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Vector-Borne Diseases

2014 Summary Report

Public Health Ontario

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Purpose

The purpose of this report is to provide an overview of the epidemiology of Ontario's reportable endemic vector-borne diseases in 2014. The target audience of this report is public health professionals. Of the five reportable vector-borne diseases, West Nile Virus (WNV) and Lyme disease are the only ones that occur in the province and are of public health importance in Ontario. There is limited mosquito surveillance on eastern equine encephalitis virus (EEEV) and no human cases, while malaria[1] and yellow fever are travel-related diseases with no endemic transmission reported in Ontario.

Background

West Nile Virus (WNV)

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. The majority of humans infected with WNV are asymptomatic; however, some can have nonneurological symptoms, such as a fever or rash, while very few will progress to neurological syndromes such as encephalitis. It is estimated that less than one percent of infections will have neurological complications[2].

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. Most human cases of WNV are initially identified by health care providers when individuals present with clinically compatible signs and symptoms. A blood sample is submitted to a PHO laboratory to confirm the diagnosis. The laboratory then notifies the public health unit (PHU) of test results, which may then be entered by the PHU into the integrated Public Health Information System (iPHIS) in accordance with provincial reporting requirements. Cases may also be reported by the Canadian Blood Services through their blood screening of donors. In addition, veterinarian sources of WNV surveillance contribute to

[1] http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0076208
[2] http://www.cdc.gov/westnile/symptoms/index.html

overall understanding of WNV epidemiology, with equine cases being reported to the Ontario Ministry of Agriculture Food and Rural Affairs (OMAFRA) and posted on their website[3].

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[4]. 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.

Prior to 2011, PHUs were seasonally allotted WNV testing on three mosquito pools per mosquito trap and testing for EEEV on one mosquito pool if *Culesita melanura* was identified. In 2011, the testing protocol was changed to one pool for WNV and two pools for EEEV. This change in testing was partially due to the discovery of EEEV-positive mosquito pools in Ontario in 2009 and 2010. These were the first years that mosquitoes tested positive in Ontario for EEEV. In addition, in 2010, there was increased EEEV activity in jurisdictions bordering Ontario. Quebec, New York and Massachusetts had reported an increased number of equine cases, and Michigan had reported three human cases and 57 equine cases, which were the highest numbers in that state in 30 years. It was determined that this change in mosquito viral testing was a proactive approach to assessing the risk of EEEV in Ontario and gathering baseline data on the prevalence of the virus in Ontario mosquitoes. This enhanced EEEV surveillance has been described in the PHO report, *Eastern equine encephalitis virus: History and enhanced surveillance in Ontario*[5]. The new order for viral testing mosquitoes captured in health unit mosquito traps as of 2011 is as follows:

1. *Culex pipiens/restuans* – WNV
2. *Culiseta melanura* – EEEV
3. *Coquilletidia perturbans* – EEEV
4. *Aedes vexans* – EEEV
5. Remaining order of WNV vectors

This change in mosquito viral testing could have led to an underestimation of the number of positive WNV pools for 2013, making it difficult to compare these results directly to previous years. In addition, in recent years, due to an increased understanding of WNV biology and epidemiology, some PHUs have reduced the number of mosquito traps or focused their mosquito surveillance efforts to areas of

[3] http://www.omafra.gov.on.ca/english/livestock/horses/westnile.htm
[4] http://www.publichealthontario.ca/en/eRepository/Guide_Considerations_Mosquito_Control_2013.pdf
[5] http://www.publichealthontario.ca/en/eRepository/Eastern_Equine_Encephalitis_Virus_Report_2014.pdf

greatest risk, e.g. there were 20,064 mosquito pools tested in 2005 compared to 14,117 mosquito pools tested in 2014.

The results of mosquito surveillance include the observation that *Ochlerotatus japonicus* (a possible WNV vector) has spread to most Ontario PHUs. *Oc japonicus* was first identified in Ontario in 2001 through the mosquito surveillance program in one PHU. The mosquito surveillance also detected a very small number of *Ae. albopictus* (the Asian tiger mosquito) in 2005 and 2012 (n=4), a vector of dengue and chikungunya. While this mosquito species is not established in Ontario and there is no endemic risk of these diseases, as the climate is not suitable for *Ae. albopictus* establishment, it is still important to note its occurrence and monitor its activity.

During the mosquito season PHO produces weekly reports that provide data on WNV human cases, mosquitoes species and testing results for WNV and WNV-infected horses in the province.[6]

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 possible rural health risk. 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 present in the equine population in Ontario since 1938[7]. As of 2009, the virus has been detected sporadically in the Ontario mosquito population. Although the risk of contracting the virus is still extremely low in Ontario, enhanced surveillance for the virus was implemented in 2011 due to increases in EEEV detection in horses and mosquitoes in surrounding jurisdictions as noted above. In addition, 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)[8]. This change could lead to an increase in reported WNV and EEEV equine infections.

[6] http://www.publichealthontario.ca/en/ServicesAndTools/SurveillanceServices/Pages/Vector-Borne-Disease-Surveillance-Reports.aspx
[7] Schofield F, Labzoffsky N. Report on cases of suspected encephalomyelitis occurring in the vicinity of st. george. *Rep Ont Dept Agric OVC*. 1938.
[8] http://www.ontario.ca/laws/regulation/120277

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. The larval form of this species develops in underwater crypts and attaches to plant stems to breathe. This lifecycle trait can make it difficult to find these larvae and control for them. 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 *Cq. 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 the 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 tested 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 HU. 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*.

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 endemic 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.

The identification and reporting of human Lyme disease cases is similar to West Nile Virus cases, where PHUs report cases via iPHIS as per provincial reporting requirements.

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 health units 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 health units. These changes will result in marked reductions in passive tick surveillance data in these jurisdictions.

Findings

West Nile Virus

Since 2002, the annual incidence of WNV illness in humans has fluctuated with peaks in incidence in 2002, when human cases were first reported, and in 2012 (Figure 1). The incidence of WNV illness in 2014 was the lowest since 2008. In 2014, 13 confirmed and probable cases[9] were reported, representing an overall incidence rate of 0.10 cases per 100,000 population (Table 1). The cases were reported by nine health units located primarily in southern Ontario (Figure 2 and Table 1). The majority of cases occurred in August and September, the time period during which 69% (9/13) of cases reported in 2014 (Figure 4).

Since a peak in positive mosquito pools in 2012, there has been a decline over subsequent years to a total of 56 positive pools in 2014 (Figure 4).

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 and, as a result, this increases the risk of transmission to humans. Conversely, fewer positive mosquitoes lead to fewer human cases. The decrease in positive mosquito pools in 2014 could be partially attributed to cooler summer temperatures in June, July, and August. Based on Environment Canada's temperature rankings between 1948 and 2014, the year 2014 was one of the coolest summers on record (Figure 4). The year 2014 had a low abundance of vector mosquitoes and WNV activity similarly to 2004 and 2009, with both 2004 and 2009 also among the coolest summers on record[10]. 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* females, as more will die as a result of colder winters. The winter of 2014 was the eighth coldest on record for the Great Lakes/St. Lawrence region.

