

Vector-Borne Diseases 2011 Summary Report

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Introduction

This report provides an overview of Ontario's 2011 vector-borne disease season. The major vector-borne diseases of public health importance in Ontario are West Nile Virus (WNV), Eastern Equine Encephalitis Virus (EEEV) and Lyme disease (LD).

The first cases of WNV in Ontario were detected in birds in 2001, with the first human cases following in 2002. Since then, WNV activity has varied from year to year. Over the last few years, Ontario has experienced low levels of WNV activity but this changed in 2011 when 78 human cases and 286 positive mosquito pools were reported. Lyme disease (LD) has been present in Ontario for many years, but the numbers and geographical range of the tick vector has expanded. Eastern Equine Encephalitis Virus (EEEV) has been present in the horse population in Ontario since 1938. In the last couple of years, surveillance data from health units and First Nations Inuit Health Branch has detected the virus in the mosquito population. Although the risk is still low in Ontario, and there has never been a human case of EEEV reported in the province, enhanced surveillance for the virus was implemented due to the increased activity (equines and mosquitoes) in the surrounding jurisdictions. In 2011, Ontario did not detect any EEEV in the mosquito population despite increased testing; however, four positive horses were reported.

West Nile Virus

There were 78 human cases and 286 mosquito pools positive for WNV in 2011. These are the highest numbers reported since 2005 (Figures 1 & 2). This could be attributed to warmer temperatures in 2011 and 2010, which contrasted with the cool, wet climate conditions and low abundance of vector mosquitoes which were observed in 2008 and 2009 (Box 1 for 2012 predictions). The majority of human cases were reported in the golden horseshoe area and were reported in August and September of 2011 (Figures 3 & 4).

Public health units in Ontario conduct mosquito surveillance from June to October each year. The majority of positive mosquito pools were also reported around the golden horseshoe, as well as Windsor and Ottawa (Figures 5 & 6) in 2011. These areas are the predominately urban areas of Ontario and have large numbers of catch basins, which are the preferred development site for the main mosquito vectors. In 2011, several species of mosquitoes tested positive for WNV, including: *Culex pipiens/restuans*, *Aedes vexans*, *Ochlerotatus stimulans*, *Oc. triseriatus*, *Oc. trivittatus*, *An. punctipennis*, *An. quadrimaculatus* and *Ochlerotatus japonicus*. *Cx. pipiens/restuans* was the species that tested positive for WNV most frequently. However, it should be noted that *Cx. pipiens/restuans* are specifically targeted for WNV testing, as this is the vector primarily responsible for human cases. It should also be noted that in 2011, Ontario implemented an enhanced EEEV mosquito surveillance program, which affected the number of WNV pools a health unit was allotted to test. In previous years health units were allotted three pools per trap to test for WNV and one pool if *Cs. melanura* was trapped for EEEV. In 2011 the testing protocol was changed to one pool for WNV and two pools for EEEV. The order for viral testing depended on the species of mosquitoes captured in the traps, and was 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 2011, making it difficult to compare to previous years. In recent years due to resource constraints, some health units have had to reduce the number of mosquito traps and/or focus their surveillance efforts to areas of greatest risk. For example there were 20,064 pools viral tested in 2005 which was reduced to 16,061 in 2011.

Box 1: 2012 West Nile Virus Predictions

- In general, temperature is the major influence on the level of WNV activity.
- If the weather remains warm, with enough precipitation, Ontario could experience another high year of WNV activity (likely similar to 2011). This is because 2011 ramped up the virus and with the mild winter conditions more mosquitoes and virus would have survived into this current year.
- If the season turns out to be hot, without enough precipitation, then Ontario would likely see lower numbers as the vector development sites would decline.
- If the weather is cool, but there is enough precipitation, Ontario could see some cases but not as high as with warmer weather.

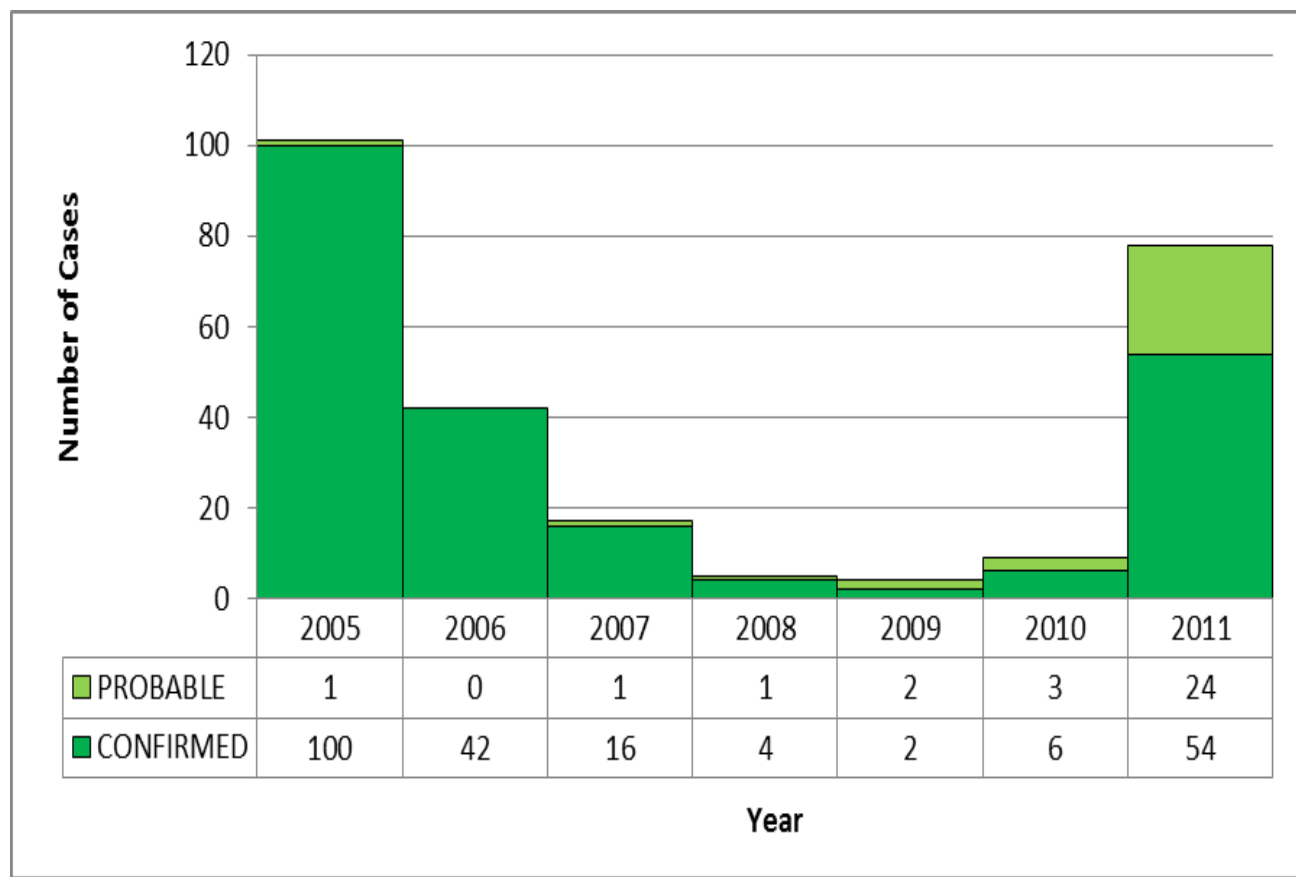


Figure 1: Number of confirmed and probable human West Nile Virus cases by year: Ontario, 2005-2011

Source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/03/27].

