Vector-borne diseases

2015 Summary report

Public Health Ontario

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Purpose

This report summarizes the 2015 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 their vector-borne diseases programs.

Out of scope for this report are human data on these diseases; this information will be made available in PHO's 2015 annual surveillance report on reportable diseases and is also available to Ontario's PHUs via the Infectious Diseases [Query tool](). Also out of scope for this report are data on the vectors that transmit malaria and yellow fever, given that these are both travel-related diseases with no endemic transmission in Ontario.

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. 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 transfer the virus from birds to humans are called bridge vectors. The main 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[1]. 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 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.

The results of mosquito surveillance include the observation that *Ochlerotatus japonicus* (a possible WNV vector) has spread to most Ontario PHUs since first identified in Ontario in 2001 in one PHU. The mosquito surveillance also detected a very small number (n=4) of *Aedes albopictus* (Asian tiger mosquito) in 2005 and 2012, a vector of dengue, chikungunya and potentially Zika viruses. *Aedes albopictus* is not established in Ontario and there is no endemic risk of these diseases, as the climate is

[1] http://www.publichealthontario.ca/en/eRepository/Guide_Considerations_Mosquito_Control_2013.pdf

not suitable for *Ae. albopictus* establishment; however, it is still important to note its occurrence and monitor its activity.

Starting in the 2016 mosquito season, PHO will provide data on WNV human cases, mosquito species and testing results for WNV and WNV-infected horses in the province though a new WNV webpage with interactive tables, figures and maps.[2]

Surveillance data – Results and interpretation of findings

Since a peak in positive mosquito pools in 2012, there has been an overall decline over subsequent years with 94 positive pools in 2015 (Figure 1).

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 relatively low number of positive mosquito pools in 2015 could be partially attributed to relatively cooler summer temperatures in June, July and August. Based on Environment Canada's temperature rankings between 1948 and 2015, the year 2015 was one of the coolest summers on record (Figure 1). The year 2015 had WNV activity similar to 2004, with 2004 also among the coolest summers on record[3]. This contrasts with the higher summer temperatures in 2002 and 2012, which had the highest levels of WNV activity in Ontario. 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. The winter of 2015 was the fourth coldest on record for the Great Lakes/St. Lawrence region.

In 2015, the species of mosquitoes that tested positive for WNV were *Cx. pipiens/restuans* and *Ae. vexans*. *Culex pipiens/restuans* tested positive for WNV most frequently; however, *Cx. pipiens/restuans* are specifically targeted for WNV testing, as these vectors are primarily responsible for human cases.