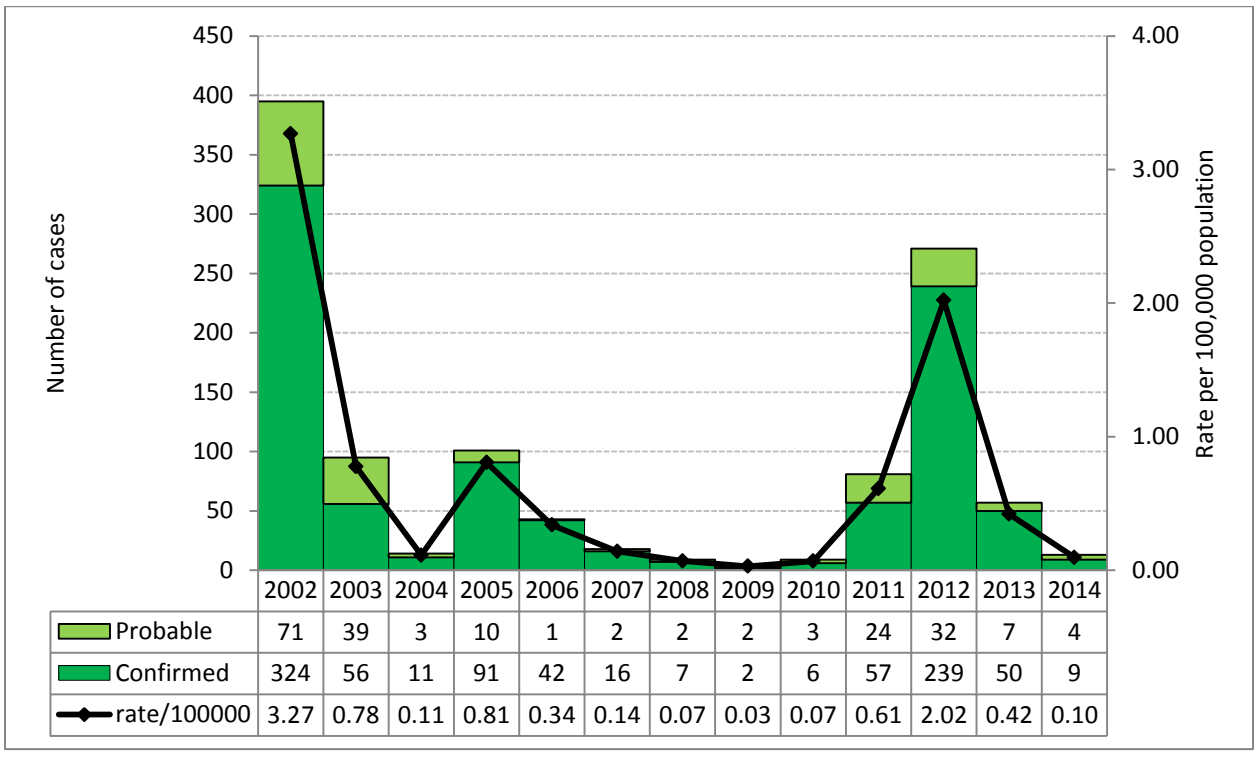
In 2014, the majority of positive mosquito pools were reported in the Golden Horseshoe area, as well as southwestern and southeastern Ontario (Figure 5). These areas are predominately urban, and have large numbers of catch basins with standing water, which are ideal development sites for the main mosquito vectors of WNV. Figure 6 shows the minimum infection rate (MIR), which is an estimation of the

[9] For WNV case definition see: http://www.health.gov.on.ca/en/pro/programs/publichealth/oph_standards/infdispro.aspx
[10] http://www.ec.gc.ca/adsc-cmda/default.asp?lang=En&n=D48C5C94-1

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 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.

In 2014, the species of mosquitoes that tested positive for WNV included *Cx. pipiens/restuans, Aedes vexans,* and *Oc. japonicus*. *Cx. pipiens/restuans* tested positive for WNV most frequently; however, *Cx. pipiens/restuans* are specifically targeted for WNV testing, as this vector is primarily responsible for human cases.

Figure 1: Number of confirmed and probable human West Nile Virus cases by year: Ontario, 2002–14



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Probable	71	39	3	10	1	2	2	2	3	24	32	7	4
Confirmed	324	56	11	91	42	16	7	2	6	57	239	50	9
rate/100000	3.27	0.78	0.11	0.81	0.34	0.14	0.07	0.03	0.07	0.61	2.02	0.42	0.10

Data Sources:

WNV cases: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2015/02/15].

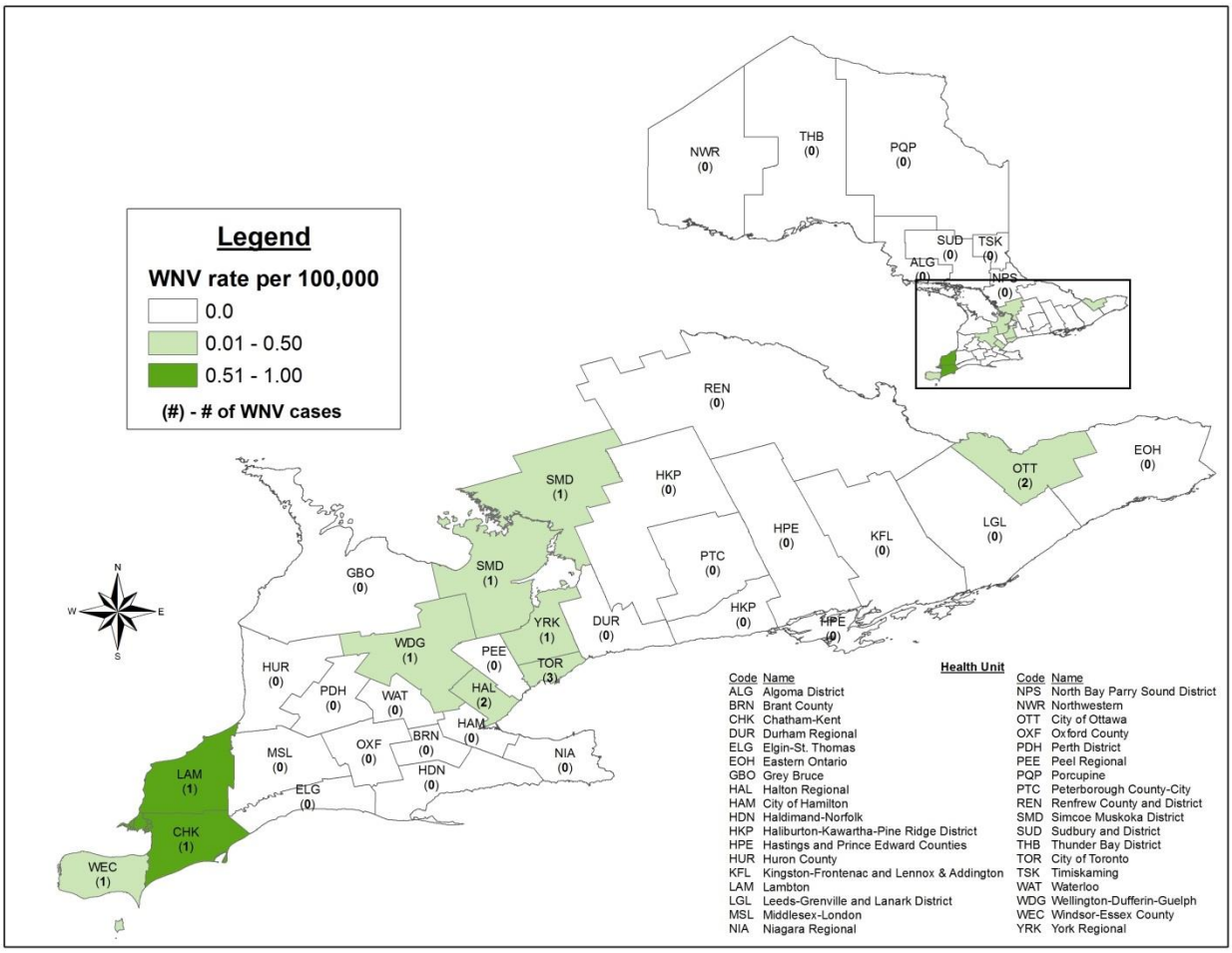
Population estimates (for rate calculations): Ontario Ministry of Health and Long-Term Care, IntelliHEALTH Ontario, extracted by Public Health Ontario [2014/08/15].

