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Vector-Borne Diseases

2018 Summary Report

November 2019

Public Health Ontario

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Disclaimer

Contents

Purpose and intended audience

This report summarizes the 2018 data on the vectors that transmit West Nile virus (WNV), eastern equine encephalitis virus (EEEV) and Lyme disease in Ontario. 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.[1] The virus circulates between birds and bird-biting mosquitoes (also referred to as amplification vectors).[2] WNV is transmitted to humans and horses when certain species of mosquito acquire the virus after biting an infected bird. The species of mosquitoes that transmit the virus from birds to humans or horses are called bridge vectors. The principal bridge vectors for human 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. As both humans and horses do not develop a high enough viremia for the mosquitoes to acquire the virus from them, they are considered dead end hosts.

WNV was first detected in New York in 1999 and since then has spread across most of North America.[3,4] WNV was first detected in Ontario in birds in 2001, with the first human cases following in 2002.[5] WNV infection in humans first became a disease of public health significance in Ontario in 2003.[6] Since then, WNV activity, in mosquitoes, humans and horses has varied from year to year.

Mosquito and horse 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, such as eastern equine encephalitis, 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.

In Ontario, horse surveillance is conducted by the Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA), where certain diseases, including WNV and EEEV are reportable under the Animal Health Act. For both WNV and EEEV, OMAFRA posts equine cases on their website.

Every year health units conduct a local WNV risk assessment to determine what level of mosquito surveillance they should conduct. This assessment determines the number of mosquito traps (CDC miniature light traps) used to monitor for the presence of the vectors species of WNV (primarily *Culex pipiens*/*restuans*). During the mosquito season, health units place the traps at different locations throughout their area once a week. After one night of trapping, the mosquitoes are collected from the traps and sent to a contracted service provider to have the trapped mosquitoes identified to species. Those species that are thought to be vectors of WNV are then tested for the WNV. The service providers then share those results, on a weekly basis, to their contracted health units and PHO. PHO then uses that data to produce the weekly West Nile Virus Surveillance interactive tool.

For additional information on mosquito trapping see the Ministry of Health WNV Preparedness and Prevention Plan.

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 PHO's West Nile Virus Surveillance interactive tool. The data are available from 2002 onwards and are updated on a weekly basis during the mosquito season.

The first year of mosquito surveillance in Ontario was in 2002, which had the highest number of WNV positive mosquito pools (Figure 1). Since 2002, the number of positive mosquito pools peaked in 2012, followed by a decline in 2013 and 2014 and increased again starting in 2015 through 2017. In 2018, there were 305 positive pools, which is lower than the 2017 total of 409 (Figure 1). There were also 11 equine cases of WNV.

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 increase the possibility that more mosquitoes acquire WNV, resulting in increased risk of transmission to humans. Conversely, 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 2018, the 2018 winter was near the baseline average, December 2017 to February 2018 (0.6°C above average), while summer the was 9th warmest (1.3°C above average), on record (Figure 1). While temperatures were warmer for the winter and summer, the spring was below the baseline average (39th coolest, -0.2 °C below average), which could affect the development of the first generations of *Cx. pipiens*/*restuans* and delay WNV activity.

Positive pools

In 2018, the species of mosquitoes that tested positive for WNV during surveillance in Ontario, in order of frequency (from high to low) were:

- *Cx. pipiens*/*restuans*
- *Ae. vexans*
- *Ochlerotatus trivittatus*

- *Anopheles punctipennis*
- *Cx. salinarius*
- *Och. japonicus*
- *Och. triseriatus*
- *Coquillettidia perturbans*

