

Vector-Borne Diseases

2016 Summary Report



June 2017

Public Health Ontario

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Contents

Purpose	1
West Nile Virus	1
Surveillance Data – Results and Interpretation of Findings.....	2
Eastern Equine Encephalitis Virus (EEEV)	7
Surveillance Data – Results and Interpretation of Findings.....	8
Lyme Disease	9
Surveillance Data – Results and Interpretation of Findings.....	9

Purpose

This report summarizes the 2016 data on the vectors that transmit West Nile virus (WNV), eastern equine encephalitis virus (EEEV) and Lyme disease. The target audience of this report is public health unit (PHU) staff associated with vector-borne diseases programs.

This report does not cover human data on these diseases; this information will be made available through Public Health Ontario (PHO)'s [Reportable Disease Trends in Ontario interactive tool](#) and is also available to Ontario's PHUs via the Infectious Diseases [Query tool](#). This report also does not cover data on the vectors that transmit malaria and yellow fever, given that these are both travel-related diseases with no endemic transmission in Ontario. All mosquito and tick data has been taken from the unpublished databases maintained by PHO, based on data compiled by health unit surveillance activities, or data acquired from the National Microbiology Laboratory (NML), of the Public Health Agency of Canada.

West Nile Virus

WNV is a mosquito-borne viral disease that was first recognized in Africa in the 1930s. The virus primarily circulates between birds and bird-biting mosquitoes (also referred to as amplification vectors). It is transmitted to humans when certain species of mosquito acquire the virus from biting an infected bird and then bite a human. The species of mosquitoes that transmit the virus from birds to humans are called bridge vectors. The principal bridge vectors for WNV in Ontario are the species *Culex pipiens/restuans*. *Culex pipiens/restuans* can be found in significant numbers in urban areas, making WNV primarily an urban health risk.

WNV was first detected in New York in 1999 and since then has spread across most of North America. WNV was first detected in Ontario in birds in 2001, with the first human cases following in 2002. WNV became reportable in Ontario in 2003. Since then, WNV activity has varied from year to year.

Since 2002, PHUs in Ontario have conducted annual WNV mosquito surveillance from June to October. Mosquito surveillance serves as an [early warning system for WNV](#). It also allows for the tracking of other mosquito-borne diseases, alerts Ontario's public health community to the introduction of new mosquito species and facilitates the assessment of potential risks posed by emerging mosquito-borne diseases. Mosquito surveillance involves placing mosquito traps in various urban locations within a PHU's geographic area and then sending the collected mosquitoes to service providers for species identification and viral testing. Only certain mosquito species are tested for WNV.

Results from mosquito surveillance have included:

- *Ochlerotatus japonicus* (a possible WNV vector) had spread to most Ontario PHUs since first identified in Ontario in 2001 in a single PHU.
- In 2016, mosquito surveillance also detected a very small number (n=4) of *Aedes albopictus* (Asian tiger mosquito), a potential vector of dengue, chikungunya and Zika viruses. *Aedes albopictus* is not established in Ontario and there is no endemic risk of these diseases, as the climate is not suitable for *Ae. albopictus* establishment; however, it is still important to note its occurrence and monitor its activity.

Data on WNV human cases, mosquito species and testing results for WNV and WNV-infected horses in Ontario are available through an interactive tool on [PHO's website](#) that includes interactive tables, figures, and maps. The data are available from 2002 onwards and are updated on a weekly basis.

