# Vector-Borne Diseases

## 2017 Summary Report

September 2018

## Public Health Ontario

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## Disclaimer

# Contents

# Purpose and intended audience

This report summarizes the 2017 data on the vectors that transmit West Nile virus (WNV), eastern equine encephalitis virus (EEEV) and Lyme disease. The intended audience for this report is public health unit (PHU) staff working in, or with, the vector-borne disease programs.

Out of scope for this report are human data on these diseases; this information will be made available through Public Health Ontario's Reportable Disease Trends in Ontario interactive tool and is also available to Ontario's PHUs via the Infectious Diseases Query tool.

# West Nile Virus

## Background

WNV is a mosquito-borne viral disease that was first recognized in Africa in the 1930s. The virus 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 *Culex pipiens* and *Culex restuans*. *Culex pipiens*/*restuans* are most common 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.

## Mosquito surveillance in Ontario

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. The program also allows for the tracking of other mosquito-borne diseases, alerting Ontario's public health community to the introduction of new mosquito species and facilitating the assessment of risks posed by emerging mosquito-borne diseases. Mosquito surveillance involves placing mosquito traps in various urban locations within a PHU and then sending the collected mosquitoes to service providers for species identification and viral testing. Only certain mosquito species are tested for WNV.

# Surveillance data – Results and interpretation of findings

Data on WNV 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 during the mosquito season.

Positive mosquito pools peaked in 2012, followed by a decline in 2013 and 2014 and increased again starting in 2015 through 2017. In 2017, there were 409 positive pools (Figure 1).

In 2016, routine WNV mosquito surveillance detected a very small number (n=4) of *Aedes albopictus* (Asian tiger mosquito) in the Windsor-Essex County (WEC) Health Unit. These findings led to additional surveillance for this species in WEC and the subsequent discovery of *Ae. aegypti* (yellow fever mosquito) in WEC in the fall of 2016. In 2017, an enhanced surveillance program was set up in WEC to look for these exotic *Aedes* species, with both species detected in 2017. This enhanced surveillance program will continue in WEC for the next three years.

## 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. Additionally, colder winters can have a negative effect on the overwintering *Cx. pipiens*/*restuans* adult females, as more will die due to colder temperatures. Based on Environment Canada's temperature rankings between 1948 and 2017, the year 2017 had the fourth warmest winter, December 2016 to February 2017 (3.8°C above average), but the 45$^{th}$ warmest summer (-0.1°C below average), on record (Figure 1).

## Positive pools

In 2017, the species of mosquitoes that tested positive for WNV were:

- *Cx. pipiens/restuans*
- *Ae. vexans*
- *Ochlerotatus japonicas*
- *Och. triseriatus*
- *Culex* species.