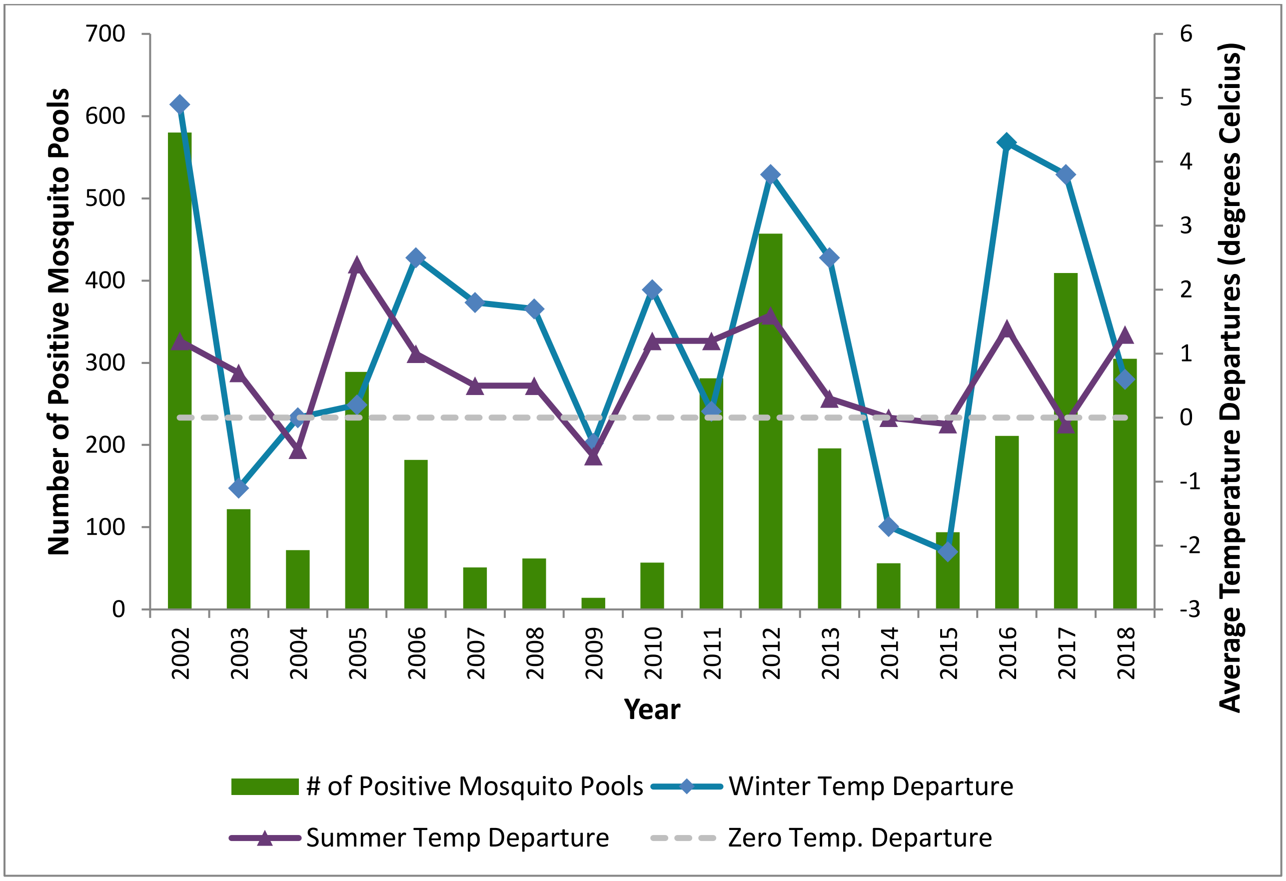
Culex pipiens/*restuans* tested positive for WNV most frequently however, *Cx. pipiens*/*restuans* are preferentially targeted for WNV testing, as these vectors are primarily responsible for human cases.

In 2018, 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 both in the southern part of the province; they 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 estimate 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 as: (# 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, compared to the actual level of WNV activity.

As WNV and its associated mosquito vectors are very dependent on climatic conditions, it is expected 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, 2002–18