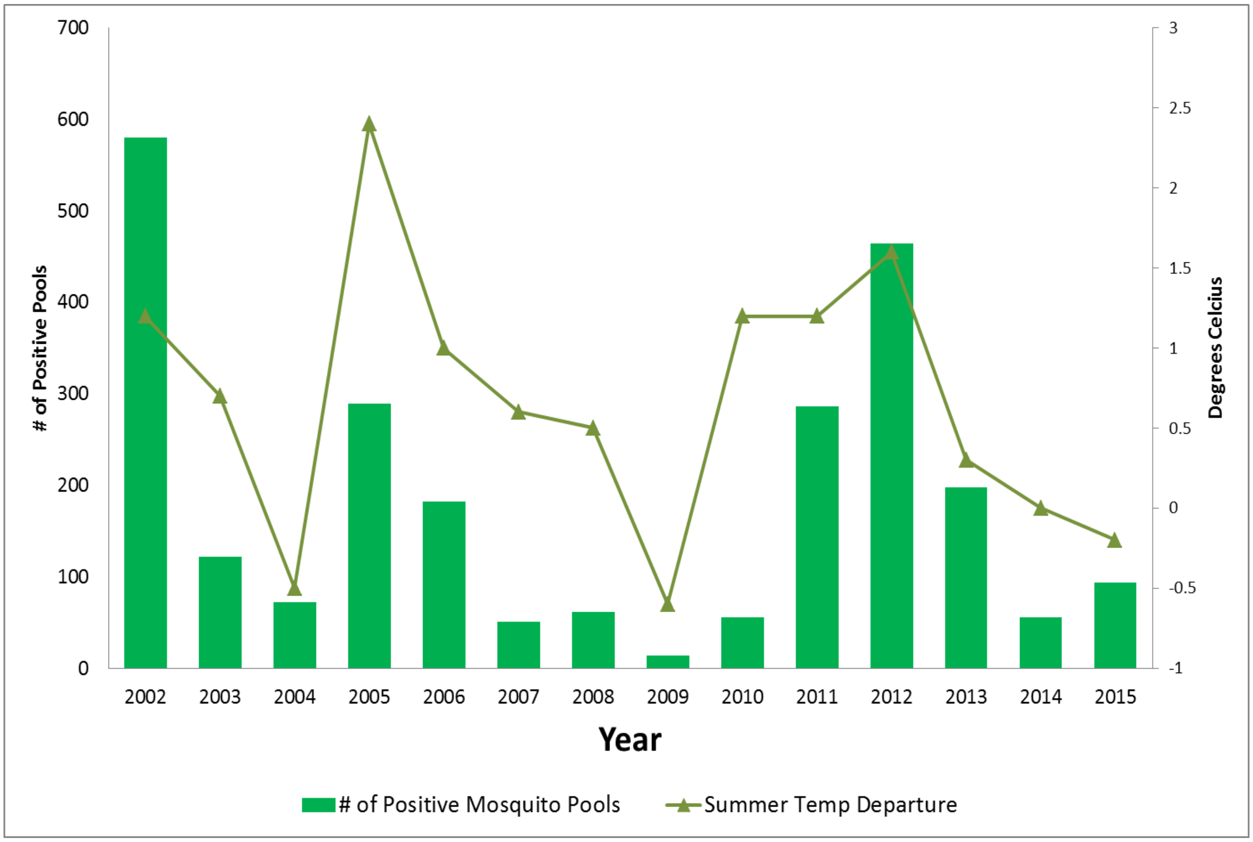
In 2015, the majority of positive mosquito pools were reported in the Golden Horseshoe area, as well as southwestern and southeastern Ontario (Figure 2). These areas are predominately urban and have large numbers of catch basins with standing water, which are ideal development sites for the main mosquito 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 level of positive mosquitoes in the environment, it can be

[2] http://www.publichealthontario.ca/en/ServicesAndTools/SurveillanceServices/Pages/Vector-Borne-Disease-Surveillance-Reports.aspx
[3] http://www.ec.gc.ca/adsc-cmda/default.asp?lang=En&n=D48C5C94-1

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.