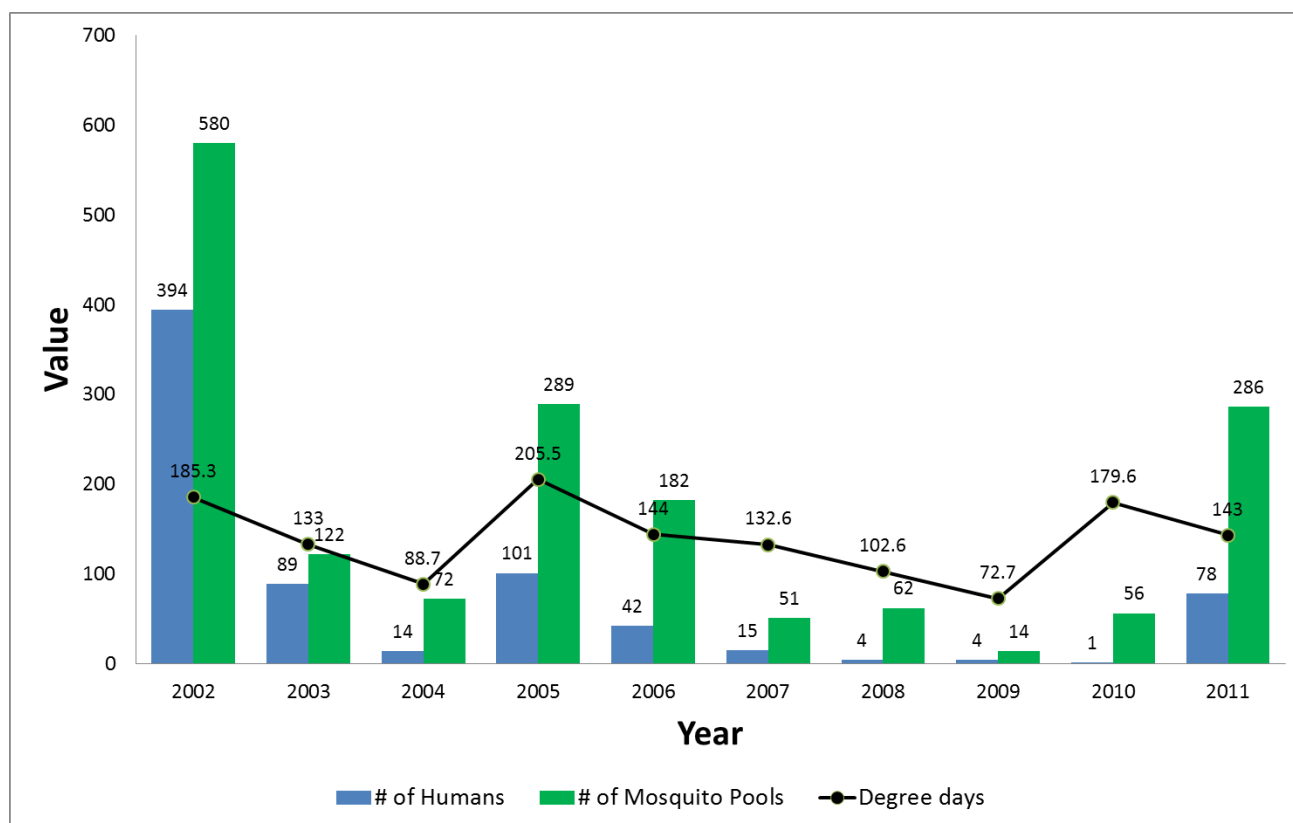


Figure 2: Number of human cases, number of positive mosquito pools and accumulated degree days¹, 2002-2011

¹ A degree day is a unit of measurement for temperature. Degree days are the amount of heat required for an organism to develop within certain life stages. Degree days are typically used in agriculture to determine when insect pests will become a problem. A degree day is one day (24 hrs) with which the temperature is above or below a fixed reference temperature; for *Cx. pipiens/restuans*, this temperature is 18.3 °C (F. Hunter, personal communication). Therefore, if the temperature remained at 18.3 °C for 24 hours, then one degree day would be accumulated.

Accumulated degree days are the continuous addition of consecutive degree days from a set starting point.

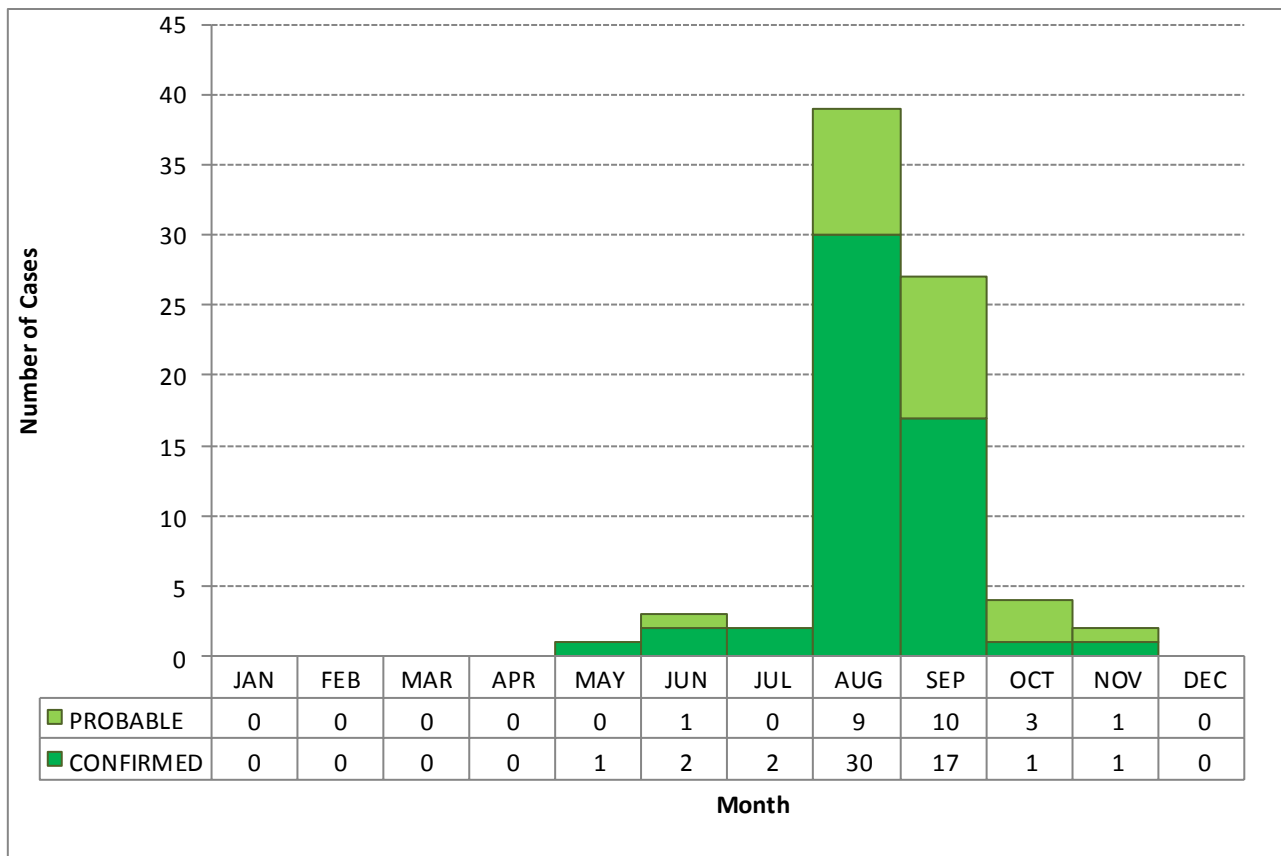


Figure 3: Number of confirmed and probable West Nile virus cases by episode month: Ontario, 2011

Source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/03/27].