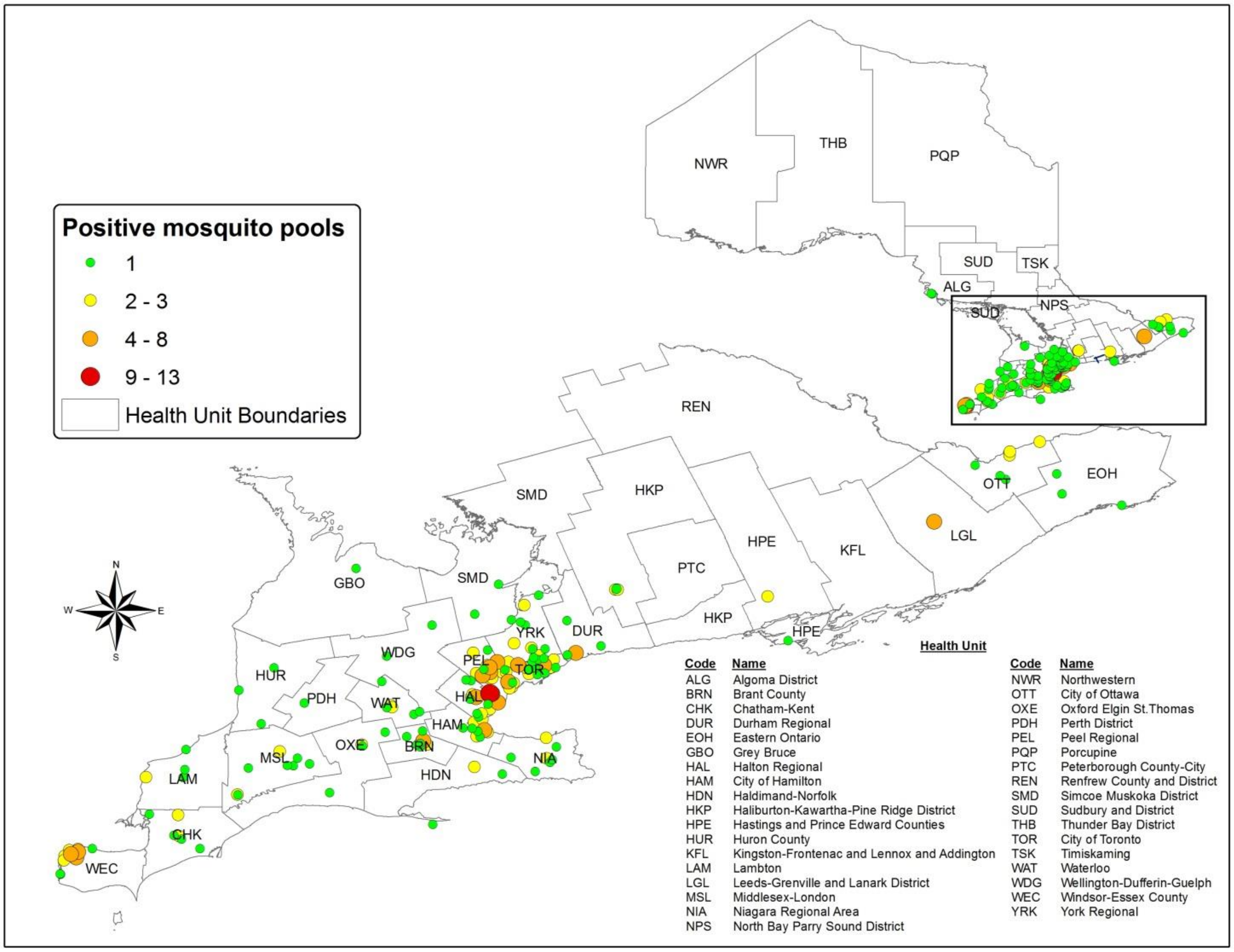
Data Sources:

Mosquito data: PHO Mosquito Database, extracted [2019/01/19] 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 1961–90 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.