Table 1: Number and incidence rate (per 100,000 population) of reported confirmed and probable human cases of West Nile Virus by health unit of residence: Ontario, 2014

Health Unit	Confirmed cases	Probable cases	Total cases	Rate per 100,000*	% of total cases	% of Ontario population
Chatham-Kent	1	0	1	0.95	7.69	0.78
City of Ottawa	1	1	2	0.21	15.38	6.90
Halton Region	2	0	2	0.37	15.38	3.98
Lambton County	0	1	1	0.77	7.69	0.96
Simcoe Muskoka District	1	0	1	0.19	7.69	3.94
Toronto	3	0	3	0.11	23.08	20.47
Wellington-Dufferin-Guelph	0	1	1	0.36	7.69	2.06
Windsor-Essex County	1	0	1	0.25	7.69	2.97
York Region	0	1	1	0.09	7.69	8.17
Ontario Overall	**9**	**4**	**13**	**0.10**	**100.00**	**100.00**

Data sources:
WNV cases: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2015/02/15].
Population estimates (for rate calculations): Ontario Ministry of Health and Long-Term Care, IntelliHEALTH Ontario, extracted by Public Health Ontario [2014/08/15].
*Rates are based on the sum of confirmed and probable cases.

Figure 2: Incidence rate per 100,000 population and number of confirmed and probable West Nile Virus cases by health unit of residence: Ontario, 2014*



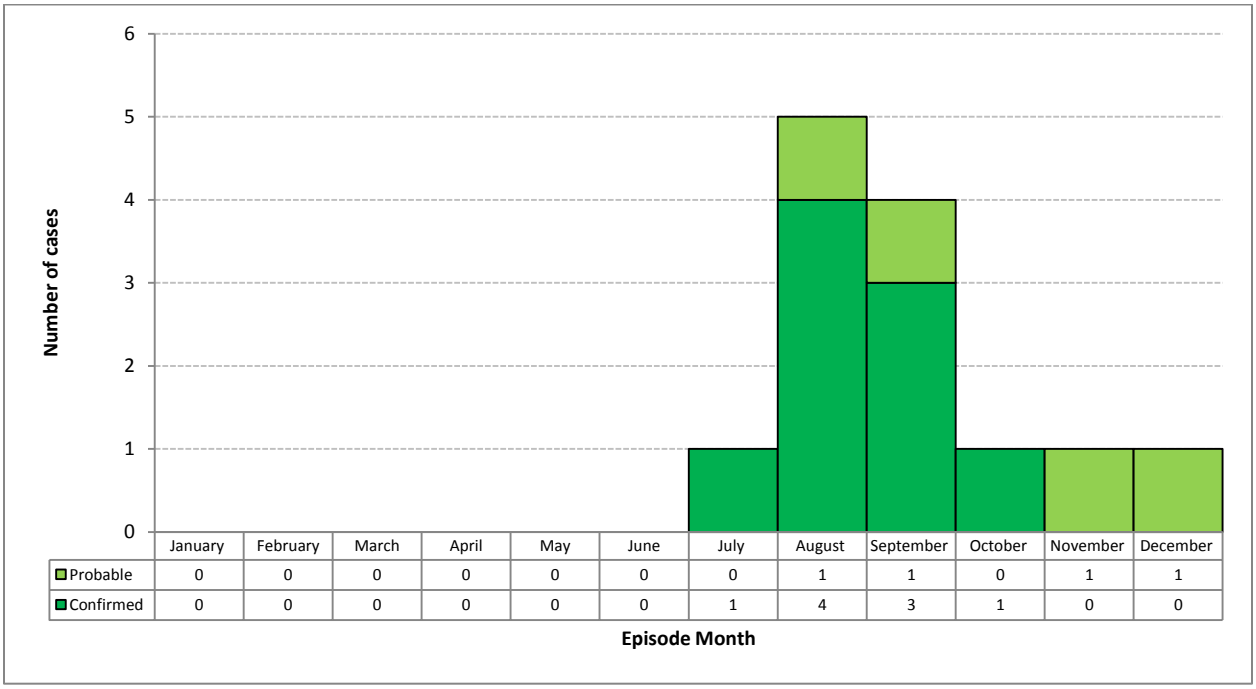
Data sources:

WNV cases: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2015/02/15].

Population estimates (for rate calculations): Ontario Ministry of Health and Long-Term Care, IntelliHEALTH Ontario, extracted by Public Health Ontario [2014/08/15].

*Rates are based on the sum of confirmed and probable cases.

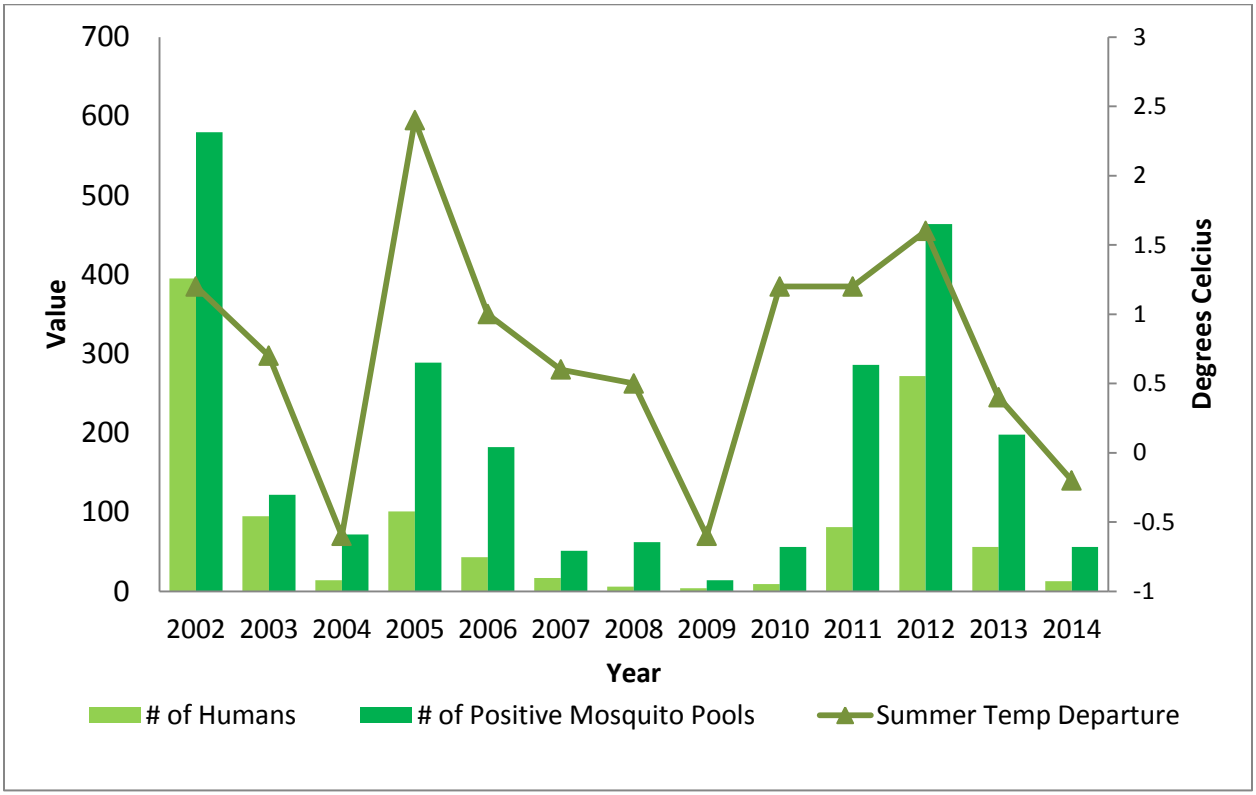
Figure 3: Number of confirmed and probable West Nile Virus cases by episode month: Ontario, 2014



	January	February	March	April	May	June	July	August	September	October	November	December
Probable	0	0	0	0	0	0	0	1	1	0	1	1
Confirmed	0	0	0	0	0	0	1	4	3	1	0	0

Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2015/02/15].