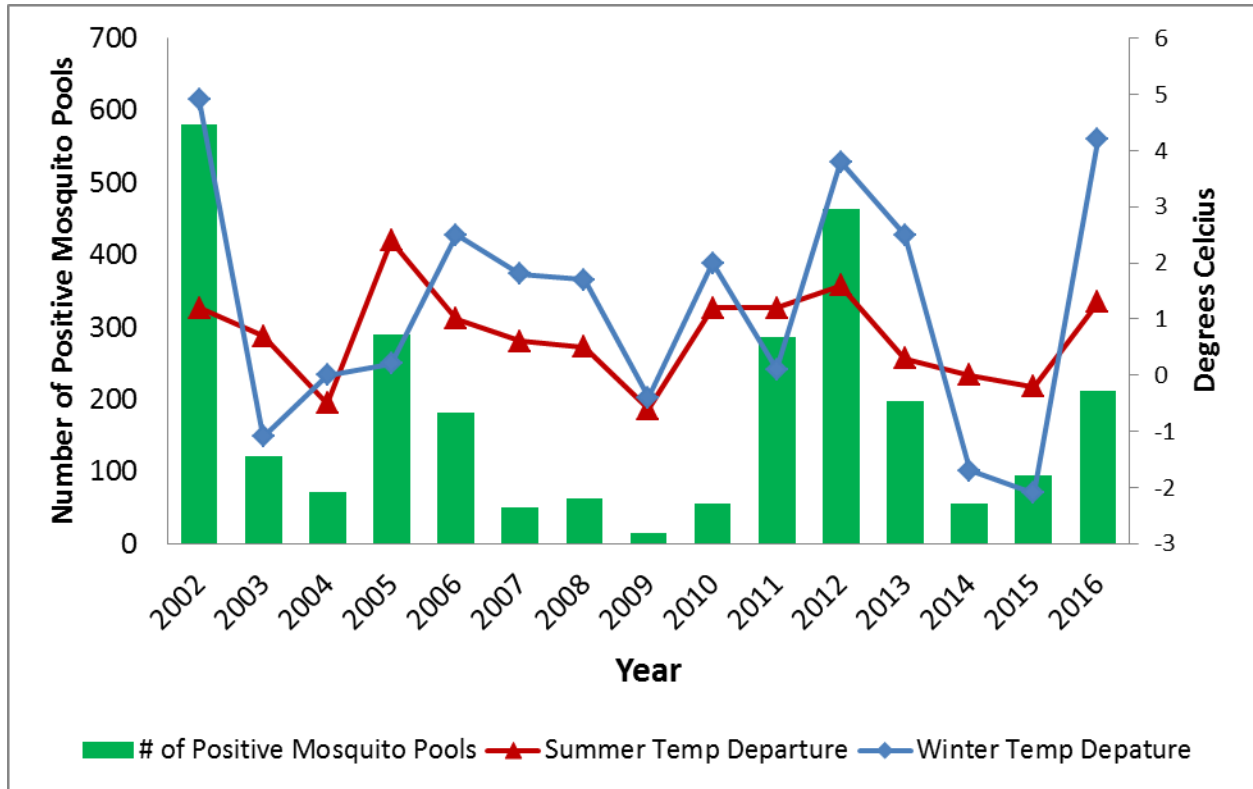
Surveillance Data – Results and Interpretation of Findings

Positive mosquito pools peaked in 2012, followed by a decline in 2013 and 2014 and an increase in 2015 and 2016. There were 211 positive pools in 2016 (Figure 1).

Temperature

Temperature has an important influence on the rate of mosquito development and the rate at which the virus can replicate inside the mosquito vectors. Warmer temperatures usually result in more mosquitoes that may carry WNV, resulting in increased risk of transmission to humans. Conversely, fewer positive mosquitoes lead to fewer human cases. The increase in the number of positive mosquito pools, compared to the relatively low number of positive mosquito pools in 2015 could be partially attributed to higher summer temperatures in June, July and August 2016. Based on Environment Canada's temperature rankings between 1948 and 2016, 2016 had the eighth warmest (1.3°C above average) summer on record (Figure 1). Additionally, colder winters can have a negative effect on the overwintering *Cx. pipiens/restuans* adult females as more will die as a result of colder temperatures. However, the winter (December 2015 to February 2016) was the second warmest (4.2°C above average) on record for the Great Lakes/St. Lawrence region (Figure 1).

Figure 1: Number of WNV-positive mosquito pools and average winter and summer temperature departures: Ontario, 2002–16



Data Sources:

Mosquito data: PHO mosquito database [extracted 2016 Dec 7]

Weather Data: Environment and Climate Change Canada. Annual 2016: Climate Trends and Variations. Ottawa, ON: Her Majesty the Queen in Right of Canada; 2017. Available from: <https://www.ec.gc.ca/sc-cs/default.asp?lang=En&n=A3837393-1>

Note: Temperature departures are computed at each observing station and for each year by subtracting the relevant baseline average (defined as average over 1961-1990 reference period) from the relevant seasonal and annual values. Additional information can be found on the [Environment and Climate Change Canada website](https://www.ec.gc.ca/sc-cs/default.asp?lang=En&n=A3837393-1). The number of mosquito traps varies yearly and health units focus mosquito trapping in areas of concern, which may affect the frequency of positive mosquito pools.