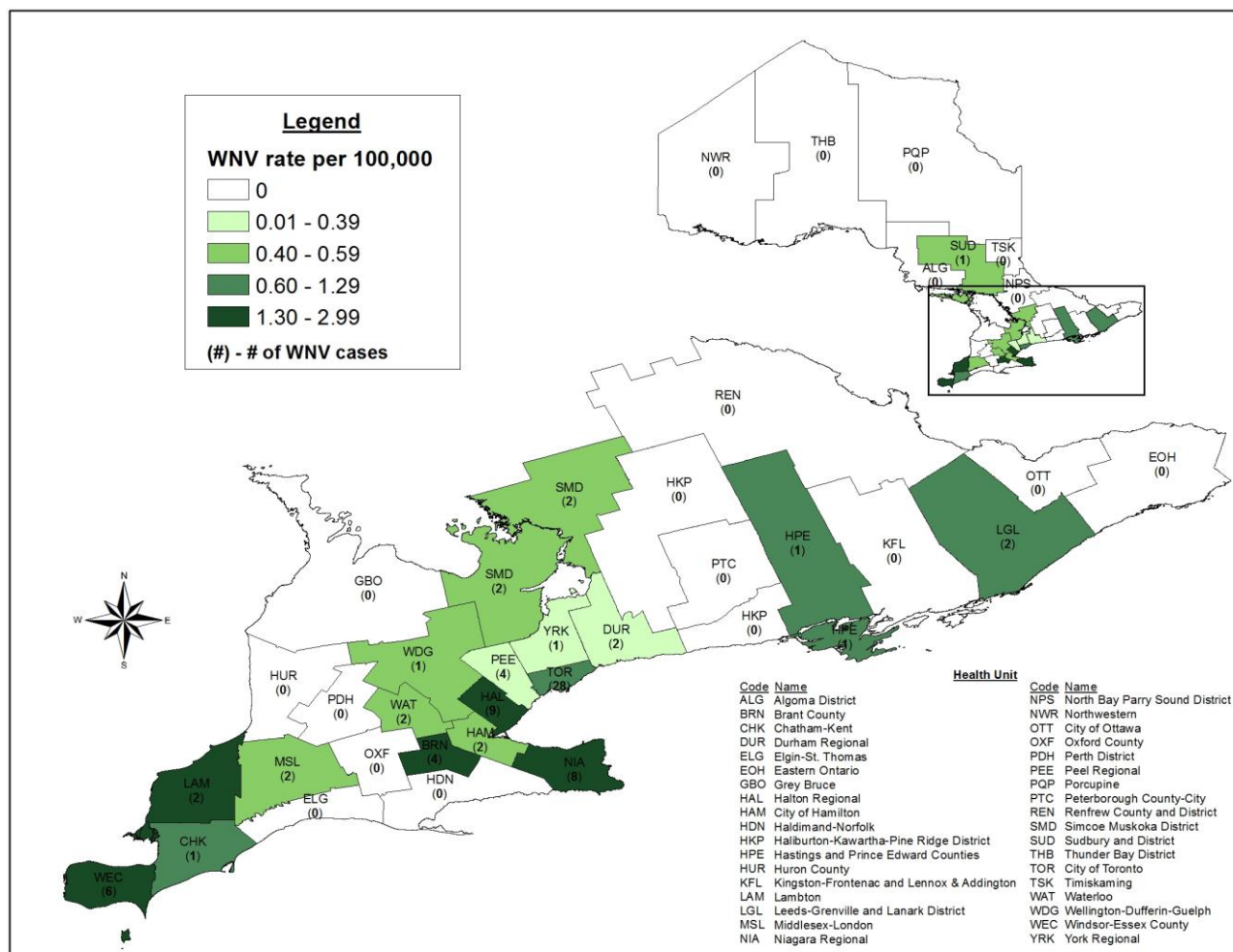


Figure 4: Incidence Rate of West Nile virus per 100,000 population and number of confirmed and probable cases by health unit: Ontario, 2011.

Source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/03/27].