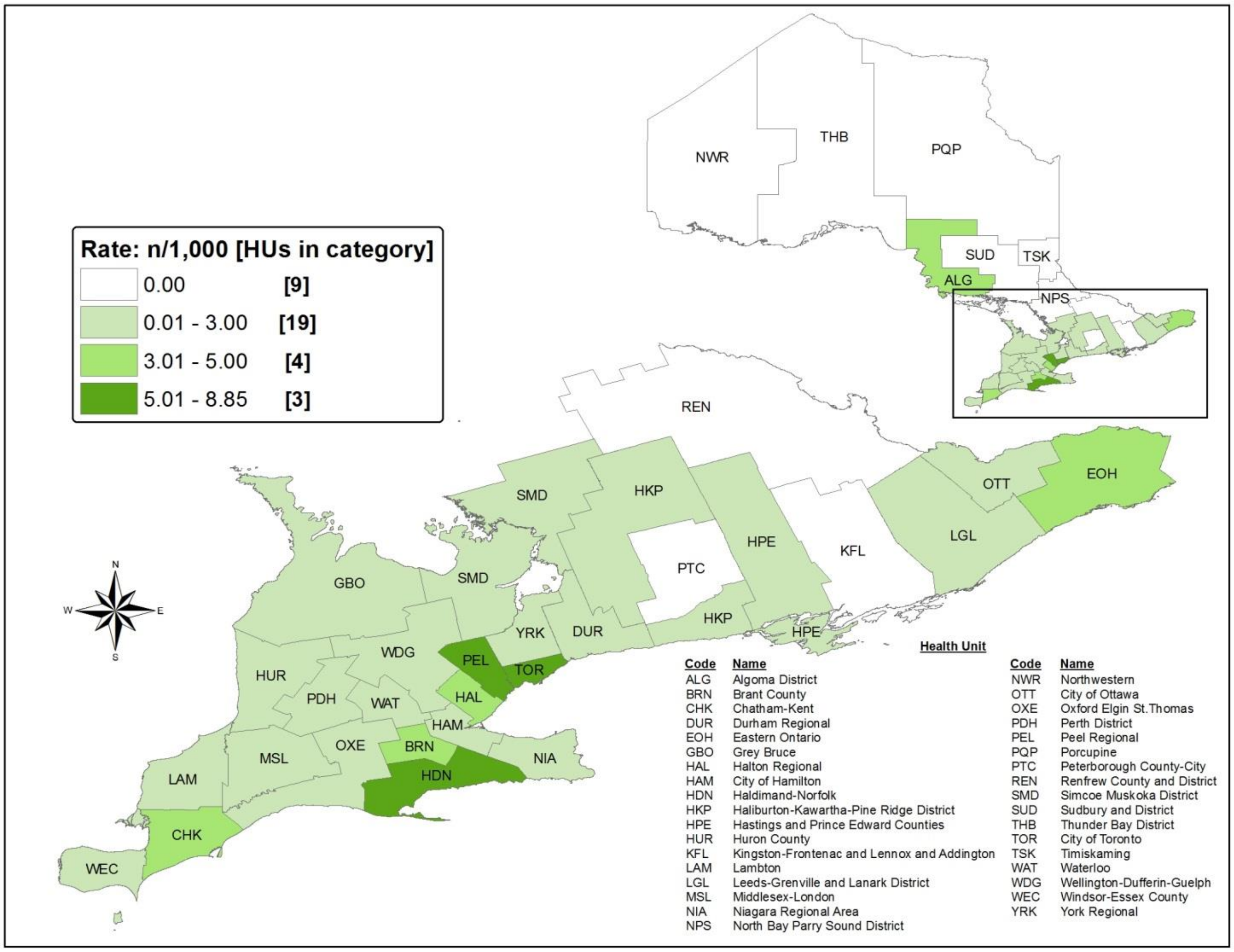
[1] https://www.ec.gc.ca/sc-cs/default.asp?lang=En&n=A3837393-1

Figure 2. Location and number of mosquito pools positive for WNV: Ontario, 2018



Data source: PHO Mosquito Database, extracted [2019/01/29]

Figure 3. Minimum infection rate of WNV-positive mosquito pools: Ontario, 2018



Data source: PHO Mosquito Database, extracted [2019/01/29]

Eastern Equine Encephalitis Virus

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. EEEV 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.[7-9] 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*, both of which readily bite humans. Additionally, these bridge vectors are more easily captured in Ontario's mosquito light-traps than *Cs. melanura* and can be found in both urban and rural areas.

Like WNV, most infected individuals will be asymptomatic; however, the risk of death among those who develop neurological symptoms is higher for those with EEEV compared to WNV.[10,11] It is estimated that one third of all cases of EEEV are fatal or associated with serious morbidity.[10,11] EEEV infections in humans are not designated as a disease of public health significance in Ontario unless an infected individual develops EEEV-associated encephalitis. Only a single human case of EEEV has been recorded in Ontario (2016).

Mosquito and horse surveillance in Ontario

EEEV mosquito surveillance is conducted in Ontario through the WNV mosquito surveillance program and testing any captured *Cs. melanura* for EEEV. As noted above, equine cases of EEEs are posted on OMAFRA's website.

Surveillance data – Results and interpretation of findings

In 2018, there were only nine *Cs. melanura* captured, compared to 613 in 2017, and none tested positive for EEEV (Table 1). Animal EEEV cases occur annually in rural PHUs throughout southern Ontario. In 2018, 13 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, 2002–18

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	0
2006	127	0	0
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
2017	613	0	2
2018	9	0	13

Data sources:

Horse data: OMAFRA online from www.omafra.gov.on.ca/english/livestock/horses/westnile.htm Mosquito data: PHO Mosquito Database, extracted [2018/01/29]

Lyme Disease

Background

Lyme disease is a tick-borne bacterial disease transmitted to humans through the bite of an infected blacklegged tick (*Ixodes scapularis*).[12] 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 a disease of public health significance in Ontario since 1990.[6,13] It is also reportable in animals under the Animal Health Act. In the early 1990s, there was only one known Lyme disease risk area in Ontario, at Long Point Provincial Park.[14] 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

The passive tick surveillance system in Ontario has changed over time. Prior to 2009, ticks could be submitted to PHO from sources other than humans. Due to the volume of ticks submitted, since 2009 only ticks found on humans are accepted for identification and testing. In 2014, due to the number of tick submissions and 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 solely active tick surveillance. In 2018, due to the same reasons, the health units of the City of Ottawa and Haldimand-Norfolk also discontinued passive surveillance. These changes will result in reductions in passive tick surveillance data in these jurisdictions.