Species

In 2016, the species of mosquitoes that tested positive for WNV were *Cx. pipiens/restuans*, *Ae. vexans*, *Och. japonicus*, *Och. triseriatus* and *Culex* species. *Culex pipiens/restuans* tested positive for WNV most frequently; however, *Cx. pipiens/restuans* are preferentially targeted for WNV testing as these vectors are primarily responsible for human cases.

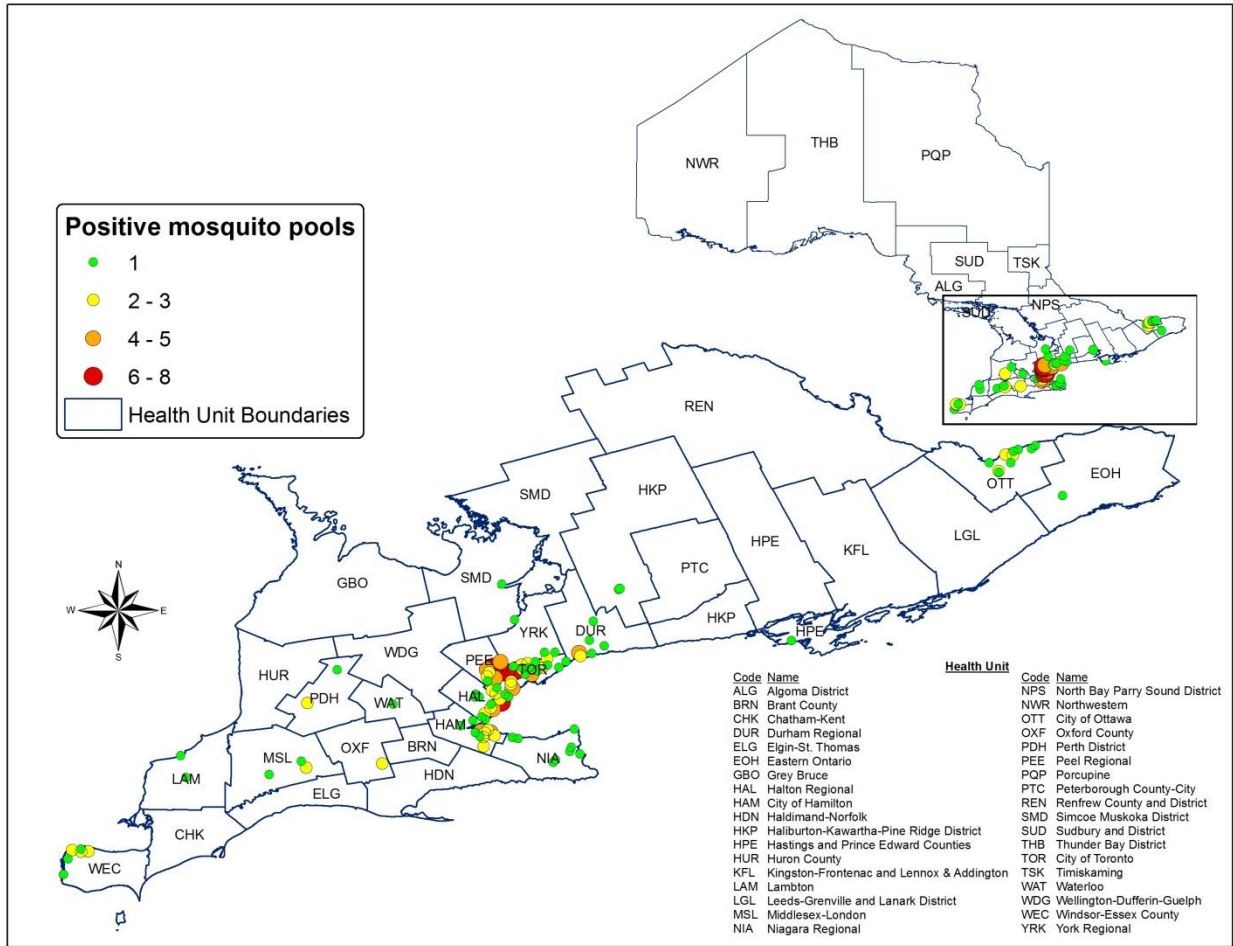
Geographic Location

In 2016, the majority of positive mosquito pools were reported in the Golden Horseshoe area, as well as the urban areas of Southwestern and Southeastern Ontario (Figure 2). These areas are predominately urban and have large numbers of catch basins with standing water, which are ideal development sites for the main mosquito vectors of WNV.