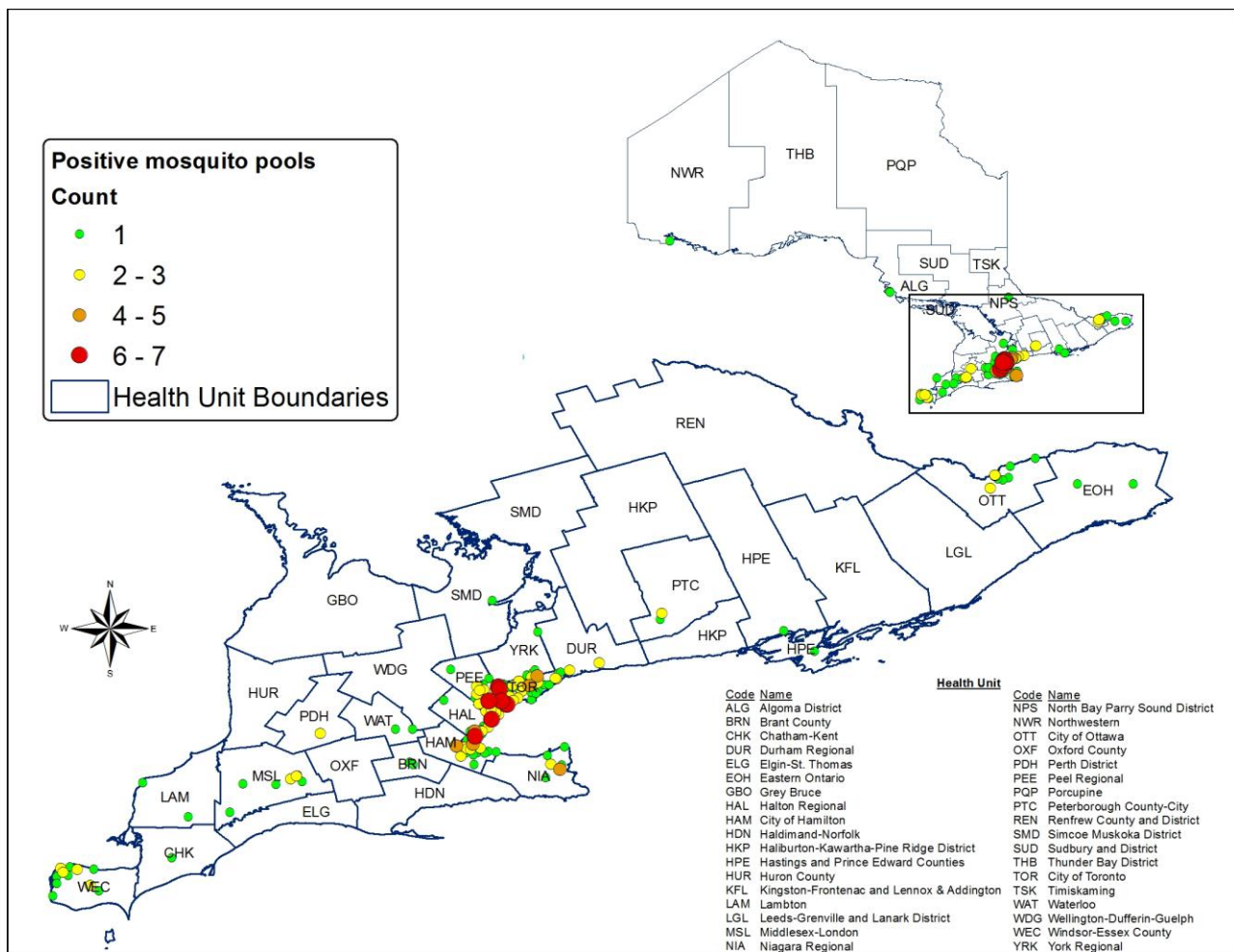


Figure 5: Location and number of West Nile Virus positive mosquito pools in Ontario, 2011.

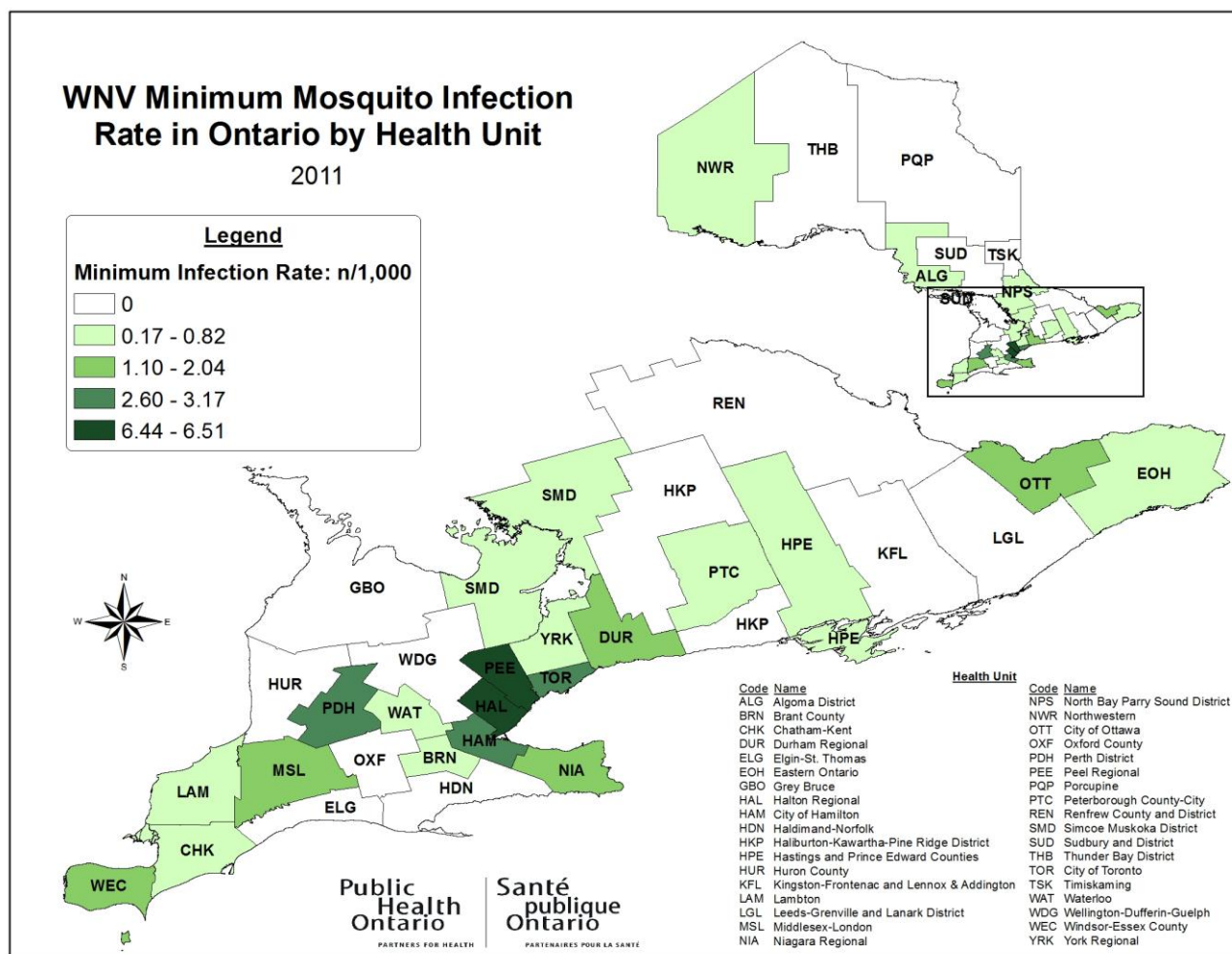


Figure 6: Minimum Infection Rate² of Positive Mosquito Pools, 2011

² Minimum Infection Rate (MIR) is an estimation of the minimum number of positive mosquitoes in the environment. It is stated as the number positive mosquitoes per 1000. It is a population-adjusted rate used for comparison and analysis. MIR formula: (# WNV positive pools/Total # of mosquitoes tested)/1000.

Eastern Equine Encephalitis

The main enzootic vector for EEEV in Ontario, and the eastern U.S., is *Cs. melanura*. This mosquito primarily feeds on birds 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 swamp-like areas, the majority of horse cases in Ontario occur in areas adjacent to swamps or flooded forests; making this more of a rural than urban disease. Possible bridge vectors include: *Ae. vexans* and *Cq. perturbans*. *Cs. melanura* is not readily captured in Ontario's mosquito light-traps, but the bridge vectors are. These bridge vectors are also thought to readily bite humans, are attracted to mosquito light-traps 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.

Ontario has a secondary adult mosquito vector surveillance program focused on *Cs. melanura*. If this species is captured during WNV mosquito trapping, the mosquitoes can be tested for EEEV by the health unit's mosquito testing service providers. For the 2011 mosquito season, health units were asked to modify the order of preference and test for the main WNV vector first followed by specific EEEV vectors (*Ae. vexans* and *Cq. perturbans*). The duration of this modified surveillance initiative will depend on the data acquired and the incidence of vector-borne diseases in Ontario. It is anticipated that this surveillance will last for at least three years to acquire a minimal baseline dataset.

There were no EEEV positive mosquitoes reported in 2011. Although there were no positive results from trapped mosquitoes, the occurrence of positive animals indicates that positive mosquitoes were in the area. The first year that Ontario had ever recorded EEEV positive mosquitoes was in 2009, found through the First Nations and Inuit Health's (FNIH) WNV mosquito program, which mirrors Ontario's program (Table 1). They were found in a First Nations community within Simcoe Muskoka District Health Unit. In 2010, EEEV positive *Cs. melanura* mosquitoes were again found in the same First Nations community; and also in North Bay-Parry Sound District Health Unit (Table 1).