In Ontario, if a person finds a tick on them, they can submit the tick to their local health unit or health care provider, where the tick can then be sent to the PHO Laboratory for species identification. If the tick is identified as a blacklegged tick (*Ixodes scapularis*) it is sent to the National Microbiology Laboratory (NML) to be tested for *Borrelia burgdorferi*, *B. miyamotoi*, and the pathogens that cause babesiosis (*Babesia microti*) and anaplasmosis (*Anaplasma phagocytophilum*). The tick identification results are provided by PHO Laboratory back to the submitter. Once the NML has the testing results completed, they report those findings back to the submitter and PHO Laboratory. At the end of each tick season, the NML provides all of the tick testing results to PHO for provincial analysis, reporting and to inform future tick surveillance activities, such as active tick surveillance in areas the data indicates an increase in blacklegged ticks.

Surveillance data - Results and interpretation of findings

Of the 7,236 tick samples submitted to PHO in 2018, approximately 54.3 percent were blacklegged ticks. The American dog tick made up the second largest number of ticks identified, at approximately 37.6 percent.

Table 2 summarizes the annual number of blacklegged tick samples submitted to PHO from 2014 to 2018.

Table 2. Annual number of blacklegged tick samples submitted to PHO for testing: Ontario, 2014-2018

Year	Number of blacklegged ticks submitted to PHO
2014	2,126
2015	1,903
2016	2,041
2017	4,882
2018	3,930

Data sources: PHO Tick Database, extracted [2019/05/13].

An increase, or decrease, 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, or discontinuing passive tick surveillance activities, as described above. 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.