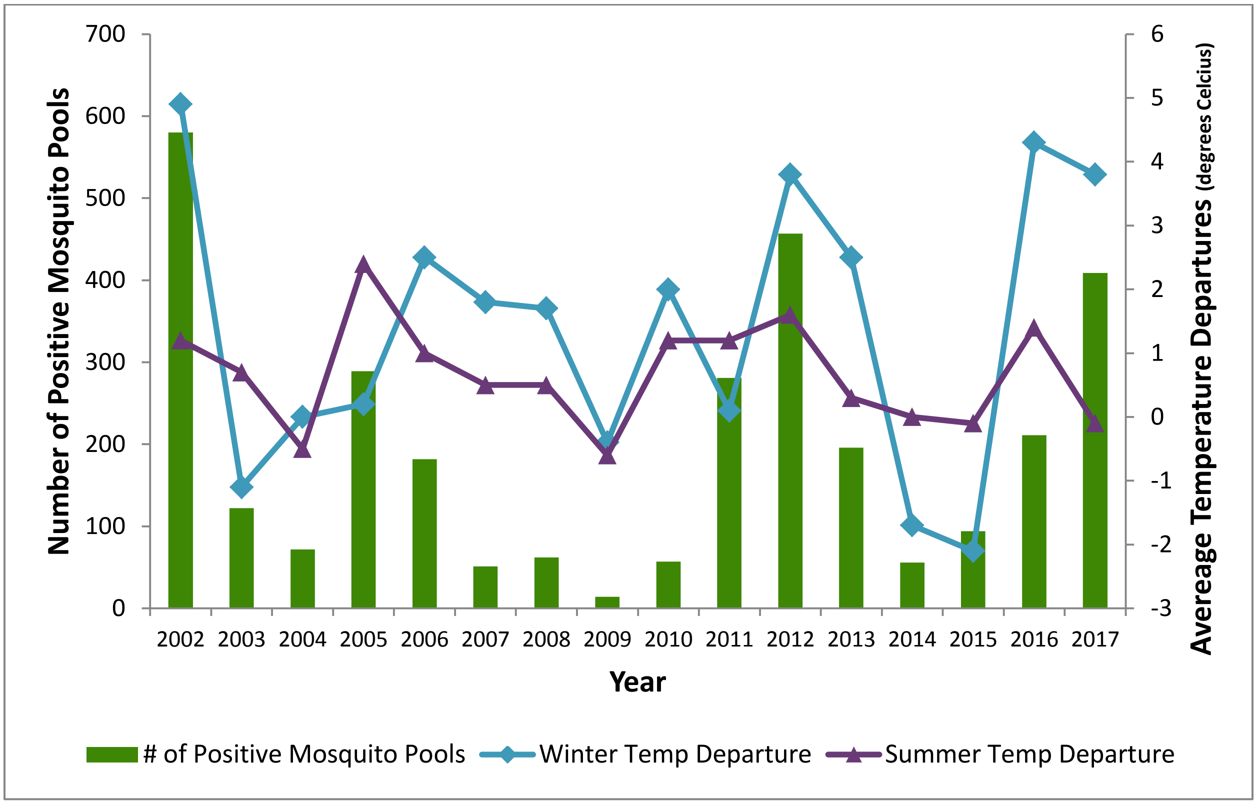
*Culex pipiens/restuans* tested positive for WNV most frequently; however, *Cx. pipiens/restuans* are preferentially targeted for WNV testing, as these vectors are primarily responsible for human cases.

In 2017, 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 (# WNV positive pools/total # of mosquitoes tested)/1000.

While MIR can be used to indicate the number 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 actual 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 1: Number of WNV-positive mosquito pools and average winter and summer temperature departures: Ontario, 2002–17**