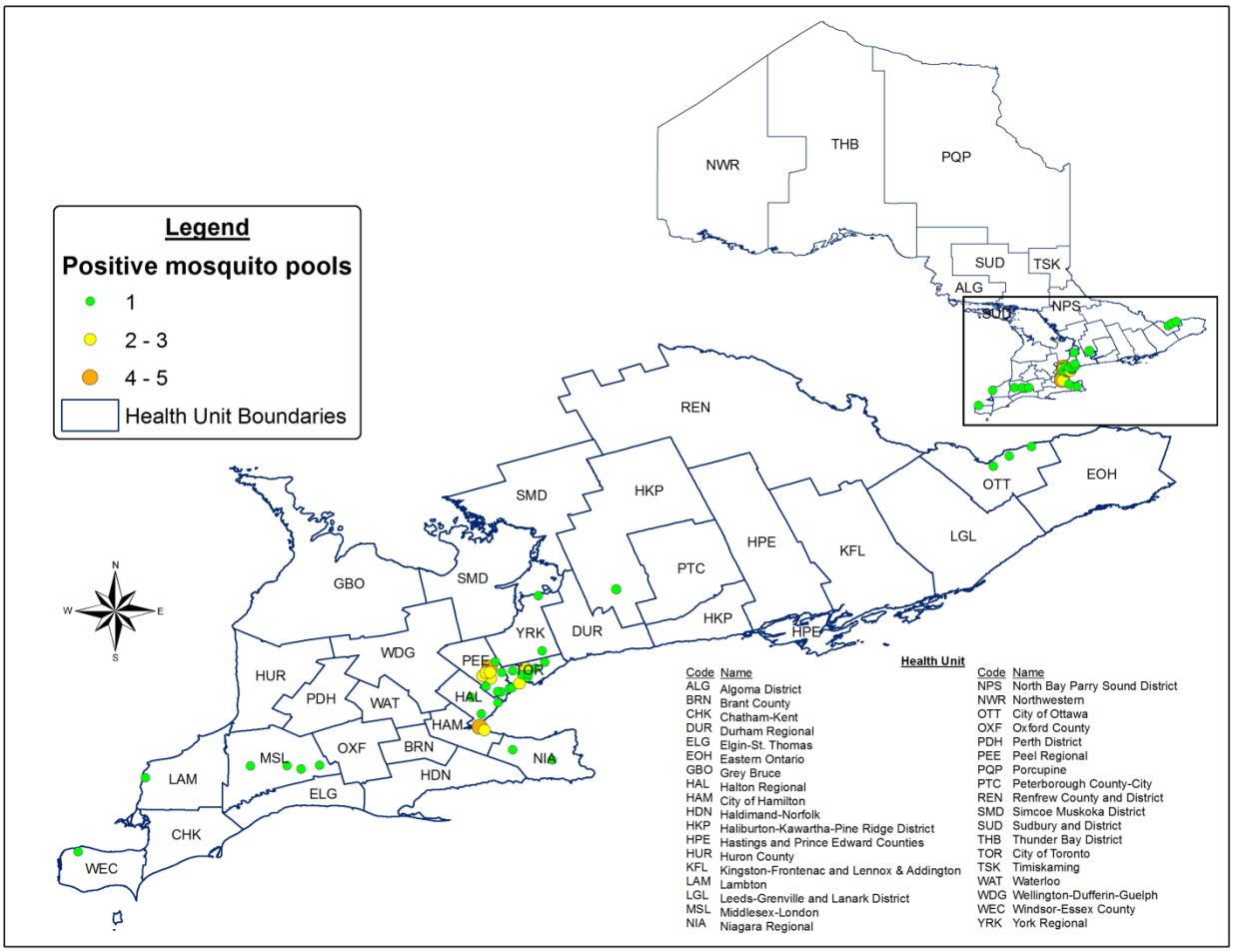
Figure 4: Number of reported West Nile Virus human cases and positive mosquito pools; and average summer temperature departures: Ontario, 2002–14



Data Sources:
WNV cases: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2015/02/04].
Mosquito data: PHO Mosquito Database [2015/02/11].
Weather Data: Environment Canada[11]
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.

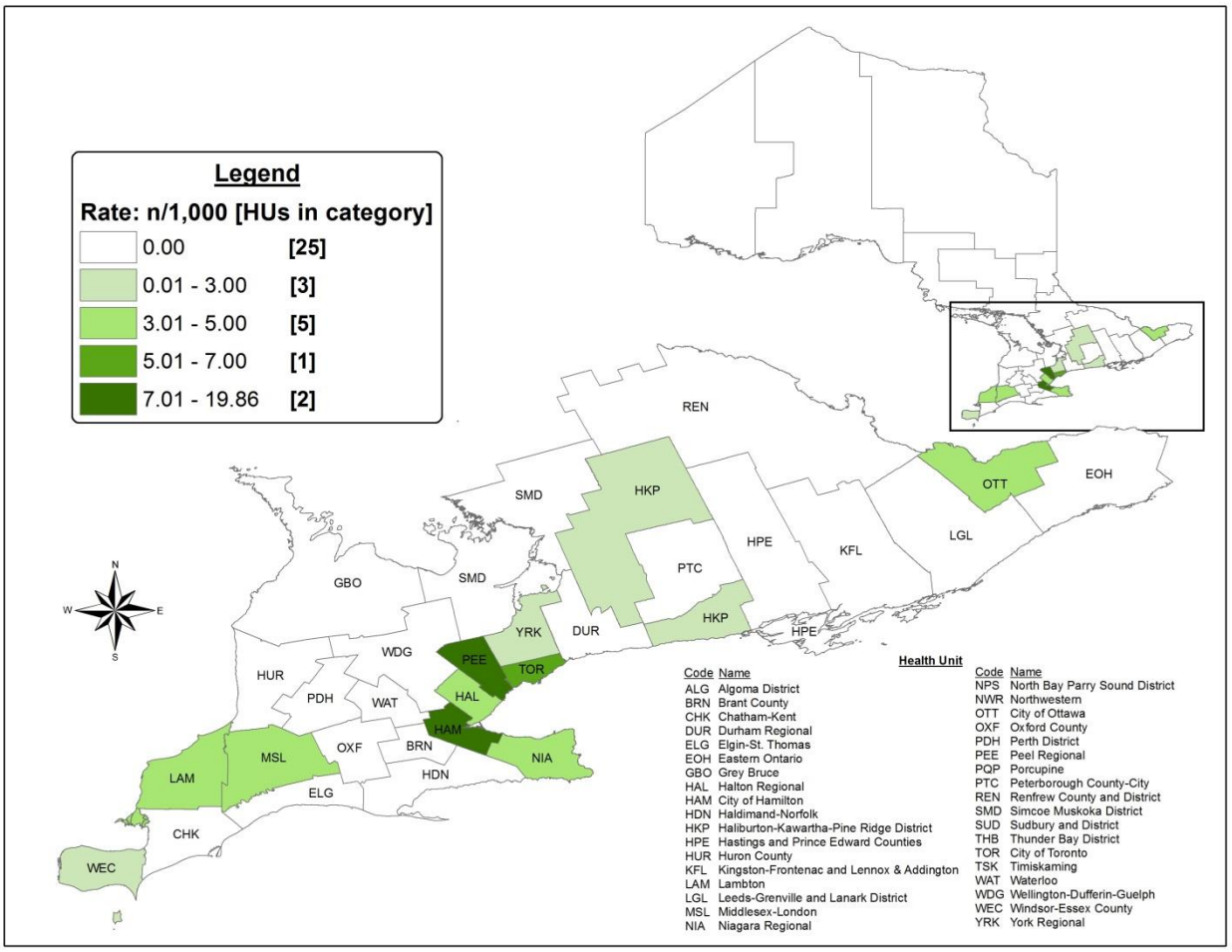
[11] http://www.ec.gc.ca/adsc-cmda/default.asp?lang=En&n=F3D25729-1