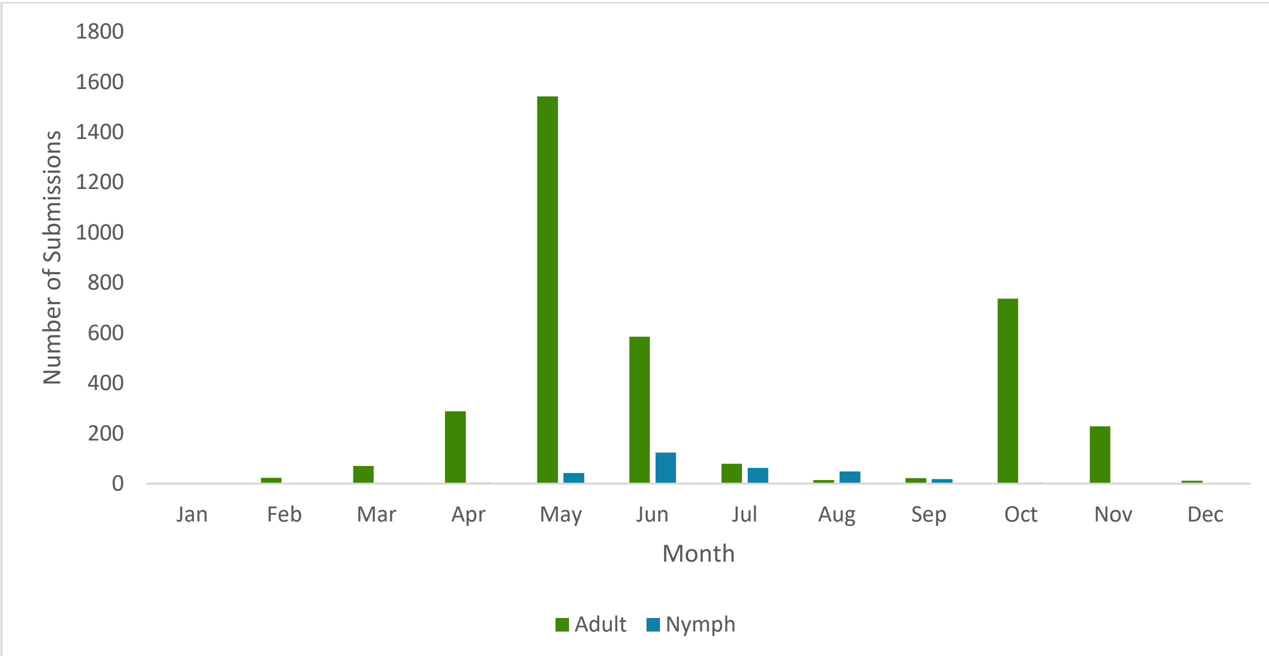
Life stage of submitted ticks

Of the blacklegged ticks submitted in 2018, 91.9 percent were adults; nymphs and larvae accounted for 7.8 and 0.3 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. The majority of human cases of Lyme disease in eastern North America (including Ontario) are acquired in the summer months. This is related to transmission from nymphal ticks which are of small size and therefore go unnoticed while feeding.

Blacklegged tick locations

Among blacklegged ticks submitted to the NML for *B. burgdorferi* testing, 2,302 had an identifiable location of acquisition within Ontario. Figure 5 provides 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 centrally in that city/town. Although there was a 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 2018 was along the north shore of Lake Erie. This area has had established blacklegged tick populations since 1990s. The Lake Erie and eastern Ontario areas, the latter of which has had established populations since the early 2000s, 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. In 2018, health units in the northwestern region of Ontario experienced an increase in tick submissions. This area has also seen an increase in the number of estimated Lyme disease risk areas since the first one was discovered in Rainy River (Northwestern Health Unit) in 2013 and the latest one in Thunder Bay (Thunder Bay District Health Unit) in 2018. It should be noted that if some health units have locations with low numbers of submitted ticks but high levels of positivity, this could be attributed to ticks being deposited off of migratory birds, and does not necessarily indicate established blacklegged tick populations. As blacklegged ticks can be transported by migratory birds almost anywhere in the province, it is not uncommon to find infected blacklegged ticks submitted from areas where previously 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 in the area.

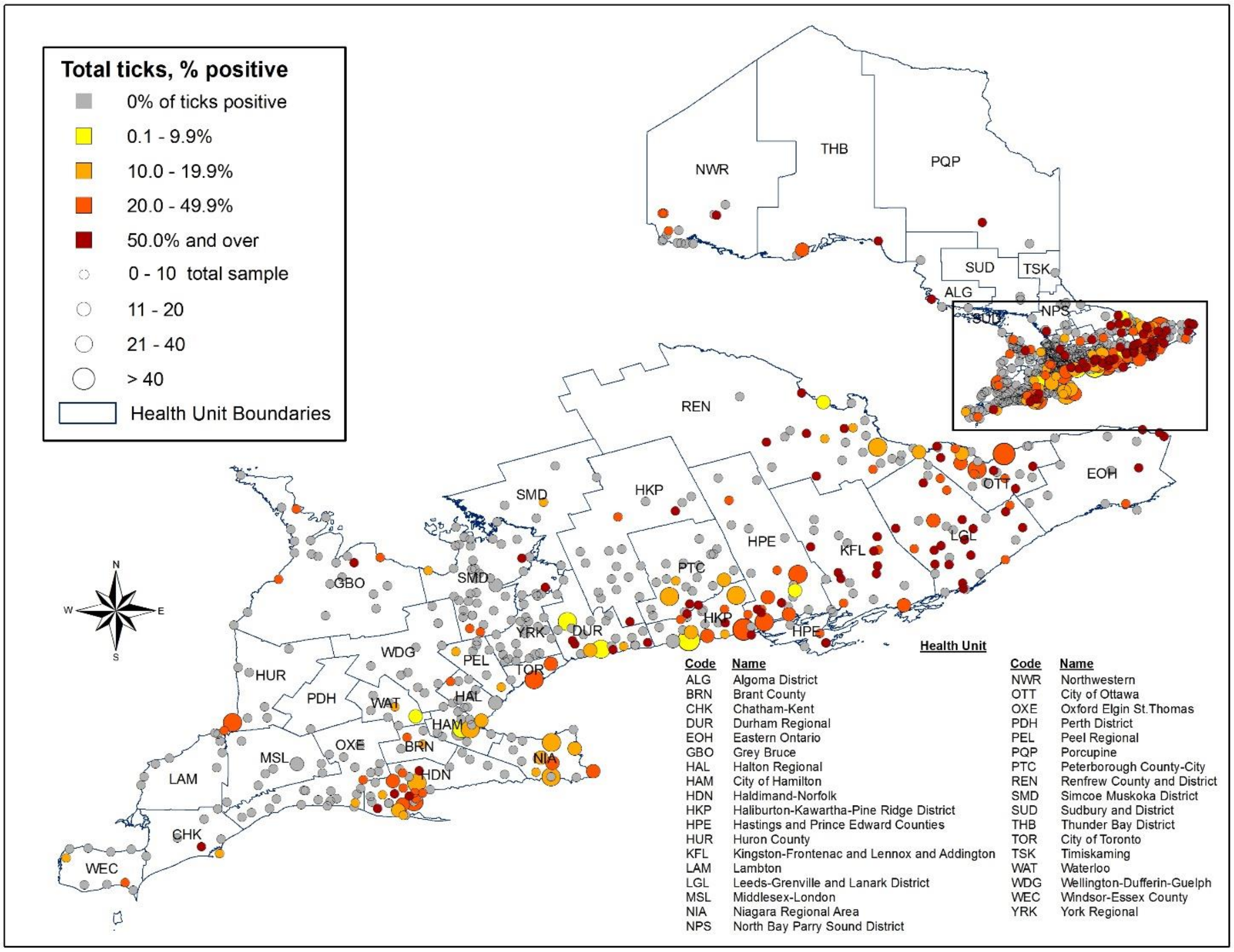
Figure 4. Number of *Ixodes scapularis* samples by month and stage submitted to PHO: Ontario, 2018