EQUINE SURVEILLANCE

EEEV has been reported in Ontario in horses, emus and pheasants dating back to 1938; however it has never been reported in humans (Table 1, Figure 7). In 2011 there were four EEEV equine cases in three health units: Eastern Ontario (n=2), Leeds-Grenville and Lanark (n=1), Simcoe-Muskoka District (n=1). Grey-Bruce Health Unit also had pheasants test positive for EEEV. Animal cases are reported to the Ministry of Agriculture, Food, and Rural Affairs (OMAFRA). Ontario animal cases occur in predominantly rural health units with the cases occurring in different locations each year. Like WNV, horses are dead-end hosts but are an indicator of EEEV positive mosquitoes in the area.

EEE EPIDEMIOLOGY IN THE US

The U.S. has had a long history of EEEV animal and human cases dating back to the early 1800s. As with Ontario, EEEV activity occurs in rural areas with hardwood swamps and can change location from year to year. While the U.S. has experienced relatively large outbreaks in horses (>50), there have been low numbers of human cases (Figure 8). The CDC has reported an average of six human cases per year for the entire country. In 2010, Michigan and Florida reported 58 and 92 cases in horses but only three and four human cases, respectively. In 2011, Wisconsin had the majority of horse cases at 34, but no human cases. New York State has had one human case in each of the last two years. Most of the people who become infected with EEEV will be asymptomatic; however, among those that develop an infection of the central nervous system, approximately a third will die.

TABLE 1: NUMBER OF *CULISETA MELANURA* CAPTURED, EEEV POSITIVE MOSQUITO POOLS AND EEEV HORSES IN ONTARIO 2002-2011.

Year	Number of <i>Cs. melanura</i>	EEEV Positive Mosquito Pools	EEEV Horses
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 ³	2
2010	218	3 ⁴	3
2011	222	0	4

Horse data obtained from OMAFRA: <http://www.omafra.gov.on.ca/english/livestock/horses/westnile.htm#surveillance>

³ First Nations (Whata): 10 pools *Culiseta melanura* and 2 pools *Aedes vexans*.

⁴ Health Units (NPS) 1 pool and First Nations (Whata) 2 pools all *Culiseta melanura*

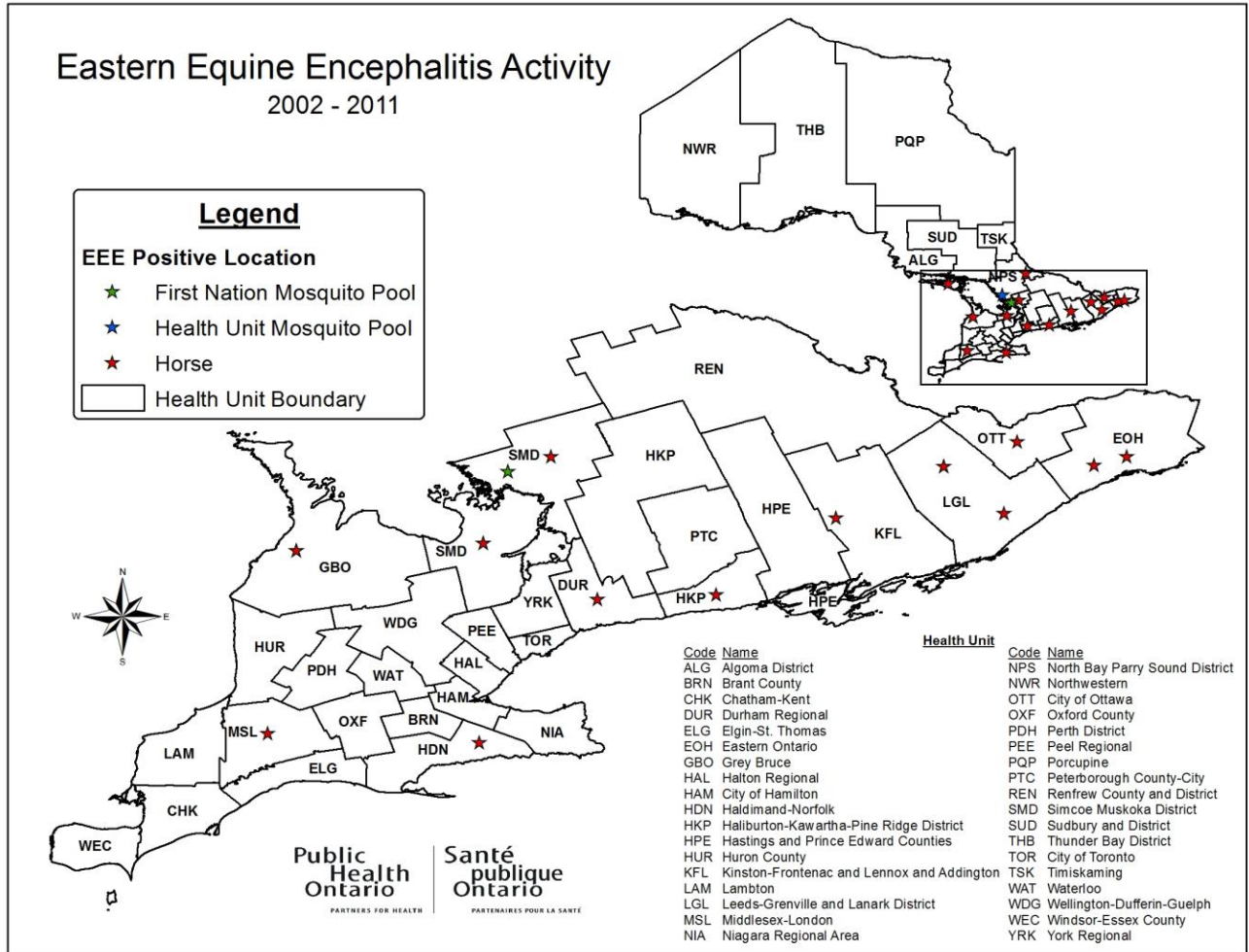


Figure 7: Eastern Equine Encephalitis Virus Activity in Ontario 2002-2011.



Figure 8: Total number of human EEEV cases reported to the CDC in the United States between 1964 and 2010. <http://www.cdc.gov/EasternEquineEncephalitis/tech/epi.html>

Lyme Disease

In 2011, the majority of blacklegged ticks submitted to the Public Health Ontario Laboratory originated from areas along the north shores of Lake Erie and Lake Ontario, and along the St. Lawrence River (Figure 9). In 2011, a total of 2286 blacklegged ticks were submitted to the Ontario Public Health Laboratory compared to 949 blacklegged ticks in 2010 (Figure 10). The majority of the tick submissions are from the health units of Kingston-Frontenac Lennox and Addington and Leeds-Grenville and Lanark. The increase in tick submissions from 2010 to 2011 could be attributed to the local public messaging campaigns from these two health units that urged the public to submit ticks. A concurrent increase and expansion of the blacklegged tick populations is also occurring in this area.