Figure 5: Location and number of mosquito pools positive for West Nile Virus: Ontario, 2014



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

Figure 6: Minimum infection rate of positive mosquito pools: Ontario, 2014



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

Eastern Equine Encephalitis Virus

As noted above, no human cases of EEEV have ever been reported in Ontario. In 2014, no mosquitoes tested positive for EEEV (Table 2).

Equine Surveillance

EEEV has been reported in Ontario in horses, emus, and pheasants dating back to 1938 (Table 2, Figure 7). In 2014, 24 EEEV equine cases were reported by the Ontario Ministry of Agriculture, Food, and Rural Affairs. The majority of these cases occurred in the eastern health units, with several reported in Simcoe-Muskoka District and Haliburton-Kawartha-Pine Ridge District. Ontario animal cases have occurred in predominantly rural health units with the cases occurring in different locations each year.

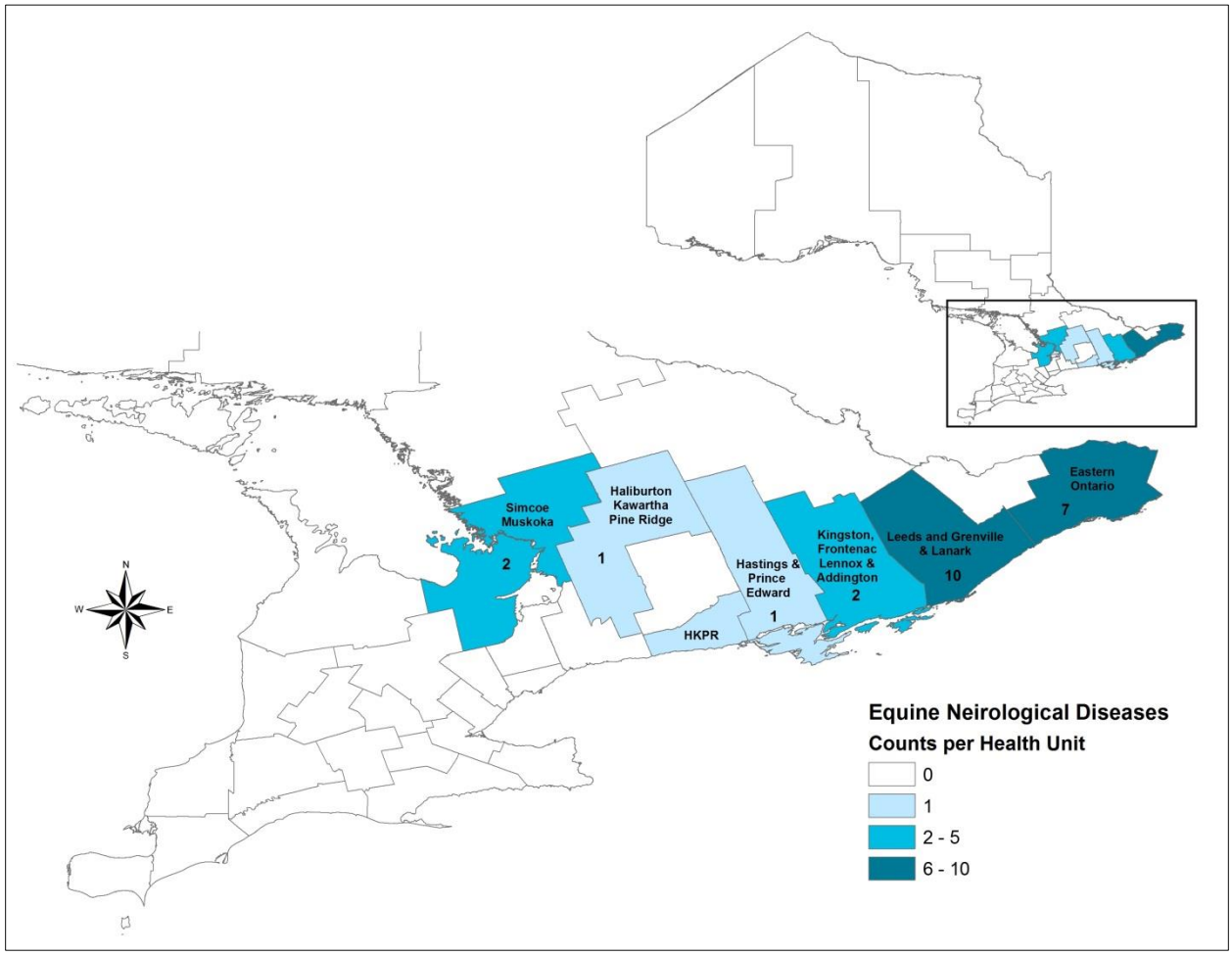
Table 2: Number of *Culiseta melanura* captured, EEEV-positive mosquito pools and EEEV horses: Ontario, 2002–14

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[12]	2
2010	218	3[13]	3
2011	222	0	4
2012	67	0	0
2013	245	1	1
2014	631	0	24

Data sources:
Horse data: OMAFRA online from http://www.omafra.gov.on.ca/english/livestock/horses/westnile.htm#surveillance
Mosquito data: PHO Mosquito Database [2015/02/11].

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

Figure 7: Eastern Equine Encephalitis Virus activity in horses: Ontario, 2014



Data source: Map information sourced from OMAFRA online [2015/04/16]: http://www.omafra.gov.on.ca/english/livestock/horses/facts/nhd_surv2014.htm

Lyme Disease

In 2014, 220 confirmed and probable human cases of Lyme disease were reported in Ontario, representing an overall incidence rate of 1.63 cases per 100,000 population (Figure 8). This rate was 34% lower than the 2013 rate of 2.47 cases per 100,000 population and is the first notable decrease in annual incidence since 2002 (Figure 8). Overall, the incidence rate of Lyme disease in Ontario has increased steadily since 2002 with rates remaining considerably higher than the national rates for the period from 2009 to 2012, when national rates ranged from 0.2 to 0.5 cases per 100,000 population[14]. The United States experienced a similar decline in Lyme disease incidence in 2014, with 29,714 reported cases in 2014, compared with 36,307 cases in 2013[15]. The reason for the decrease in incidence in Ontario and the U.S. is not known; however it is suspected that a variety of weather-related and/or human behavioural factors could have contributed to the decrease.

The majority of Lyme disease cases reported in Ontario in 2014 occurred from May to October, with June, July and August accounting for 68.6% of cases (Figure 9). This peak during the summer months is similar to other Lyme disease-endemic regions in the United States and Canada and coincides with both greater participation in outdoor activities and increased presence of infectious nymphs in the environment. Compared to adult ticks, feeding nymphs are much more difficult to detect and are more likely to result in longer duration of attachment with a higher risk of Lyme disease transmission.