Data sources: PHO Tick Database, extracted [2019/05/13].

Note: Larva only made up 0.3% 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, 2018



Data source: PHO Tick Database and National Microbiology Laboratory (NML) data, extracted [2019/05/23].

Emerging Vectors

In the past decade, Ontario has seen the introduction of other exotic vectors, such *Ae. japonicus*. This species of mosquito was first discovered in Ontario in 2001, and since then has been recorded in every health unit in Ontario. With ever-changing climatic conditions, and global trade, there is always the possibility of additional exotic vectors being introduced into Ontario. With Ontario's WNV mosquito surveillance and tick surveillance programs we are able to monitor for these possible introductions.

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 enhanced 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. In that same year, a small number of adult (n=3) *Ae. albopictus* were found; along with four adult *Ae. aegypti*. This enhanced surveillance program continued in 2018 and will continue for another two years. In 2018, no *Ae. aegypti* were discovered, however a larger number (n=1,129) of adult *Ae. albopictus* were captured in different sections of the City of Windsor.[15] The continued capture of *Ae. albopictus* suggests that this species in now established in WEC.

Through Ontario's passive tick surveillance system, PHO can also monitor for other tick species of interest, including adventive or invasive species. Two species that PHO is currently monitoring include the lone star tick (*Amblyomma americanum*), and the Asian longhorned tick (*Haemaphysalis longicornis*). While there are currently no records of the Asian Longhorned tick in Ontario, it has recently been discovered in the US and has been spreading in eastern parts of that country.[16] The lone star tick is established across most of the eastern US, and every year small numbers are found, in varying locations, across southern Ontario.[17] In 2018, only 73 lone star tick samples were submitted, accounting for approximately one percent of the total tick submissions. Due to the likelihood of the lone star tick being seasonally introduced from migratory birds, a small number of lone star ticks are expected to be found in Ontario. Currently there is no evidence that the lone star ticks are established in the province.

Summary

A number of emerging vectors are now established in Ontario emphasizing the importance of ongoing surveillance. Yearly variations in both WNV and EEEV activity continue to occur, primarily due to the strong influence of weather, making predictions on seasonal activity difficult. Over the last few years, a steady increase in the number of blacklegged tick submissions and their spread into new areas of the province has been observed. It is expected that blacklegged ticks will continue to spread into suitable habitats, leading to new Lyme disease risk areas in the province. PHO in collaboration with PHUs will continue to conduct tick surveillance to monitor this expansion while continuing to monitor for other invasive species.