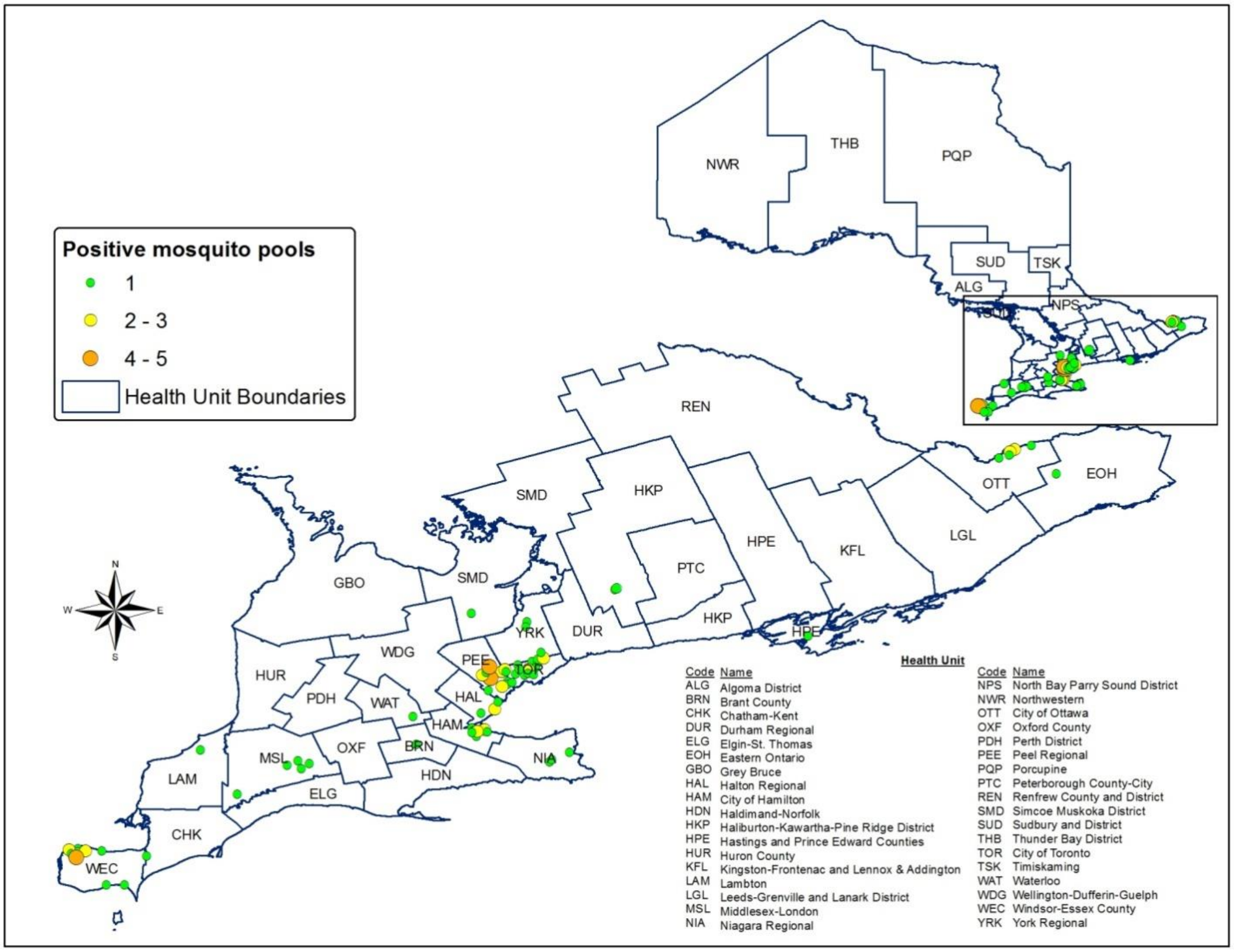
Figure 1. Number of positive mosquito pools and average summer temperature departures: Ontario, 2002–15



Data Sources:
Mosquito data: PHO Mosquito Database, extracted [2015/02/11]
Weather Data: Environment Canada[4]
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 health units focus mosquito trapping in areas of concern, which may affect the frequency of positive mosquito pools.