Figure 3 shows the minimum infection rate (MIR), which is an estimation of the minimum number of positive mosquitoes in the environment. Stated as the number of positive mosquitoes per 1000 mosquitoes tested, it is a population-adjusted rate used for comparison and analysis and is calculated by the formula $(\# \text{ WNV positive pools} / \text{total } \# \text{ of mosquitoes tested}) / 1000$. While MIR can be used to indicate the level of positive mosquitoes in the environment, it can be somewhat misleading in areas with lower numbers of mosquito traps. In those areas, one positive mosquito pool can make the MIR seem quite large, when compared to the level of WNV activity.

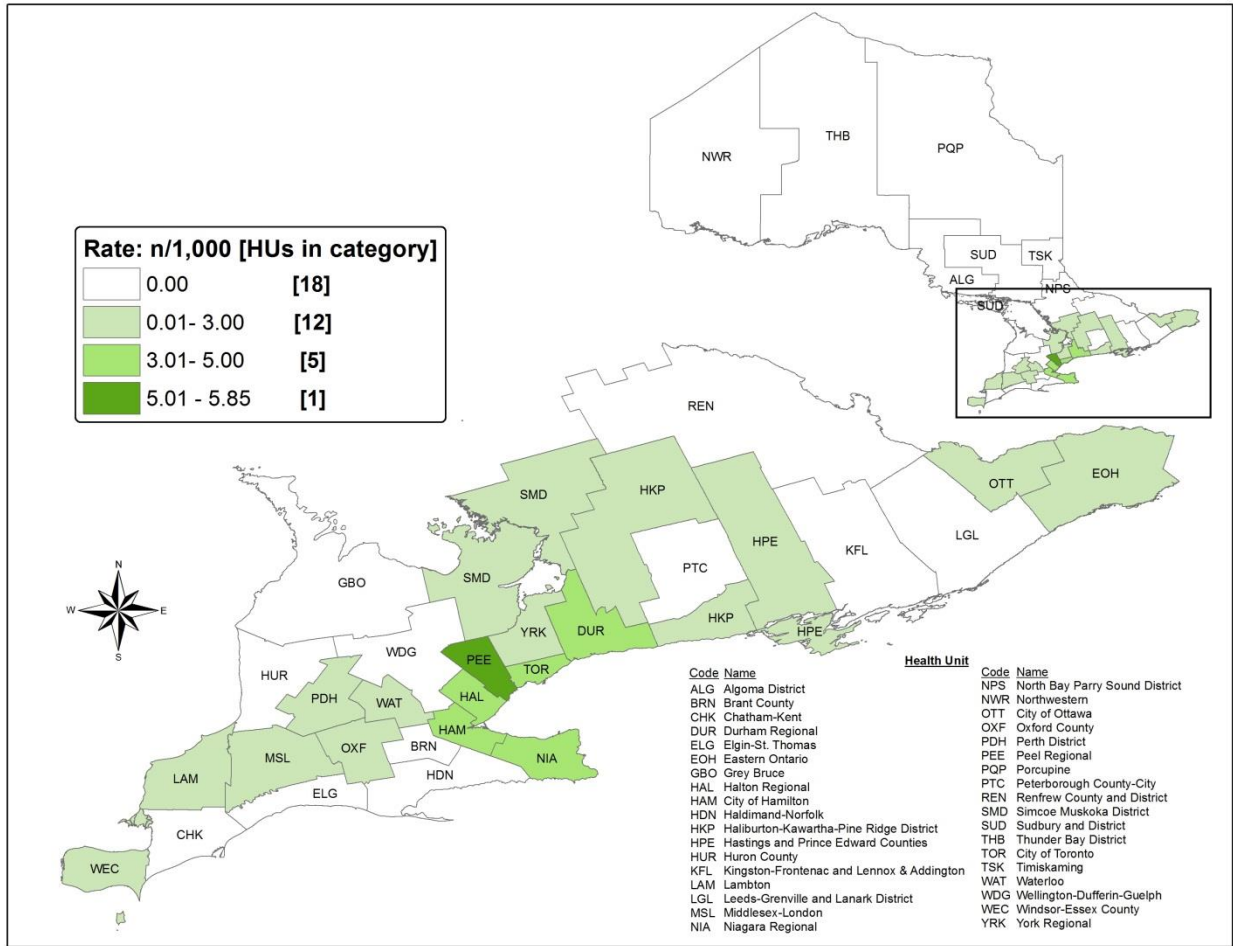
As WNV and its associated mosquito vectors are very dependent on climatic conditions, we anticipate that Ontario will continue to see variable WNV activity from year to year.