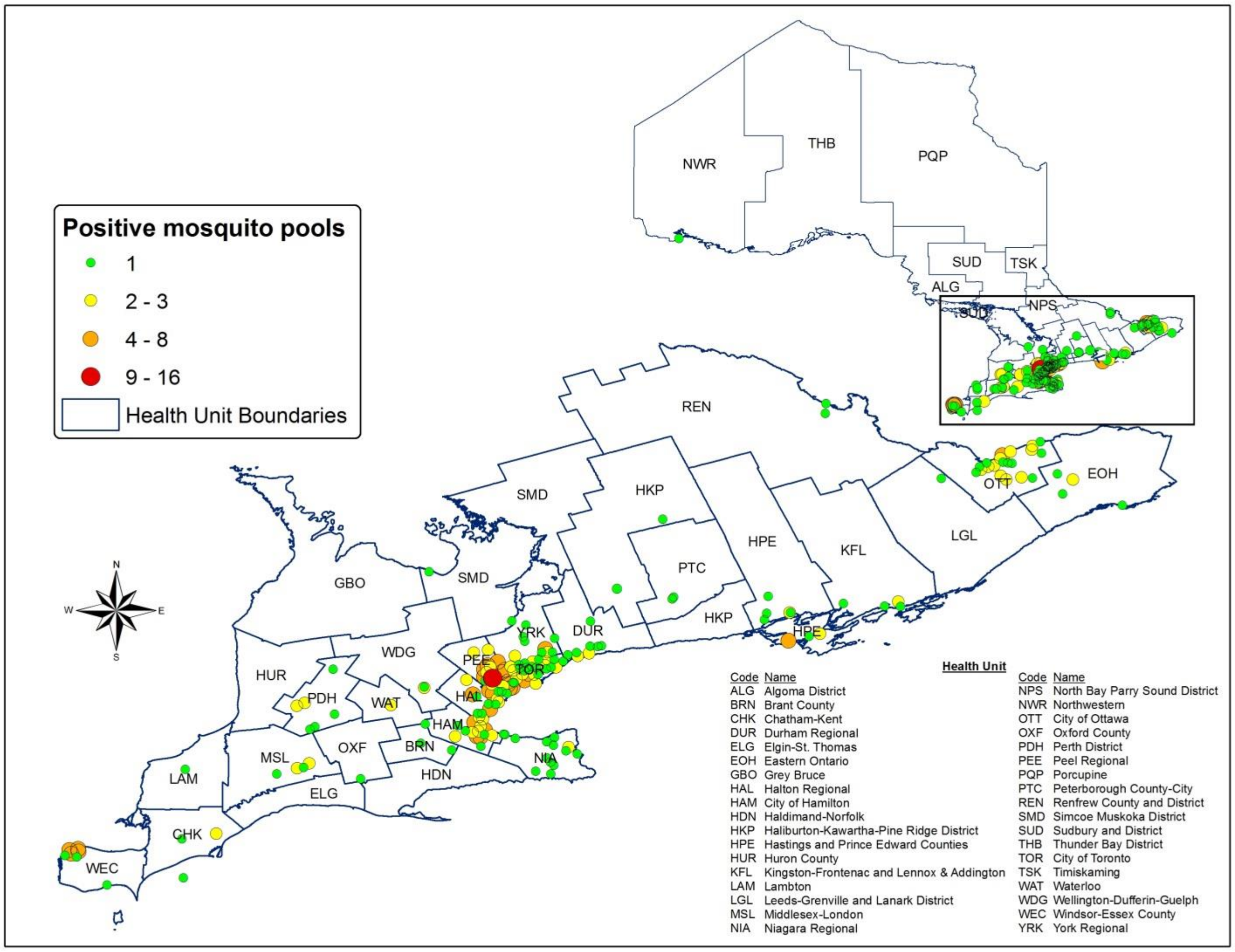



**Data Sources:**
Mosquito data: PHO Mosquito Database, extracted [2018/02/20]
Weather Data: Environment Canada[1]

**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 Canada website. The number of mosquito traps varies yearly and PHUs focus mosquito trapping in areas of concern, which may affect the frequency of positive mosquito pools.