In 2011, there were 140 human cases of Lyme disease (LD) reported in Ontario with 91 (65%) cases classified as “confirmed” and the remaining 49 (35%) as “probable”. This represents an combined incidence rate of 1.06 cases per 100,000 population, and a significant increase in comparison to 2010 when 96 confirmed and probable cases were reported for a rate of 0.73 cases per 100,000 population (z score = 2.85; p = 0.004). The 2010 incidence rate for all of the U.S. and New York State was 7.3 and 12.3 per 100,000, respectively. Figure 11 shows that the rate of LD in Ontario has been gradually increasing since 2006. Six health units (Toronto, Leeds, Grenville and Lanark District, Kingston, Frontenac, Lennox and Addington, Ottawa, Halton Region and Peel Region) accounted for 64% (90/140) of LD cases reported in Ontario in 2011. On the other hand, just three health units (Leeds, Grenville and Lanark District, Haldimand-Norfolk and Kingston, Frontenac, Lennox and Addington) accounted for 62% (41/66) of exposures that occurred within Ontario. Although no cases were reported by Ontario’s northern most health units, two cases reported exposures that occurred in Northwestern and North Bay-Parry Sound District health units (Figure 12).

In 2011, 79% (111/140) of Lyme disease cases reported an exposure, including 80 locally acquired cases and 31 travel-related cases. Of the locally acquired cases, 35 (44%) were associated with non-endemic areas in Ontario, 31 (39%) with established endemic areas, and 14 (18%) with unspecified exposures within Ontario (Table 2). The higher proportion of exposures attributed to non-endemic areas in comparison to endemic areas since 2008, as well as the gradual decline in the proportion of travel related cases, is suggestive of an increase in the range of exposure locations for the acquisition of Lyme disease in Ontario. However, it is important to note that the number of cases with missing exposures has nearly doubled from 2008 to 2011 (Table 2). The majority of non-endemic cases have occurred in relatively close proximity to endemic areas and are the areas that are considered higher risk for exposure to blacklegged tick vector.

Figure 13 shows the monthly distribution of LD cases, which peaks from May to September. This peak during the summer months is similar to other LD endemic regions in the United States and Canada and coincides with both increased human outdoor activities and the vector (nymph) feeding cycle which results in increased risk of transmission of LD.

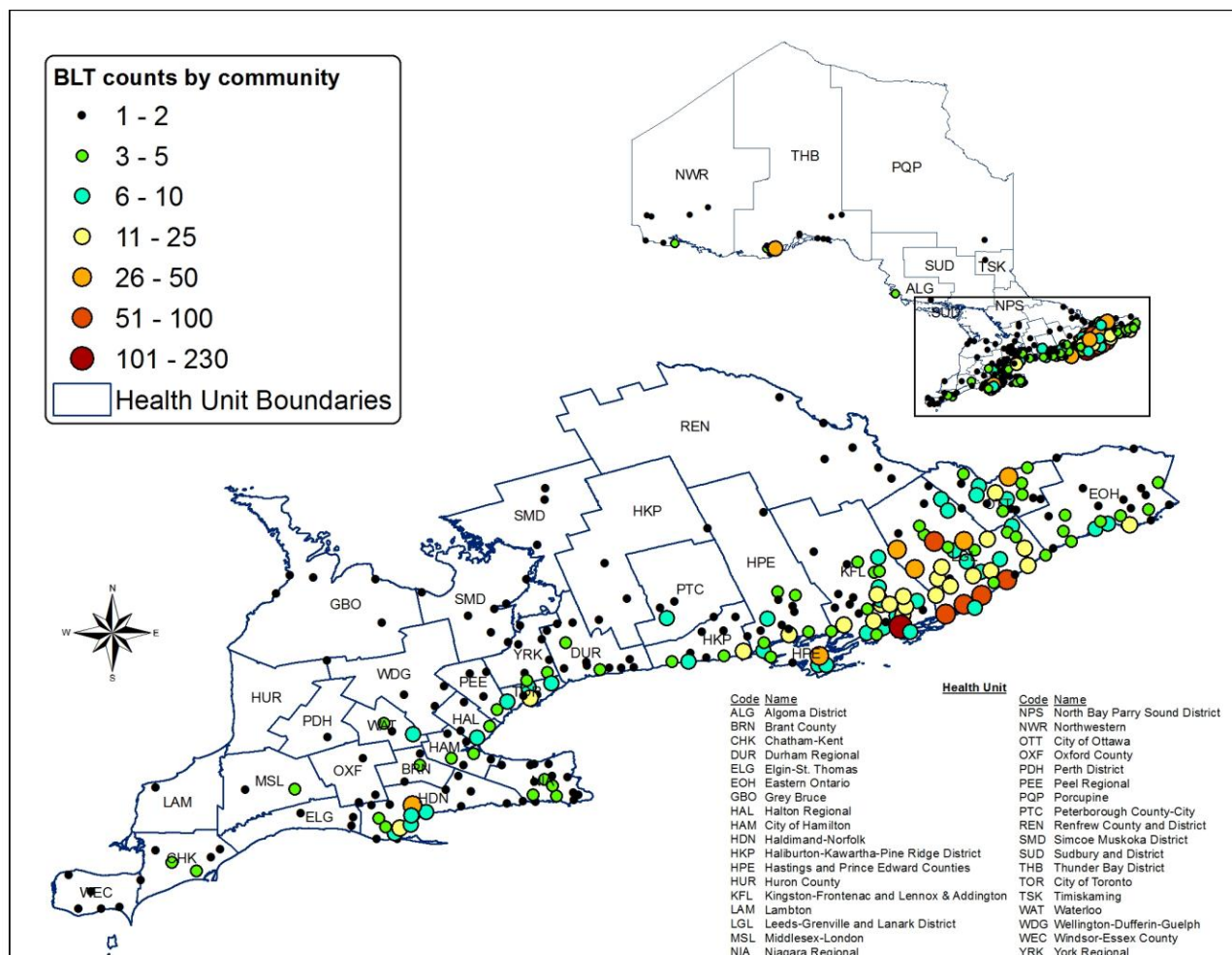


Figure 9: The location and number of blacklegged ticks submitted to the Ontario Public Health Laboratory, based on the submitter's community of residence, 2011.