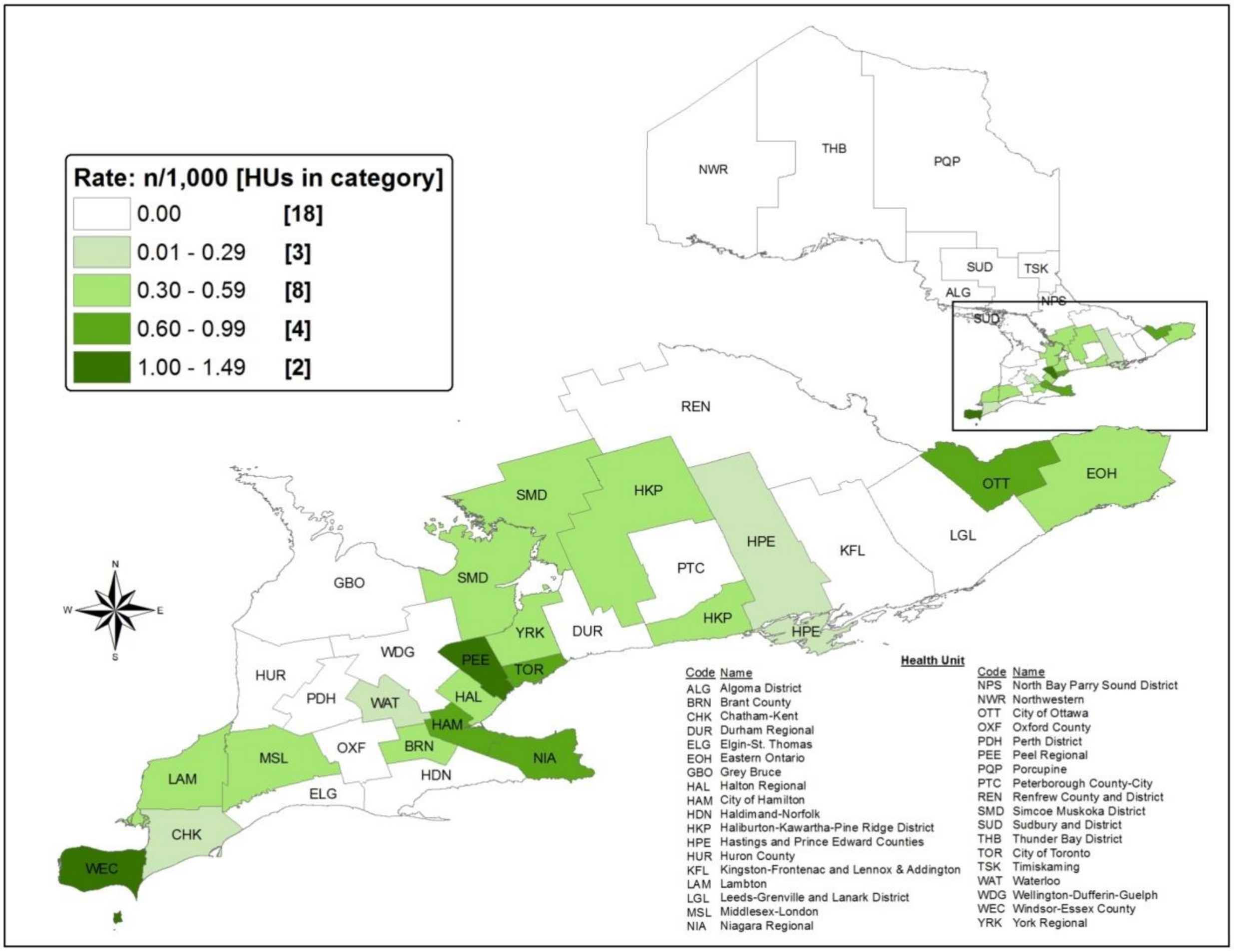
[4]https://www.ec.gc.ca/sc-cs/default.asp?lang=En&n=A3837393-1

Figure 2. Location and number of mosquito pools positive for West Nile Virus: Ontario, 2015



Data source: PHO Mosquito Database, extracted [2015/02/11]

Figure 3. Minimum infection rate of positive mosquito pools: Ontario, 2015



Data source: PHO Mosquito Database, extracted [2015/02/11]

Eastern Equine Encephalitis Virus (EEEV)

EEEV is also a mosquito-borne virus that circulates between birds and mosquitoes, with bridge vectors transferring the virus to humans and horses. Like WNV, horses and humans are dead-end hosts, from which the mosquito vector cannot acquire the virus, but 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, no human cases of EEEV have been reported in Ontario. 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 the equine population in Ontario since 1938[5]. 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 the *Animal Health Act* of Ontario (Ontario Regulation 277/12)[6]. This change could lead to an increase in reported WNV and EEEV equine infections.