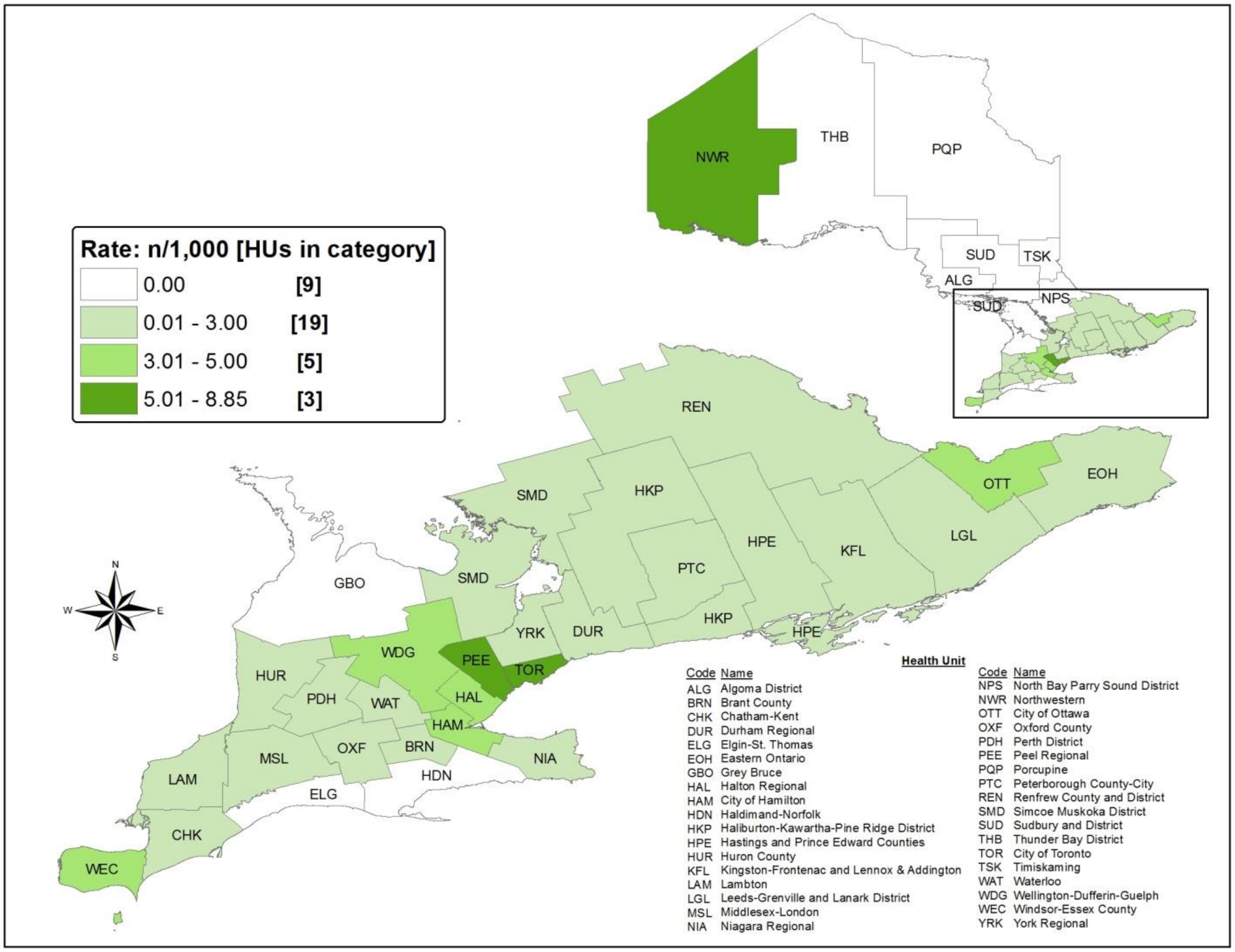
[1]https://www.ec.gc.ca/sc-cs/default.asp?lang=En&n=A3837393-1

## Figure 2: Location and number of mosquito pools positive for WNV: Ontario, 2017




**Data source:** PHO Mosquito Database, extracted [2018/01/29]

## Figure 3: Minimum infection rate of WNV-positive mosquito pools: Ontario, 2017




**Data source:** PHO Mosquito Database, extracted [2018/01/29]

# Eastern Equine Encephalitis Virus (EEEV)

## Background

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, *Culiseta melanura*, the principal amplification vector for EEEV in Ontario and the eastern United States, is 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 in rural areas. This also makes EEEV more of a rural health risk, compared to the urban risk of WNV. Possible bridge vectors include *Ae. vexans* and *Coquillettidia perturbans* species. 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.

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. Only a single human case of EEEV has been recorded in Ontario (2016).

## Mosquito surveillance in Ontario

EEEV mosquito surveillance is conducted in Ontario by using the WNV mosquito surveillance program and testing any captured *Cs. melanura* for EEEV.

# Surveillance data – Results and interpretation of findings

In 2017, there were 613 *Cs. melanura* captured and none tested positive for EEEV (Table 1). EEEV has been reported in Ontario in horses, emus and pheasants dating back to 1938. Ontario animal cases occur annually in rural PHUs throughout southern Ontario. In 2017, two equine cases of EEEV equine were reported by the Ontario Ministry of Agriculture, Food, and Rural Affairs.