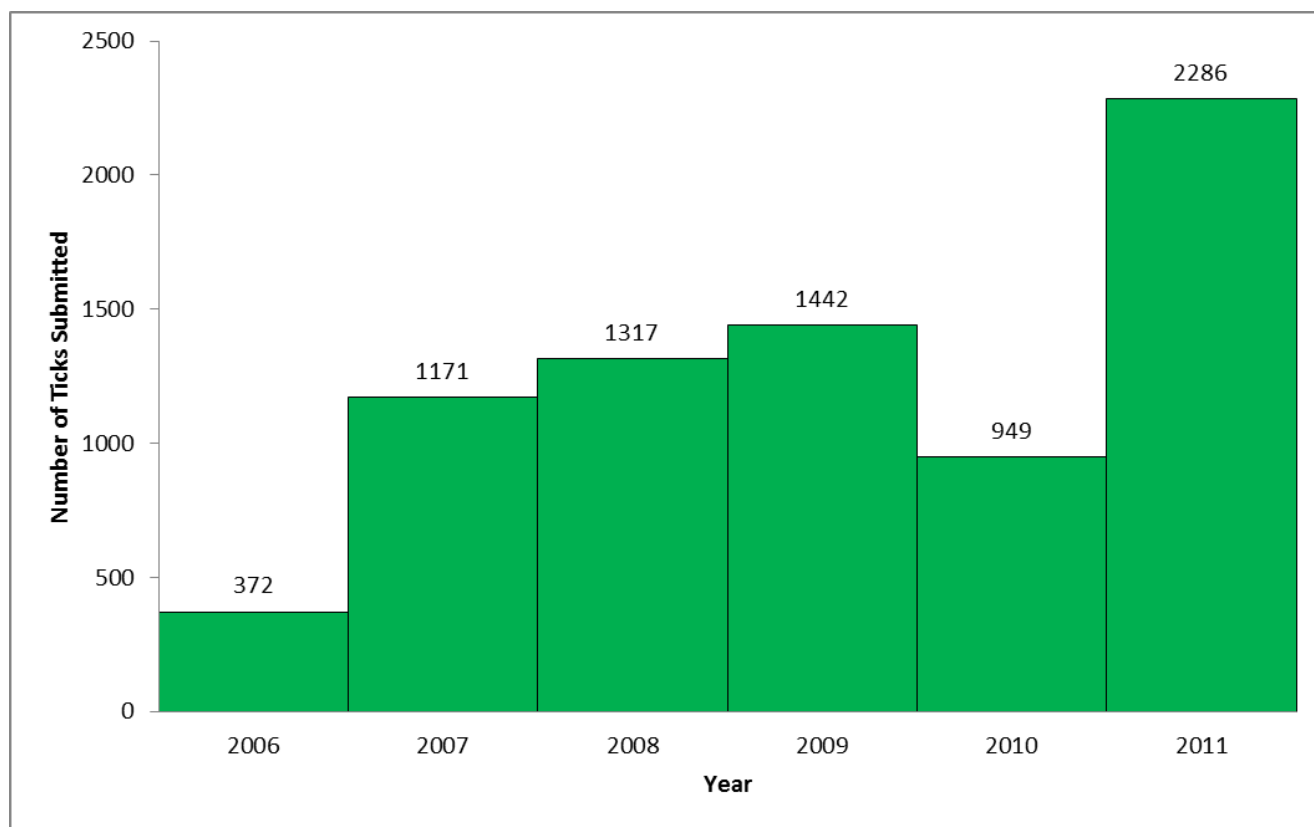


Figure 10: Number of blacklegged tick submitted to the Ontario Public Health Laboratories 2006-2011.

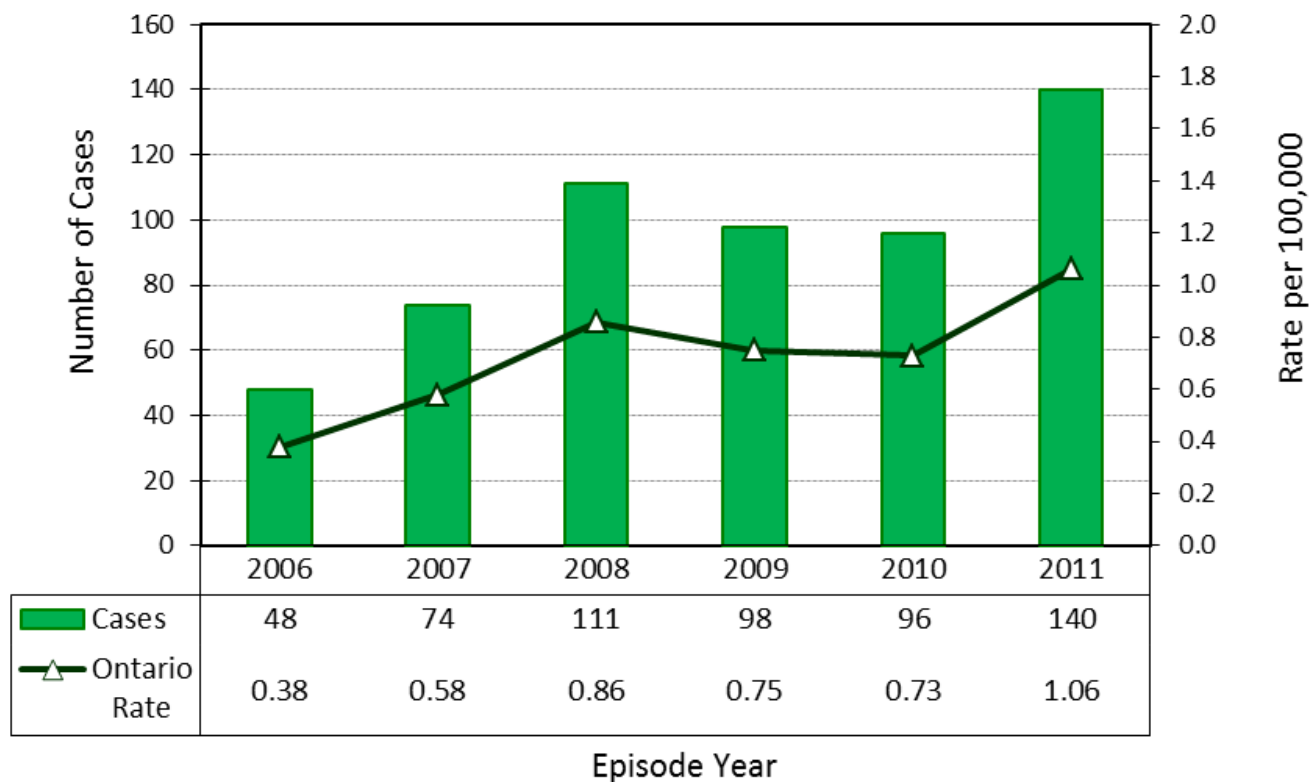


Figure 11: Number of cases and rates of Lyme disease: Ontario, 2006 – 2011

Source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/02/14]. Population data obtained from IntelliHEALTH Ontario, retrieved by Public Health Ontario [2012/01/30].

Note: Data from 2009 onwards include both confirmed and probable cases. 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.