Culiseta melanura is the main bird-biting 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 more of a rural than urban 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*.

[5] Schofield F, Labzoffsky N. Report on cases of suspected encephalomyelitis occurring in the vicinity of st. george. *Rep Ont Dept Agric OVC*. 1938.
[6] http://www.ontario.ca/laws/regulation/120277

Surveillance data – Results and interpretation of findings

No human cases of EEEV have ever been reported in Ontario. In 2015, 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, Figure 4). In 2015, five EEEV equine cases were reported by the Ontario Ministry of Agriculture, Food, and Rural Affairs. The majority of these cases occurred in the eastern PHUs, with one also reported in North Bay Parry Sound District. Ontario animal cases have occurred in predominantly rural PHUs with the cases occurring in different locations 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.

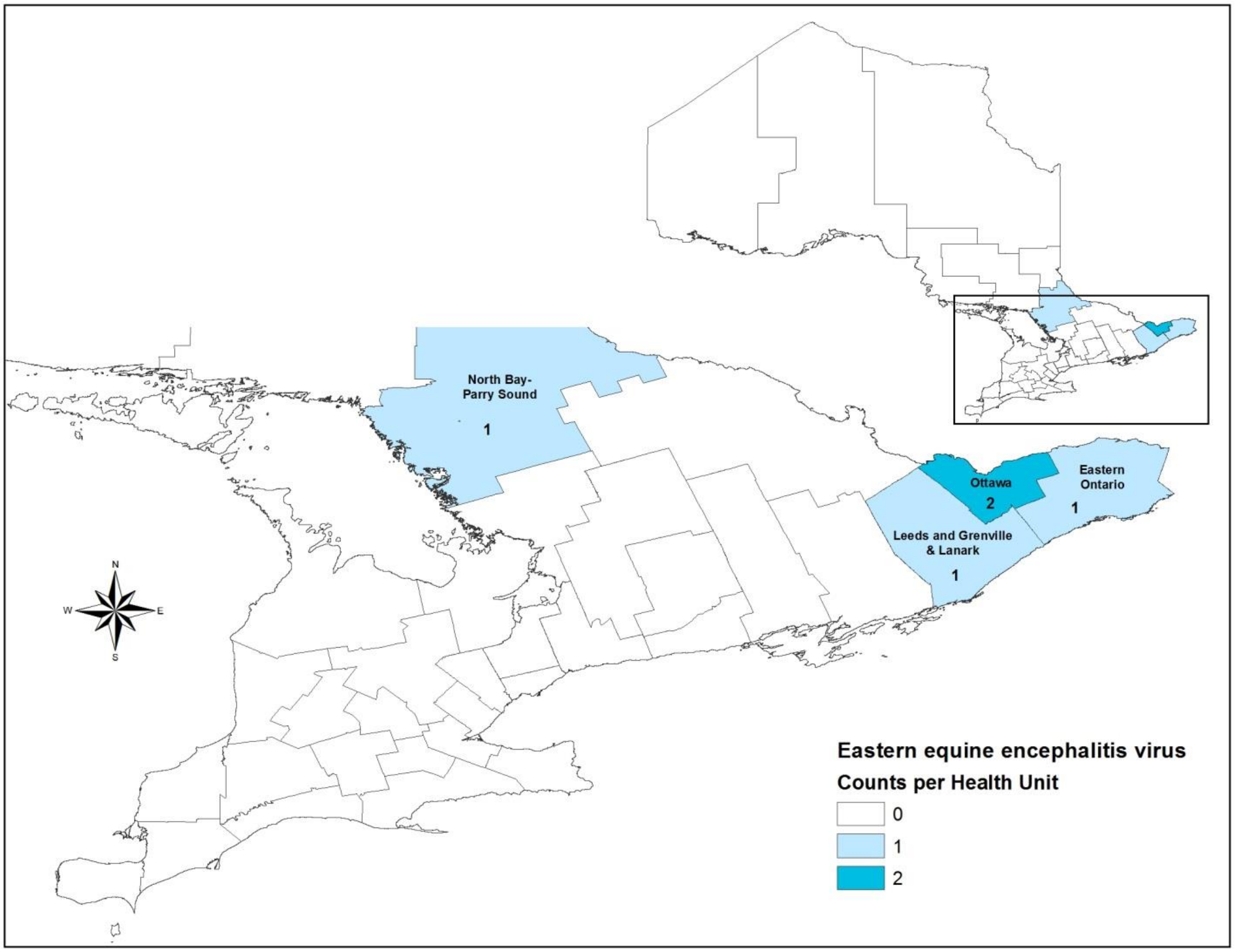
Table 1. Number of *Culiseta melanura* captured, EEEV-positive mosquito pools and EEEV horses: Ontario, 2002–15