Like WNV, EEEV is influenced by temperature and precipitation; therefore, activity will vary yearly. Additionally, there is a vaccine available for the equine population, influencing the number of equine cases reported each year.

**Table 1: Number of *Culiseta melanura* captured, EEEV-positive mosquito pools and Equine cases: Ontario, 2002-2017**

| Year | Number of *Cs. Melanura* | Number of EEEV-Positive Mosquito Pools | Number of EEEV Equine 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] | 2 |
| 2010 | 218 | 3[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 |
| 2017 | 613 | 0 | 2 |

**Data sources:**
Horse data: OMAFRA online from http://www.omafra.gov.on.ca/english/livestock/horses/westnile.htm
Mosquito data: PHO Mosquito Database, extracted [2018/01/07]

[2]First Nations: 10 pools *Cs. melanura* and two pools *Ae. vexans.*
[3]Public Health Units (North Bay Parry Sound District) one pool and First Nations two pools, all *Cs. melanura.*

# Lyme Disease

## Background

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. 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 with established blacklegged tick populations.

## Passive tick surveillance in Ontario

Over the years, there have been changes to the passive tick surveillance system in Ontario. Prior to 2009, ticks could be submitted to PHO from sources other than humans. Due to the volume of ticks submitted, from 2009 to 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 (Eastern Ontario, Kingston-Frontenac and Lennox and Addington, and Leeds-Grenville and Lanark District) 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

Of the 10,170 tick samples submitted to PHO in 2017, approximately 48 percent were blacklegged ticks. The American dog tick made up the second largest number of ticks identified, at approximately 42 percent.

Table 2 summarizes the annual number of blacklegged tick samples submitted to PHO from 2014 to 2017. The PHUs with highest percentage of total submissions in 2017 were the City of Ottawa; Haliburton-Kawartha-Pine Ridge; Hastings and Prince Edward Counties.

**Table 2. Annual number of blacklegged tick samples submitted to PHO for testing**

| Year | Number of ticks submitted to PHO |
|---|---|
| 2014 | 2,126 |
| 2015 | 1,903 |
| 2016 | 2,041 |
| 2017 | 4,882 |

**Data sources:** PHO Tick Database, extracted [2018/04/24].

An increase in local submissions for some PHUs could be due to a number of factors, such as the identification of new estimated Lyme disease risk areas in a PHU or increased knowledge about submitting ticks. For example, in 2015, the Rouge Park was identified as a new Lyme disease risk area. This park borders Durham Regional, City of Toronto and York Regional PHUs, all of which have seen an increase in blacklegged tick submissions, since 2015.

