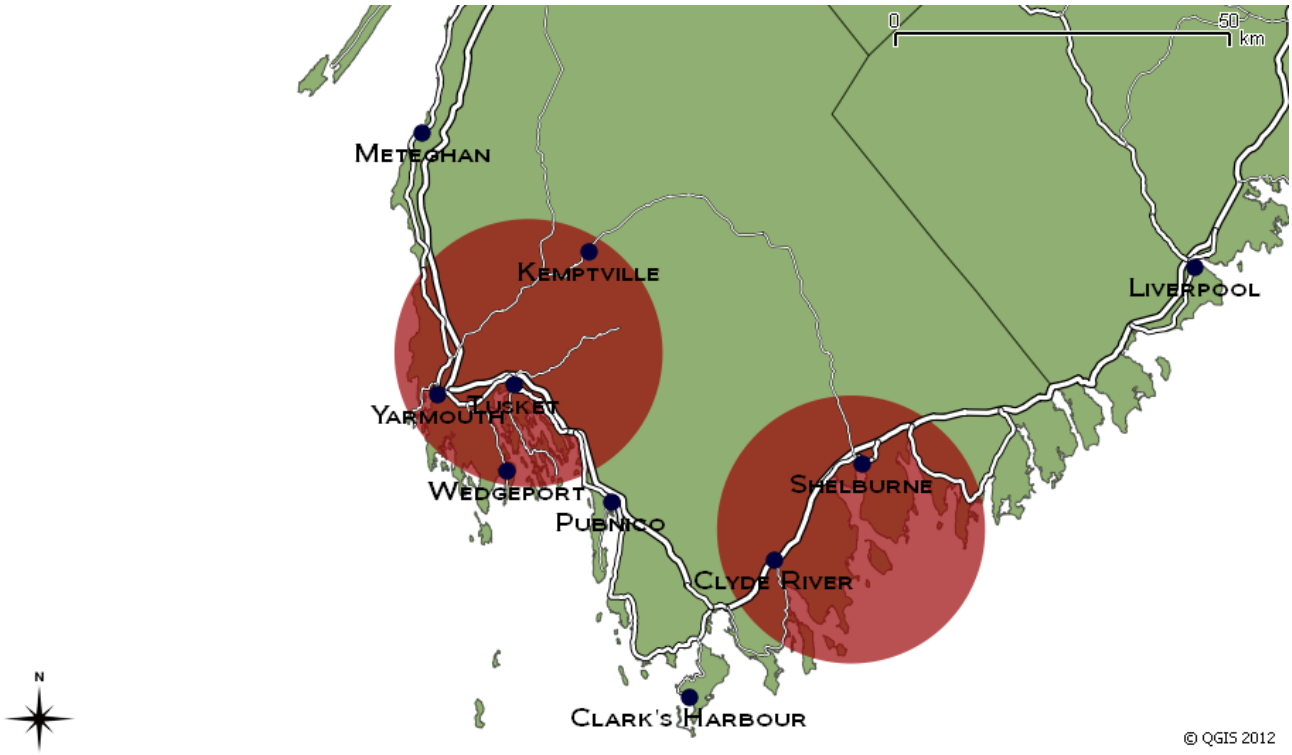
*If not all life stages of BLTs found, further work required.

APPENDIX D: LYME DISEASE ENDEMIC AREAS IN NOVA SCOTIA, 2012

Lunenburg and Halifax counties



Shelburne and Yarmouth counties



Pictou county