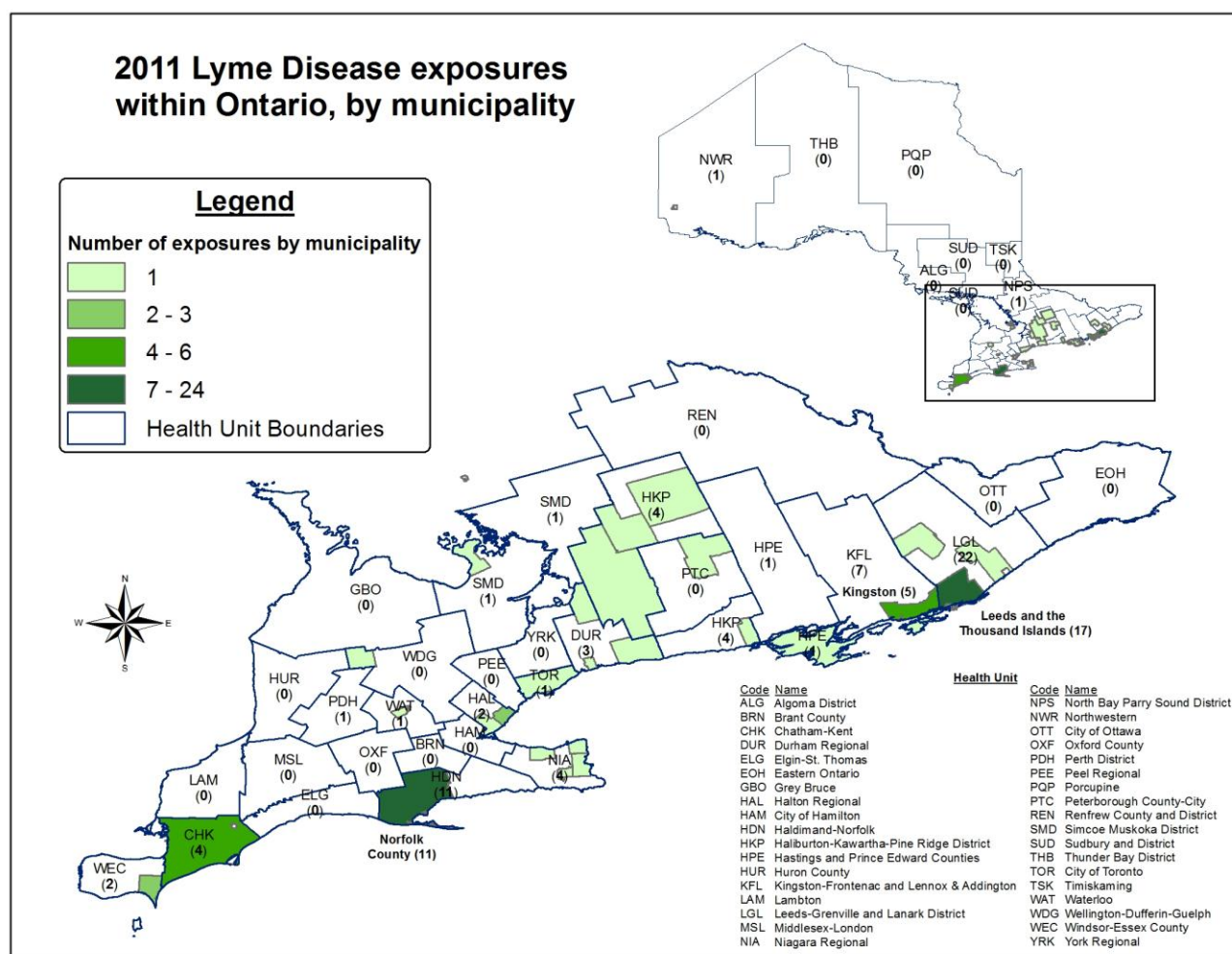


Figure 12: Location of human Lyme disease cases acquired in Ontario in 2011, based on municipality where exposure most likely occurred.

Source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/02/14].

Note: Includes confirmed and probable cases. 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.

TABLE 2: LYME DISEASE CASES BY EXPOSURE SETTINGS: ONTARIO, 2008 - 2011

EXPOSURE SOURCE ⁵	Percentage of total in each Year			
	2008 (n=111)	2009 (n=98)	2010 (n=96)	2011 (n=140)
Within Ontario Exposures:				
Endemic area in Ontario	15.4	17.8	18.9	22.1
Non-endemic area in Ontario	33.6	20.8	18.9	25.0
Unknown Ontario area	7.3	4.9	4.2	10.0
Travel outside Ontario	32.7	38.6	34.7	22.1
Missing	10.9	17.8	23.2	20.7
Total (%)	100%	100%	100%	100%

Source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/02/14].

Note: Includes confirmed and probable cases. 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.

⁵ An endemic area is a location where there is an established black-legged tick population and confirmed presence of Lyme disease in the ticks and mammal population.

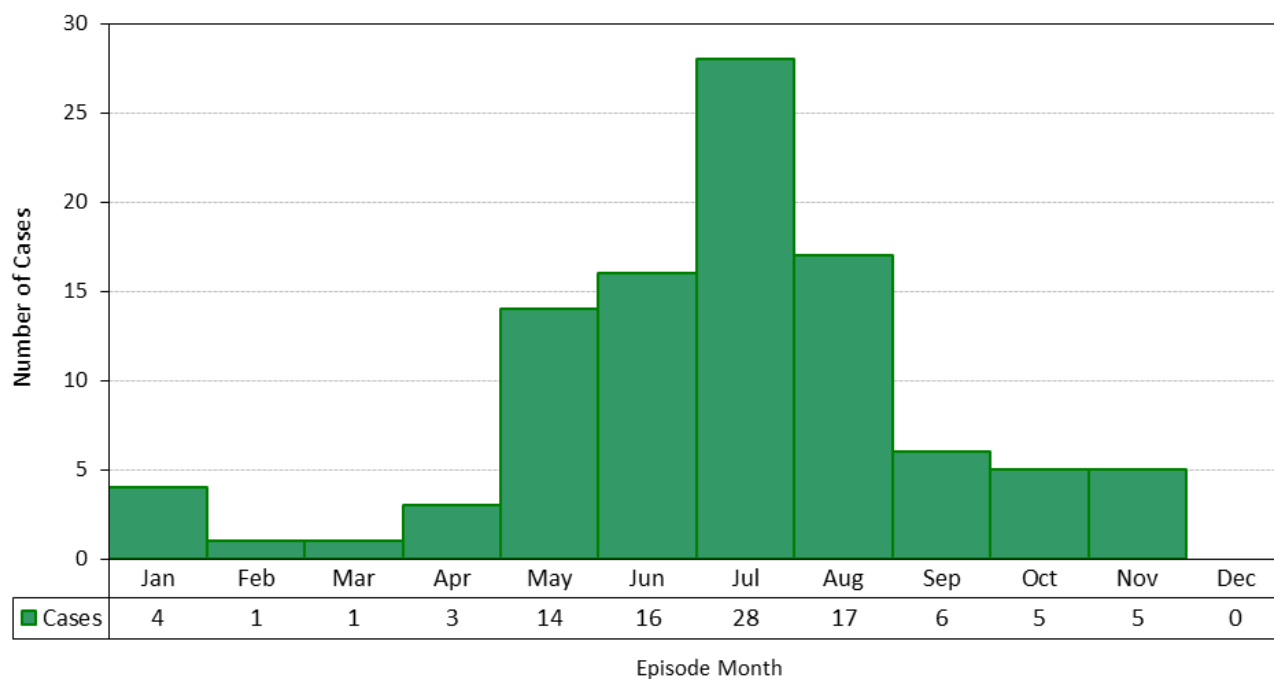


Figure 13: Seasonal distribution of Lyme disease cases: Ontario, 2011.

Source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/02/14].

Note: Includes confirmed and probable cases.

Summary

Mosquito surveillance serves as a valid early warning system for WNV. It also allows for the tracking of other mosquito-borne diseases, such as EEEV and alerts the province to the introduction of new mosquito species. An example of this is *Och. japonicus* (a possible WNV vector) which was first identified in Ontario through the mosquito surveillance program in one health unit and has since spread to most health units. The secondary EEEV mosquito surveillance and viral testing will continue for 2012 and 2013. This will give a three year baseline of the disease in the mosquito population. After 2013, a review of the data will be conducted and it will be determined if the EEEV mosquito surveillance program should continue.

Ontario's blacklegged tick populations are increasing and expanding into new areas of the province. Eastern Ontario has seen the majority of this increase in blacklegged ticks; it also has the majority of non-travel human cases. It is important to continue human, as well as active and passive tick surveillance to determine areas of risk and relay that information to the public and health care professionals.