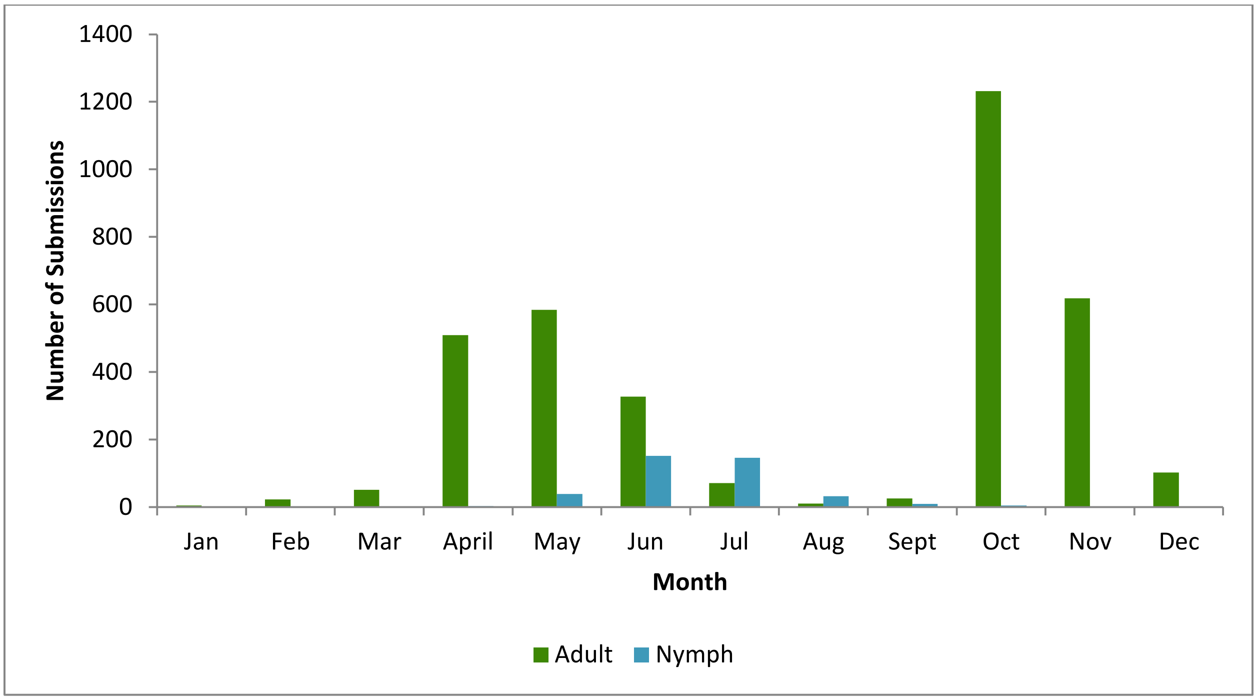
## Life stage of submitted ticks

Of the blacklegged ticks that were submitted, 90.3 percent were adults; nymphs and larvae accounted for 9.6 and 0.08 percent, respectively. Adult ticks are submitted most often, as they 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 nymphs are mainly submitted in the summer (Figure 4), aligning with the expected seasonality of the tick. Additionally, the majority of human cases in eastern North America, including in Ontario, are acquired in the summer months, a consequence of transmission from nymphal ticks whose small size results in them going unnoticed while feeding.