Figure 2: Location and number of mosquito pools positive for West Nile Virus: Ontario, 2016



Data source: PHO mosquito database [extracted 2016 Dec 7]

Figure 3: Minimum infection rate of WNV-positive mosquito pools: Ontario, 2016



Data source: PHO mosquito database [extracted 2016 Dec 7]

Eastern Equine Encephalitis Virus (EEEV)

EEEV is also a mosquito-borne virus that circulates between birds and mosquitoes, with bridge vectors transmitting the virus to humans and horses. Like WNV, horses and humans are dead-end hosts. Although the mosquito vector cannot acquire the virus from such hosts, human and equine infections are an indicator of EEEV positive mosquitoes in the area. It differs from WNV in that the main mosquito vector inhabits persistently flooded forests that tend to exist in rural areas. As a result, EEEV is a more of a rural health risk, than urban. To date, only one locally-acquired human case of EEEV has been reported in Ontario (2016). Like WNV, most infected people will be asymptomatic; however, the risk of death among those who develop neurological symptoms is higher for those with EEEV compared to WNV. It is estimated that one third of all people infected with EEEV may have serious morbidity or mortality. EEEV infections are not designated as a reportable disease in Ontario unless an infected person develops EEEV-associated encephalitis.

EEEV has been reported in Ontario's equine population since the 1930s. As of 2009, the virus has been detected sporadically in the Ontario mosquito population. As of January 1, 2013 laboratory-confirmed cases of WNV and EEEV in animals are notifiable to the Chief Veterinarian for Ontario under [Ontario Regulation 2777/12](#) in accordance with the *Animal Health Act*. This change could lead to an increase in reported WNV and EEEV equine infections.

Culiseta melanura is the main amplification vector for EEEV in Ontario and the eastern U.S. and is mainly found in flooded forests and swamps. With this species primarily inhabiting swampy areas, the majority of equine cases in Ontario occur in areas adjacent to swamps or flooded forests, making this a rural health risk. Possible bridge vectors include *Ae. vexans* and *Coquillettidia perturbans*. These bridge vectors are more easily captured in Ontario's mosquito light-traps than *Cs. melanura*. They are also thought to readily bite humans and can be found in both urban and rural areas. This is important because the greatest risk to humans will be present if EEEV is found in the bridge vectors.

During a three year EEEV mosquito pilot testing period from 2011 to 2013, a total of 249,775 mosquitoes were tested from 18,177 mosquito pools. Of those, 534 mosquitoes were identified as *Cs. melanura* and were in 181 pools. Of all 18,177 pools tested for EEEV, only one tested positive (*Cq. perturbans*) in 2013, that pool being collected in the Eastern Ontario PHU. Based on the low number of *Cs. melanura* identified and the one positive pool result over the three year period, PHO recommended that PHUs revert to the previous WNV testing order of preference listed in the Ministry of Health and Long-Term Care's 2010 West Nile Virus Preparedness and Prevention Plan.

Surveillance Data – Results and Interpretation of Findings

Only one human case of EEEV has ever been recorded in Ontario (2016). In 2016, no mosquitoes tested positive for EEEV (Table 1).