Year	Number of *Cs. Melanura*	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[7]	2
2010	218	3[8]	3
2011	222	0	4
2012	67	0	0
2013	245	1	1
2014	631	0	24
2015	55	0	5

Data sources:
Horse data: OMAFRA online from http://www.omafra.gov.on.ca/english/livestock/horses/westnile.htm
Mosquito data: PHO Mosquito Database, extracted [2015/03/31]

[7] First Nations: 10 pools *Culiseta melanura* and two pools *Aedes vexans.*
[8] Public Health Units (NPS) one pool and First Nations two pools all *Culiseta melanura.*

Figure 4. Eastern Equine Encephalitis Virus activity in horses: Ontario, 2015



Data source: Map information sourced from OMAFRA online [2015/04/16]:
http://www.omafra.gov.on.ca/english/livestock/horses/facts/nhd_surv2015.htm

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 accepting ticks and have switched to programs of active tick surveillance. As passive tick surveillance is used to inform actions for active tick surveillance, passive tick surveillance is no longer required in these PHUs. These changes will result in reductions in passive tick surveillance data in these jurisdictions.

Surveillance data – Results and interpretation of findings

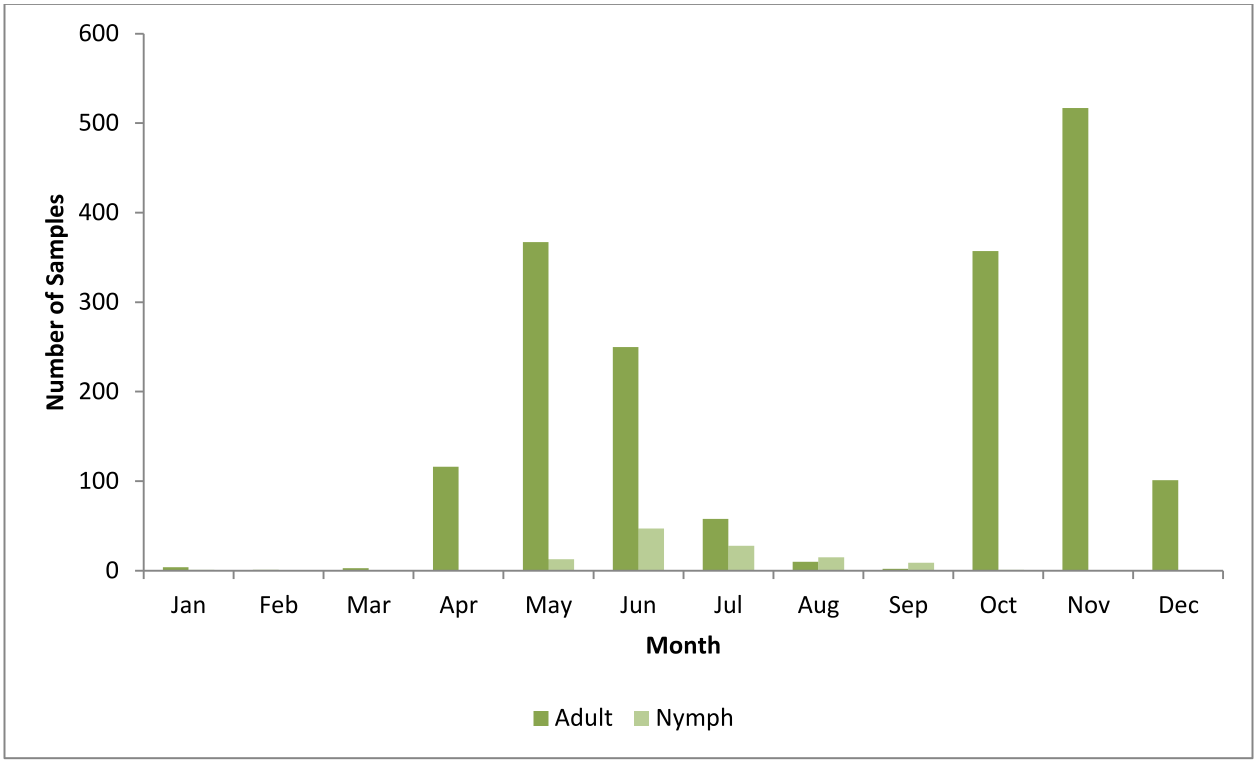
There was a drop in the number of blacklegged tick samples submitted to PHO from 2,126 in 2014 to 1,903 in 2015. Of 1,903 blacklegged tick samples from 2015, 50.1 percent came from the following eastern PHUs: Hastings and Prince Edward Counties, Kingston-Frontenac and Lennox & Addington, Leeds-Grenville and Lanark District, Eastern Ontario, Renfrew County and District and City of Ottawa (Table 4).The eastern region had a lower number of submissions in 2015 due to the switch from passive tick surveillance to active tick surveillance in Kingston-Frontenac and Lennox & Addington, Leeds-Grenville and Lanark District and Eastern Ontario. These three PHUs had an 81.7 percent drop in blacklegged tick submissions. Other PHUs saw an increase in local submissions, which could be due to a number of factors, such as a new Lyme disease risk area 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 Regional PHUs, all of which saw an increase in blacklegged tick submissions.

Of the blacklegged ticks that were submitted, 93.8 percent of them were in the adult stage, with nymphs accounting for six percent. 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 5). 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, which is due to the nymph's small size which results in them going unnoticed while feeding. While the date for tick submission is based on the date they arrived at the PHO Laboratory for testing, they are occurring with the general trends of when these ticks are expected to occur in the environment.

There were 1,397 samples submitted to the NML for *B. burgdorferi* testing that had an identifiable location of acquisition within Ontario. Figure 6 shows the locations of these samples, along with the percent that were positive for *B. burgdorferi*. 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 St. Lawrence River areas had the highest levels of positive ticks, which coincides 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 smalls sample sizes 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 to almost anywhere in the province, it is not uncommon to find blacklegged ticks in areas with no known risk areas. 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.