## Blacklegged tick locations

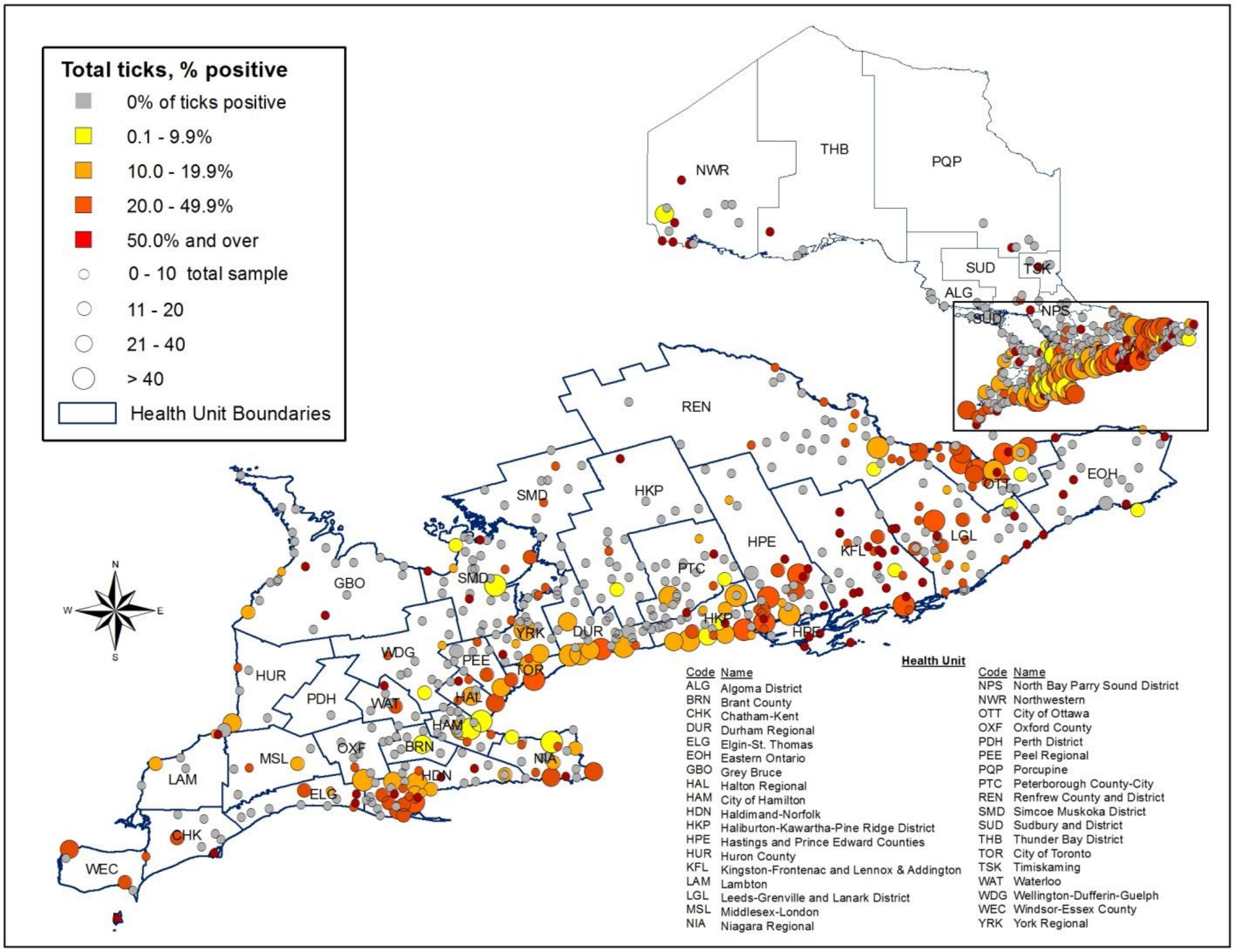
There were 4,767 blacklegged ticks submitted to the National Microbiology Laboratory (NML) for *B. burgdorferi* testing that had an identifiable location of acquisition within Ontario. Figure 5 shows the locations of these samples, along with the percent that were positive for *B. burgdorferi*. Locations of acquisition that are noted by a city/town have a corresponding dot located at the central location of that city/town. Even with the reduction in blacklegged tick submissions, a relatively large number were still being submitted from eastern Ontario. Another area with relatively higher numbers of tick submissions in 2017 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 coincides with the number of ticks being submitted, and the length of time they have had established tick populations. The northwestern region of Ontario is starting to see higher levels of tick submissions. This area has also seen an increase in the number of estimated Lyme disease risk areas. 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 4: Number of *Ixodes scapularis* samples by month and stage submitted to PHO: Ontario, 2017




**Data sources:** PHO Tick Database, extracted [2018/04/24].
**Note**: Larva only made up 0.08% of total identifications, and therefore, are not shown.

**Figure 5: Number of *Ixodes scapularis* samples and percent positivity for *Borrelia burgdorferi* based on most-likely location of acquisition: Ontario, 2017**




**Data source:** PHO Tick Database and National Microbiology Laboratory (NML) data, extracted [2018/04/26].

# Summary

A number of vectors are established in Ontario making ongoing surveillance important. We continue to see yearly variations in both WNV and EEEV activity, primarily due to the strong influence of weather, making predictions on seasonal activity difficult. Over the last few years, we have seen a steady increase in the number of blacklegged tick submissions and their spread into new areas of the province. It is expected that blacklegged ticks will continue to spread into suitable habitats, leading to new Lyme disease risk areas. PHO in collaboration with PHUs will continue to conduct passive and active tick surveillance to monitor this expansion.

# Related links

- West Nile Virus
- West Nile Virus Surveillance
- Lyme Disease
- Ontario Lyme disease estimated risk areas map, 2018
- Monthly Infectious Diseases Surveillance Report

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