Thirteen health units, including Ontario's northern-most health units, did not report any cases of Lyme disease in 2014. In contrast, incidence rates for Lyme disease in ten health units were higher than the provincial rate of 1.63 cases per 100,000 population (Table 3). Rates in these health units ranged from 1.71 in Durham Region to 21.86 in Leeds, Grenville and Lanark District; the corresponding number of reported cases ranged from two to 37 cases within these ten health units. Health units with incidence rates that exceeded the provincial rate for 2014 were mostly located in eastern and southwestern Ontario and together accounted for 63.1% (139/220) of cases reported in 2014. However, most of these cases were reported by Kingston-Frontenac andLennox & Addington and Leeds, Grenville and Lanark District (37 cases each). Toronto was the only other health unit that reported more cases in 2014 (38 cases).

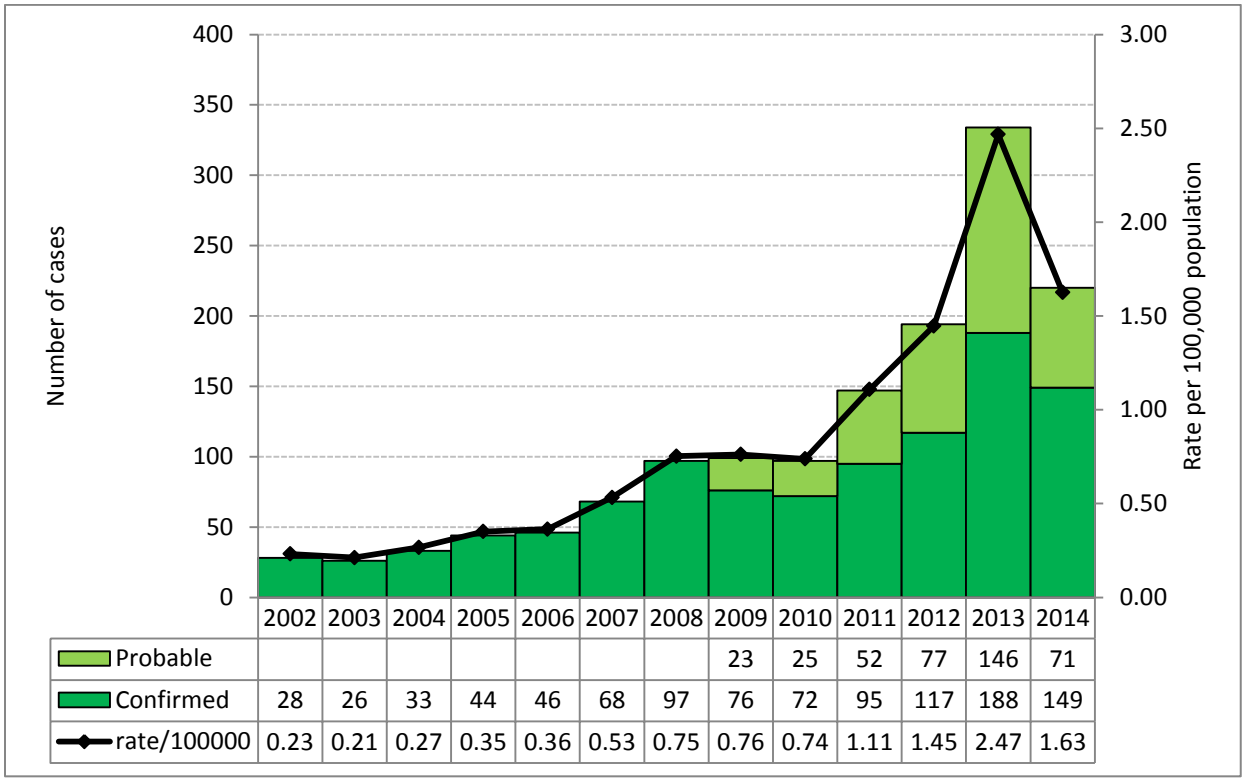
Place of exposure was reported for 87% (192/220) of Lyme disease cases reported in Ontario in 2014. Of these cases, 182 reported a single exposure, including 128 (70.3%) cases that were acquired within Ontario (Table 4). In 2014, the proportion of locally acquired cases of Lyme disease decreased by 5.9% in comparison to 2013. This is the first year since 2010 that a decrease was observed. Figure 10 shows the geographic distribution of Lyme disease exposure locations among locally-acquired cases in Ontario. The majority of cases from health units in Eastern Region [Hastings and Prince Edward Counties (HPE),

[14]Public Health Agency of Canada, Canadian Notifiable Disease Section, received by PHO [2014/07/15].
[15]CDC. Notifiable Diseases and Mortality Tables in MMWR January 9, 2015 / 63(53);ND-733-ND-746.

Kingston, Frontenac and Lennox & Addington (KFL), Leeds, Grenville and Lanark District (LGL), Eastern Ontario (EOH), Renfrew (REN), and Ottawa (OTT)] reported being exposed in Ontario (97.0%, 96/99), whereas just 38.6% (32/83) of cases from other health units reported being exposed in Ontario.

This trend of higher incidence of exposures and cases in Eastern Region correlates well with areas which are responsible for the largest number of blacklegged ticks submitted (Figures 10 and 11). Of 2126 blacklegged ticks submitted for testing to PHO in 2014, 2004 had information on the submitter's residence; of these, 1237 came from the eastern health units HPE, KFL, LGL, EOH, and OTT (Table 4). This number is lower than previous years, most likely due to the switch from passive tick surveillance to active tick surveillance in KFL, LGL and EOH.

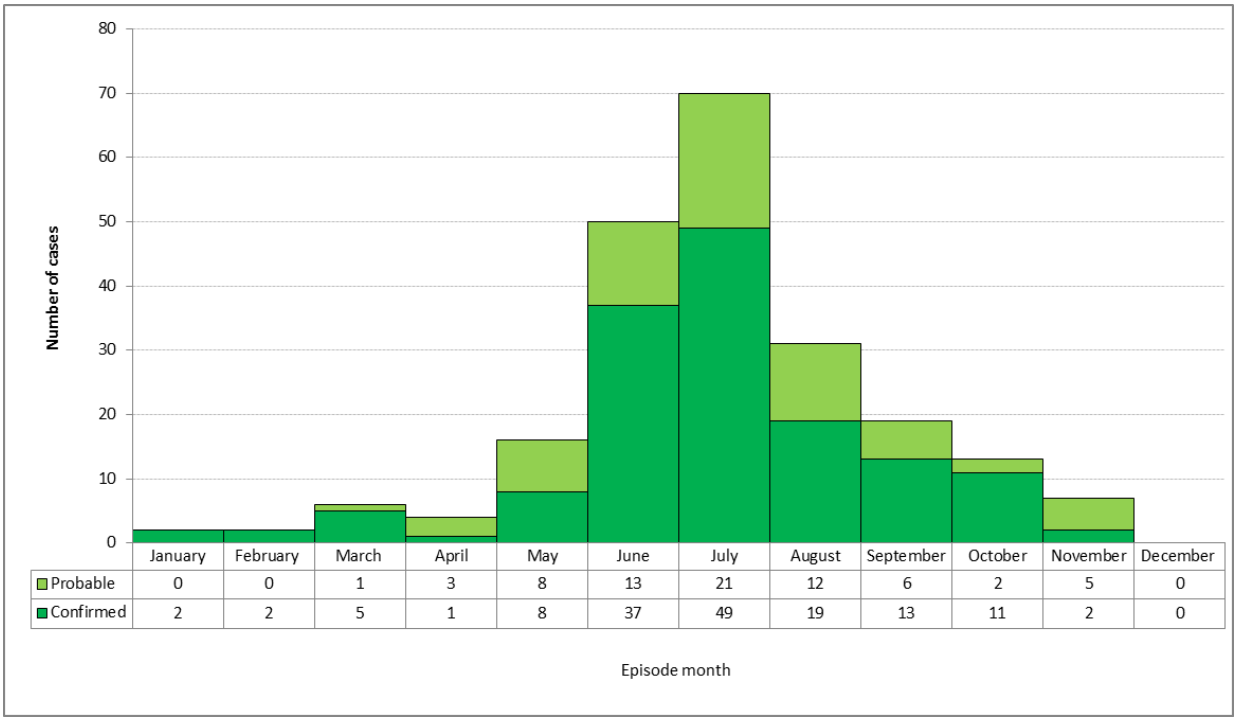
Figure 8: Number of cases of Lyme disease and incidence rate per 100,000 population: Ontario, 2002–2014