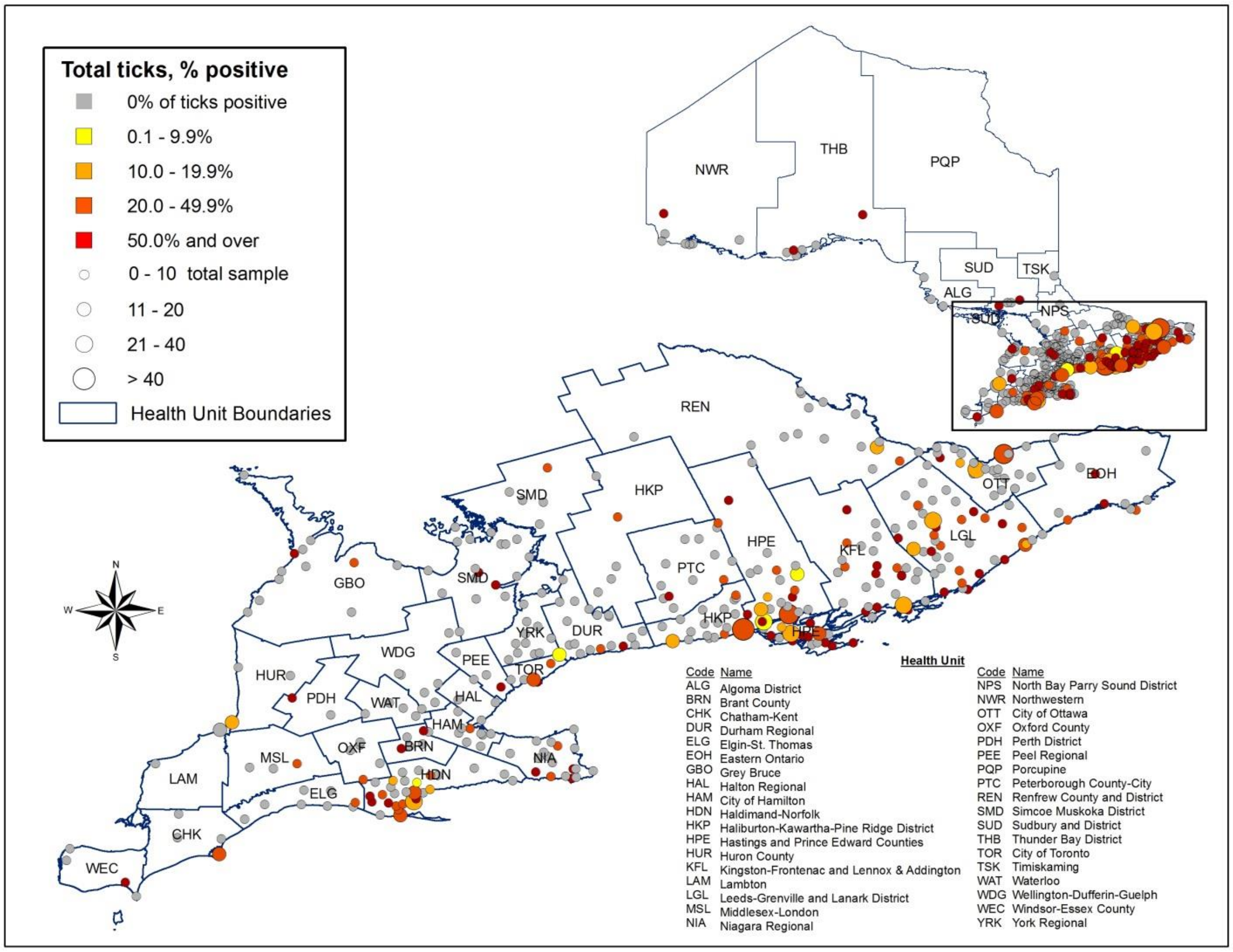
While Ontario is seeing an increase in the number of blacklegged ticks, along with the number of risk areas, there are still areas of the province that are still more conducive to the establishment of blacklegged ticks. These are typically areas with deciduous or mixed deciduous forest that have adequate amounts of leaf litter, as the ticks need this to prevent them from drying out. We will continue to see small numbers of blacklegged ticks reported from across the province, however, as previously stated, these are coming off of migratory birds and do not necessarily mean there is an established population.

Figure 5. Number of *I. scapularis* samples by month and stage submitted to PHO as passive tick submissions: Ontario, 2015



Data sources: PHO Tick Database, extracted [2015/04/20].

Figure 6. Number of *I. scapularis* samples and percent positive for *B. burgdorferi* based on the most-likely location of acquisition: Ontario, 2015.



Data source: PHO Tick Database and National Microbiology Laboratory (NML) data, extracted [2015/04/29].

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