References

1. Smithburn KC, Hughes TP, Burke AW, Paul JH. A neurotropic virus isolated from the blood of a native of Uganda. Am J Trop Med Hyg. 1940;20:471-92.
2. Andreadis TG, Anderson JF, Vossbrinck CR, Main AJ. Epidemiology of West Nile virus in Connecticut: a five-year analysis of mosquito data 1999–2003. Vector-Borne Zoonotic Dis. 2004;4:360–78.
3. Nash DMF, Fine A, Miller J, O'Leary D, Murray K, Huang A, et al. The outbreak of West Nile virus infection in the New York City area in 1999. N Engl J Med. 2001;344: 1807–14. Available from: www.nejm.org/doi/full/10.1056/nejm200106143442401
4. Gubler, DJ. The continuing spread of West Nile virus in the western hemisphere. Clinical Inf Dis. 2007;45:1039–46. Available from: https://academic.oup.com/cid/article/45/8/1039/344802
5. Ontario. Ministry of Health. West Nile virus preparedness and prevention plan, 2018. Toronto, ON: Queen's Printer for Ontario; 2018. Available from: www.health.gov.on.ca/en/pro/programs/publichealth/oph_standards/docs/reference/WNV_plan_2018_en.pdf
6. Ontario. Public Health Ontario. Factors affecting reportable diseases in Ontario: case definition changes and associated trends 1991-2016. Toronto, ON: Queen's Printer for Ontario; 2019. Available from: https://www.publichealthontario.ca/-/media/documents/factors-reportable-diseases-ontario-1991-2016.pdf?la=en
7. Armstrong PM, Andreadis TG. Eastern equine encephalitis virus in mosquitoes and their role as bridge vectors. Emerg Infect Dis. 2010;16(12):1869-74. Available from: www.ncbi.nlm.nih.gov/pmc/articles/PMC3294553/
8. Molaei G, Oliver J, Andreadis TG, Armstrong PM, Howard JJ. Molecular identification of blood-meal sources in *Culiseta melanura* and *Culiseta morsitans* from an endemic focus of eastern equine encephalitis virus in New York. Am J Trop Med Hyg. 2006;75(6):1140-7. Available from: www.ajtmh.org/content/75/6/1140.long
9. Scott TW, Weaver SC. Eastern equine encephalomyelitis virus: epidemiology and evolution of mosquito transmission. Adv Virus Res. 1989;37:277-328.
10. Centers for Disease Control and Prevention. Eastern equine encephalitis [Internet]. Atlanta, GA: Centers for Disease Control and Prevention; 2018 [cited 2019 Jul 26]. Available from: www.cdc.gov/easternequineencephalitis/tech/symptoms.html
11. Deresiewicz, RL, thaler SJ, Hsu L, et al. Clinical and neuroradiographic manifestations of eastern equine encephalitis. N Eng J Med. 1997;336(26):1867-74. Available from: www.nejm.org/doi/full/10.1056/NEJM199706263362604
12. Ogden NH, Koffi KJ, Pelcat Y, Lindsay LR. Environmental risk from Lyme disease in central and eastern Canada: a summary of recent surveillance information. Can Commun Dis Rep 2014;40(5):74–82. Available from: www.phac-aspc.gc.ca/publicat/ccdr-rmtc/14vol40/dr-rm40-05/assets/pdf/14vol40_05-eng.pdf
13. Steere AC, Malawista SE, Snydman DR, Shope RE, Andiman WA, Ross MR. et al. Lyme arthritis: an epidemic of oligoarticular arthritis in children and adults in three Connecticut communities. Arthritis Rheum. 1977;20(1):7-17.
14. Barker IK, Surgeoner GA, Artsob H, McEwen SA, Elliott LS, Campell GD, et al. Distribution of the Lyme disease vector, Ixodes dammini (Acari: Ixodidae) and isolation of *Borrelia burgdorferi* in Ontario, Canada. J Med Entomol 1992;29:1011–22.
15. Windsor-Essex County Health Unit. *Aedes albopictus* mosquito [Internet]. Windsor, ON: Windsor-Essex County Health Unit; 2019 [cited 2019 July 26]. Available from: www.wechu.org/z-

health-topics/aedes-albopictus-mosquito
16. Centers for Disease Control and Prevention. What you need to know about Asian longhorned ticks - a new tick in the United States [Internet]. Atlanta, GA: Centers for Disease Control and Prevention; 2019 [cited 2019 July 26]. Available from: www.cdc.gov/ticks/longhorned-tick/index.html
17. Centers for Disease Control and Prevention. Tickborne diseases of the United States [Internet]. Atlanta, GA: Centers for Disease Control and Prevention; 2019 [cited 2019 July 26]. Available from: www.cdc.gov/ticks/tickbornediseases/tickID.html

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