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Probable								23	25	52	77	146	71
Confirmed	28	26	33	44	46	68	97	76	72	95	117	188	149
rate/100000	0.23	0.21	0.27	0.35	0.36	0.53	0.75	0.76	0.74	1.11	1.45	2.47	1.63

Data sources:
Lyme disease cases: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2015/01/30].
Population estimates (for rate calculations): Ontario Ministry of Health and Long-Term Care, IntelliHEALTH Ontario, extracted by Public Health Ontario [2014/08/15].

Figure 9: Distribution of confirmed and probable Lyme disease cases by episode month: Ontario, 2014



	January	February	March	April	May	June	July	August	September	October	November	December
Probable	0	0	1	3	8	13	21	12	6	2	5	0
Confirmed	2	2	5	1	8	37	49	19	13	11	2	0

Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2015/01/30].

Table 3: Number and incidence rate (per 100,000 population) of reported confirmed and probable human cases of Lyme disease by health unit of residence: Ontario, 2014

Health Unit	Confirmed cases	Probable cases	Total cases	Rate per 100,000*	% of total cases	% of Ontario population
Brant County	3	0	3	2.1	1.36	1.05
Chatham-Kent	3	0	3	2.84	1.36	0.78
City of Hamilton	5	1	6	1.1	2.73	4.03
City of Ottawa	1	20	21	2.25	9.55	6.9
Durham Region	8	3	11	1.71	5	4.76
Eastern Ontario	3	4	7	3.42	3.18	1.51
Halton Region	3	2	5	0.93	2.27	3.98
Hastings & Prince Edward Counties	6	4	10	6.12	4.55	1.21
Kingston, Frontenac, Lennox & Addington	26	11	37	18.53	16.82	1.47
Leeds, Grenville and Lanark District	30	7	37	21.86	16.82	1.25
Middlesex-London	3	1	4	0.87	1.82	3.41
Niagara Region	5	3	8	1.8	3.64	3.29
North Bay Parry Sound District	0	1	1	0.78	0.45	0.95
Peel Region	2	2	4	0.29	1.82	10.25
Peterborough County-City	1	0	1	0.72	0.45	1.03
Porcupine	0	1	1	1.15	0.45	0.64
Renfrew County and District	0	2	2	1.9	0.91	0.78
Simcoe Muskoka District	4	1	5	0.94	2.27	3.94
Toronto	34	4	38	1.37	17.27	20.47
Waterloo Region	5	0	5	0.93	2.27	3.95
Wellington-Dufferin-Guelph	1	0	1	0.36	0.45	2.06
Windsor-Essex County	2	2	4	0.99	1.82	2.97
York Region	4	2	6	0.54	2.73	8.17
Ontario Overall	**149**	**71**	**220**	**1.63**	100	100

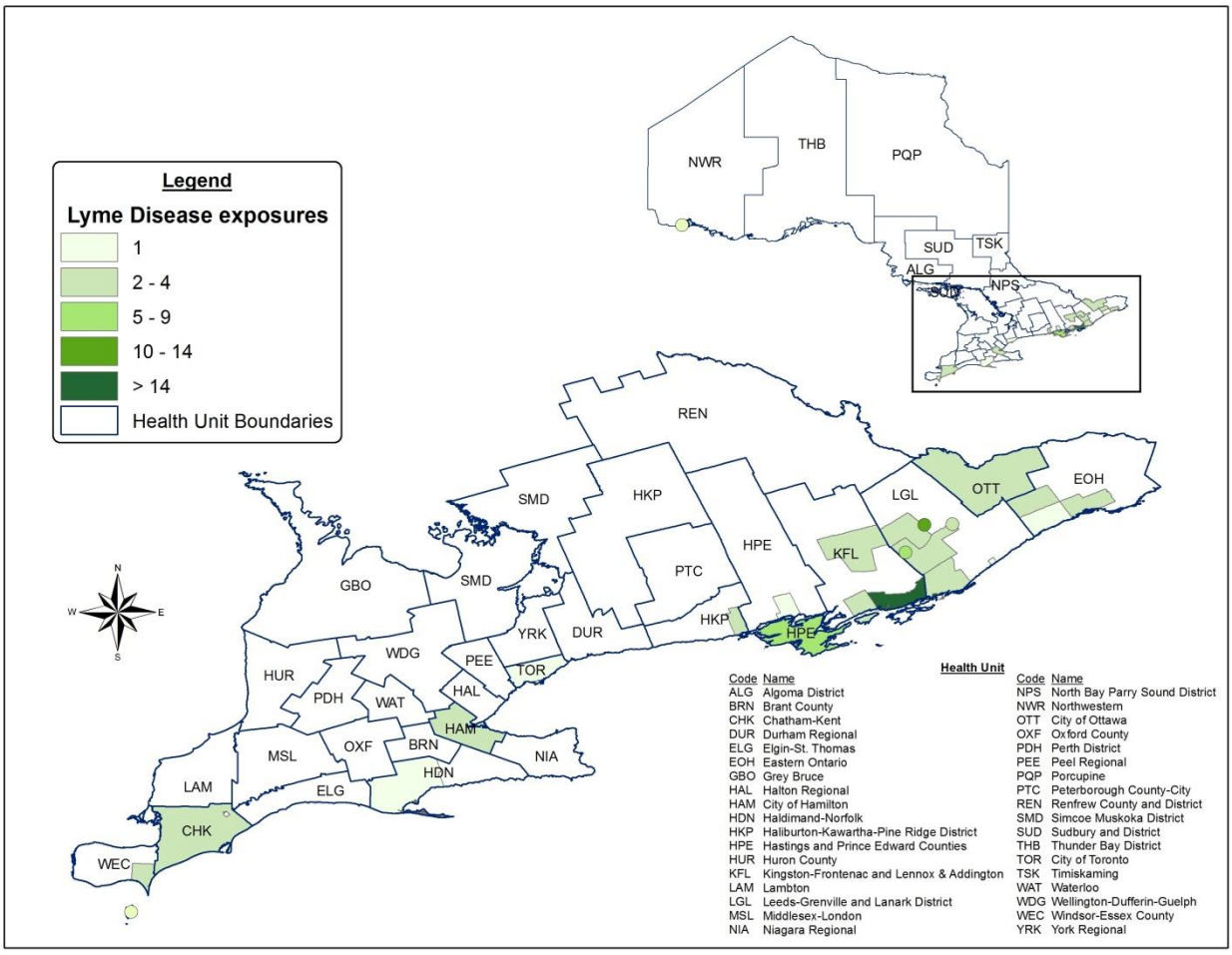
Data sources:
Lyme disease cases: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2015/01/30].
Population estimates (for rate calculations): Ontario Ministry of Health and Long-Term Care, IntelliHEALTH Ontario, extracted by Public Health Ontario [2014/08/15].
*Rates are based on the sum of confirmed and probable cases.