EEEV has been reported in Ontario in horses, emus, and pheasants dating back to 1938 (Table 1). In 2016, no cases of EEEV equine were reported by the Ontario Ministry of Agriculture, Food, and Rural Affairs. Ontario animal cases have occurred in predominantly rural PHUs with the cases occurring in different locations, of Southern Ontario, each year.

Like WNV, EEEV is influenced by weather and can have yearly variations. Additionally, there is a vaccine available for the equine population. This can influence the number of equine cases reported each year, based on the extent to which owners vaccinate their horses.

Table 1: Number of *Culiseta melanura* captured, EEEV-positive mosquito pools and horses: Ontario, 2002–16.

Year	Number of <i>Cs. Melanura</i>	Number of EEEV-Positive Mosquito Pools	Number of EEEV Horse Cases
2002	15	0	1
2003	5	0	11
2004	26	0	2
2005	11	0	no data
2006	127	0	no data
2007	32	0	0
2008	438	0	4
2009	298	12	2
2010	218	3	3
2011	222	0	4
2012	67	0	0
2013	245	1	1
2014	631	0	24
2015	102	0	5
2016	26	0	0

Data sources:

Horse data: Ontario. Ministry of Agriculture, Food and Rural Affairs. Equine neurological disease [Internet]. Guelph, ON: Queen's Printer for Ontario; c2016 [modified 2017 Feb 22; cited 2017 Jun 21]. Available from:

<http://www.omafra.gov.on.ca/english/livestock/horses/westnile.htm>

Mosquito data: PHO mosquito database [extracted 2016 Dec 7]

Lyme Disease

Lyme disease is a tick-borne bacterial disease transmitted to humans by the bite of an infected blacklegged tick (*Ixodes scapularis*). Blacklegged ticks are usually associated with deciduous or mixed forests, with the majority of human exposures occurring where blacklegged ticks have become established in those types of environments. Lyme disease was first recognized in North America in the late 1970s and has been reportable in Ontario since 1991. In the early 1990s, there was only one known Lyme disease risk area in Ontario, at Long Point Provincial Park. Since then, Ontario has seen an increase in the distribution of blacklegged ticks and an expansion of their populations, particularly in Eastern Ontario. With this increase in blacklegged tick populations, there has also been an increase in locally acquired human cases of Lyme disease. The majority of these human cases have occurred in areas associated with the blacklegged tick populations.

Over the years, there have been changes to the passive tick surveillance system in Ontario. Prior to 2009, ticks could be submitted from sources other than humans. Due to the volume of ticks submitted, from 2009 to the present, only ticks found on humans are accepted for identification. In 2014, due to the number of tick submissions and the understanding of the established epidemiology of Lyme disease in their jurisdictions, several PHUs in Eastern Ontario discontinued passive tick surveillance and have switched to programs of active tick surveillance. These changes will result in reductions in passive tick surveillance data in these jurisdictions.

Surveillance Data – Results and Interpretation of Findings

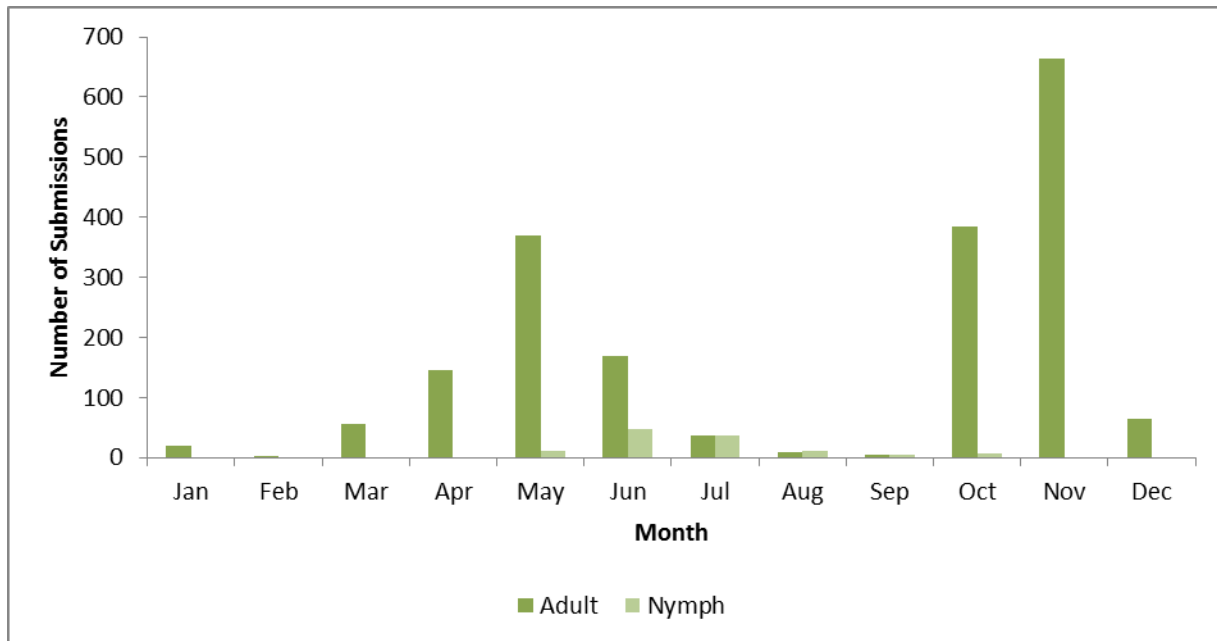
Species

Of the 4,643 tick samples submitted to PHO during 2016, approximately 44 per cent were identified as blacklegged ticks. The American dog tick made up the second largest number of ticks identified at approximately 42 per cent. The annual number of blacklegged tick samples submitted to PHO from 2014 to 2016 was 2,126, 1,903, and 2,041, respectively. Of the 2,041 blacklegged tick samples from 2016, the three PHUs with greater than 10 per cent of the total submissions were the City of Ottawa, Haldimand-Norfolk and Hastings and Prince Edward Counties. As some of the Eastern region PHUs switched from passive tick surveillance to active tick surveillance, this has significantly reduce their submission numbers. Other PHUs saw an increase in local submissions, which could be due to a number of factors, especially new [estimated Lyme disease risk areas](#) being identified in the PHU or increased knowledge about submitting ticks. In 2015, the Rouge Park was identified as a new Lyme disease risk area. This park borders Durham Regional, City of Toronto and York Region PHUs, all of which saw an increase in blacklegged tick submissions over the last three years.

Of the blacklegged ticks that were submitted, 94.3 percent were in the adults, with nymphs accounting for 5.6 per cent. This is expected as adult ticks are larger and more noticeable to humans than immature stages such as nymphs. Adult blacklegged ticks are primarily submitted in the spring and fall, while the nymphs are mainly submitted in the summer (Figure 4). This also aligns with the typical timeline of when these stages are most active in the environment. Additionally, the majority of human cases in eastern

North America are acquired in the summer months, a consequence of transmission from nymphal ticks whose small size results in them going unnoticed while feeding.

Figure 4: Number of *Ixodes scapularis* samples by month and stage submitted to PHO: Ontario, 2016