Table 4. Lyme disease cases by exposure setting, and total number of *I. scapularis* submissions to PHO: Ontario, 2010–14

Exposure Locations	2010		2011		2012		2013		2014	
	n	%	n	%	n	%	n	%	n	%
Within Ontario	38	55.9	92	69.2	113	73.9	168	74.7	128	70.3
Within Canada, outside Ontario	1	1.5	6	4.5	3	2	6	2.7	2	1.1
Outside Canada	28	41.2	33	24.8	35	22.9	45	20	42	23.1
Unknown	1	1.5	2	1.5	2	1.3	6	2.7	10	5.5
Subtotal of specified exposure locations	68	100	133	100	153	100	225	100	182	100
Missing*	23	23.7	12	8.2	34	17.5	96	28.7	29	13.2
Total number of reported cases	97		147		194		334		220	
Total number of *I. scapularis* submissions	580		956		2291		2535		2126	

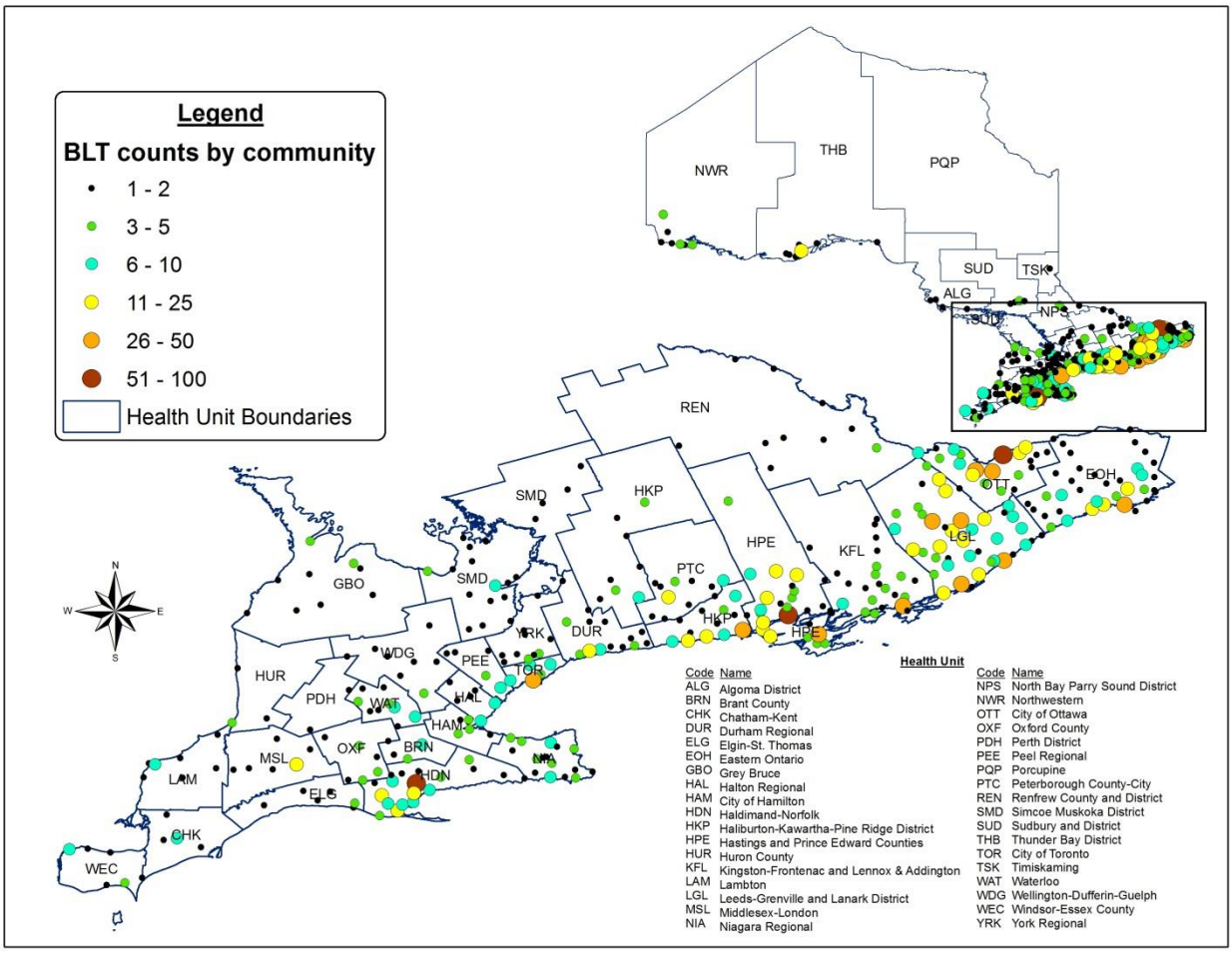
Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2015/01/30].
Tick Data, Public Health Ontario (PHO), extracted [2015/03/12].
Notes: Cases may report multiple exposures. The presented exposure categories do not include cases that reported more than one exposure with the exception of cases that reported two exposures where one of the reported exposures is specified as 'unknown'. As a result of this exclusion criterion, column totals do not sum to the total number of reported cases.
* Percentage of total number of reported cases.

Figure 10: Number of Lyme disease cases by municipality of most likely exposure for locally acquired cases: Ontario, 2014



Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2015/01/30].
Note: Circles in southern Ontario represent small municipalities that would not be visible. Circles in northern Ontario represent areas that are not within a municipality.

Figure 11: The location and number of blacklegged ticks submitted to Public Health Ontario, based on the submitter's community of residence: Ontario, 2014



Data source: Public Health Ontario (PHO), extracted [2015/04/15].

Data Considerations and Limitations

- The data are current as of January 30, 2015 for human cases of Lyme disease and West Nile Virus.
- The data only represent cases reported to public health units and recorded in iPHIS. Counts are subject to varying degrees of underreporting depending on the disease.
- iPHIS is a dynamic disease reporting system which allows ongoing updates to data previously entered. As a result, data extracted from iPHIS represent a snapshot at the time of extraction and may differ from previous or subsequent reports.
- Cases are reported based on "episode date". The Episode Date is an estimate of the onset date of disease for a case. In order to determine this date, the following hierarchy is in place in iPHIS: Onset Date > Specimen Collection Date > Reported Date.
- Cases for which the Disposition Status was reported as "ENTERED IN ERROR", "DOES NOT MEET DEFINITION", "DUPLICATE-DO NOT USE" or any variation on these values have been excluded.
- Case counts for Lyme disease include only confirmed cases for cases with episode dates up to December 31, 2008 and confirmed and probable cases for cases with episode dates as of 2009. Case counts for WNV illness include confirmed and probable cases for all years.
- Calculated rates are based on confirmed cases or the sum of confirmed and probable cases as applicable. Population counts for 2013 are used to estimate health unit and provincial population counts for 2014.
- The Lyme disease confirmed case definition changed in 2009 such that clinical cases were no longer considered confirmed. Clinical cases are now considered probable cases and case counts for 2009 and subsequent years include both confirmed and probable cases to ensure valid comparisons of trends over time.
- Health unit refers to the case's health unit of residence at the time of illness onset and not necessarily the location of exposure.
- The possibility of duplicates exists because duplicate sets were not identified and excluded unless they were resolved prior to data extraction either at the local or provincial level.
- Cases may report multiple exposures. The presented exposure categories do not include cases for which no exposure was reported, or cases that reported more than one exposure with the exception of cases that reported two exposures where one of the reported exposures is specified as 'unknown'.
- Exposures cannot be definitively attributed to illness, but are assumed to be possible sources of illness. The number of reported exposures may be an underestimate because of missing data.
- PHO stopped accepting ticks from non-humans in 2009. Health units KFL, LGL, and EOH switched to only active tick surveillance in 2014.

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