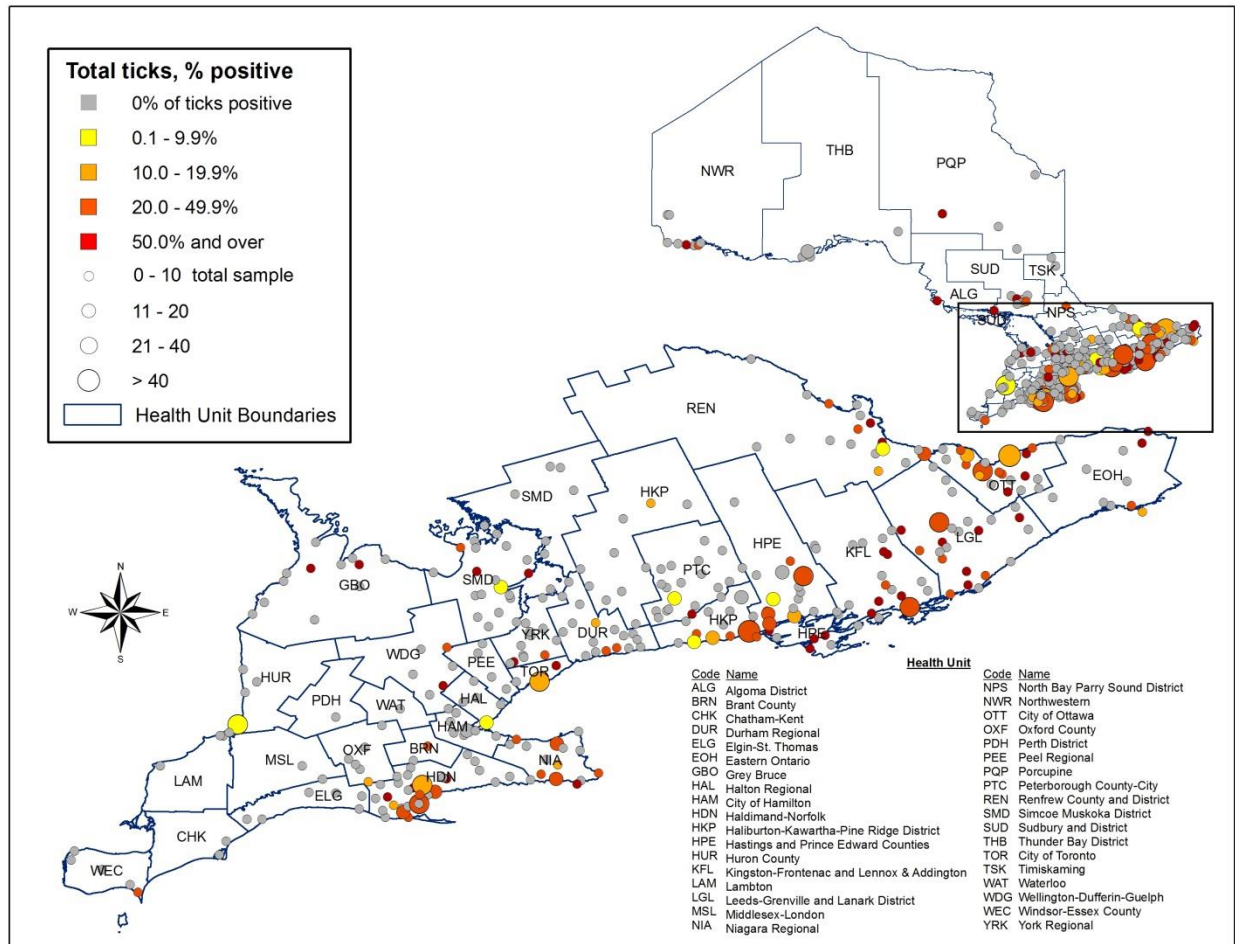


Data source: PHO tick database [extracted 2017 May 11].

Geographic Location

There were 1,399 blacklegged tick samples submitted to the NML for *B. burgdorferi* testing that had an identifiable location of acquisition within Ontario. Figure 5 shows the locations of these samples, along with the per cent that were positive for *B. burgdorferi*. Some of these locations of acquisition are noted by a city/town and so the corresponding dot will be located at the central location of that city/town. Even with the reduction of blacklegged ticks from portions of eastern Ontario, a relatively large number were still being submitted from this region. Another area with relatively higher numbers of tick submissions was along the north shore of Lake Erie, which is expected given the length of time this area has had established blacklegged tick populations. The Lake Erie and Eastern Ontario areas had the highest proportions of positive ticks, which coincide with the number of ticks being submitted, and the length of time they have had established tick populations. It should be noted that locations with low numbers of submitted ticks but high levels of positivity could be attributed to ticks being deposited off of migratory birds, and do not necessarily indicate an established blacklegged tick population. As blacklegged ticks can be transported by migratory birds almost anywhere in the province, it is not uncommon to find blacklegged ticks being submitted from areas where previous infected blacklegged ticks have not been documented. These ticks may be present during the tick season, but the habitat and/or climatic conditions are not suitable for them to establish a population.

Figure 5: Number of *Ixodes scapularis* samples and percent positive for *Borrelia burgdorferi* based on most-likely location of acquisition: Ontario, 2016



Data sources:

PHO Tick Database [extracted 2017 May 11]

Public Health Agency of Canada, National Microbiology Laboratory passive tick data [extracted 2017 May 11]

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