Britto, John C 19.1

From: Cam Milani <cammilani@bellnet.ca>
Sent: Tuesday, June 17, 2014 12:29 PM
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Cc: Clerks@vaughan.ca
Subject: Natural Heritage Network Study
Attachments: Tick Risk Map.pdf; Vector_Borne_Diseases_Summary_Report_2013.pdf; West Nile Monitoring Report TRCA 2013.pdf

C 19
COMMUNICATION
CW (PH) - JUNE 17/14
ITEM - 6

Members of Council,

Please accept these as my comments on the Public Hearing item for today.

In an attempt to not sound repetitive to my comments made verbally during the open houses as well as all my discussions with staff over the last months, I am still very concerned over this document, not only from a site specific perspective, but from a city's health and safety perspective.

During the Open House last month, I posed the question to the external consultant, North South Environmental, about the recent concerns raised regarding the basis for a "Network" serving as a conduit or highway for the transfer of diseases into populated areas. The answer was "yes". Councillor Schulte at the meeting then attempted to comment on the consultants response, and if my memory serves me right, Councillor Schulte stated there is no proof yet for such disease transfer and therefore the network should proceed and the risks are acceptable. I am not sure who to believe, councillor Schulte or the consultant. I have also spoken to other environmental consultants in the industry, who confirmed the North South response of "yes". While a "network" of natural areas may sound good on paper to some, the potential risks of creating a highway for the transferring of diseases such as Dengue Fever, West Nile Virus and Lyme Disease into central Vaughan may not be such a great idea. I've attached a few reports and maps indicated the risks that could surface.

Further, swamps and wetlands as well as storm water management lands seem to serve as breeding grounds for the West Nile Virus. Why we would want such breeding grounds enhanced and connected into our population areas is beyond me. They should be removed if this is what they are. The health and safety of our residents should be of the highest priority, bar none. I am keenly interested in a detailed response to this concern. While "yes" is enough for me to throw the whole report out the window, perhaps a detailed response is appropriate.

The report to Public Hearing also has responses to my initial concerns outlined near the end, however, those responses are unsatisfactory. We maintain our disagreement with the findings and opinions.

Yours Truly,

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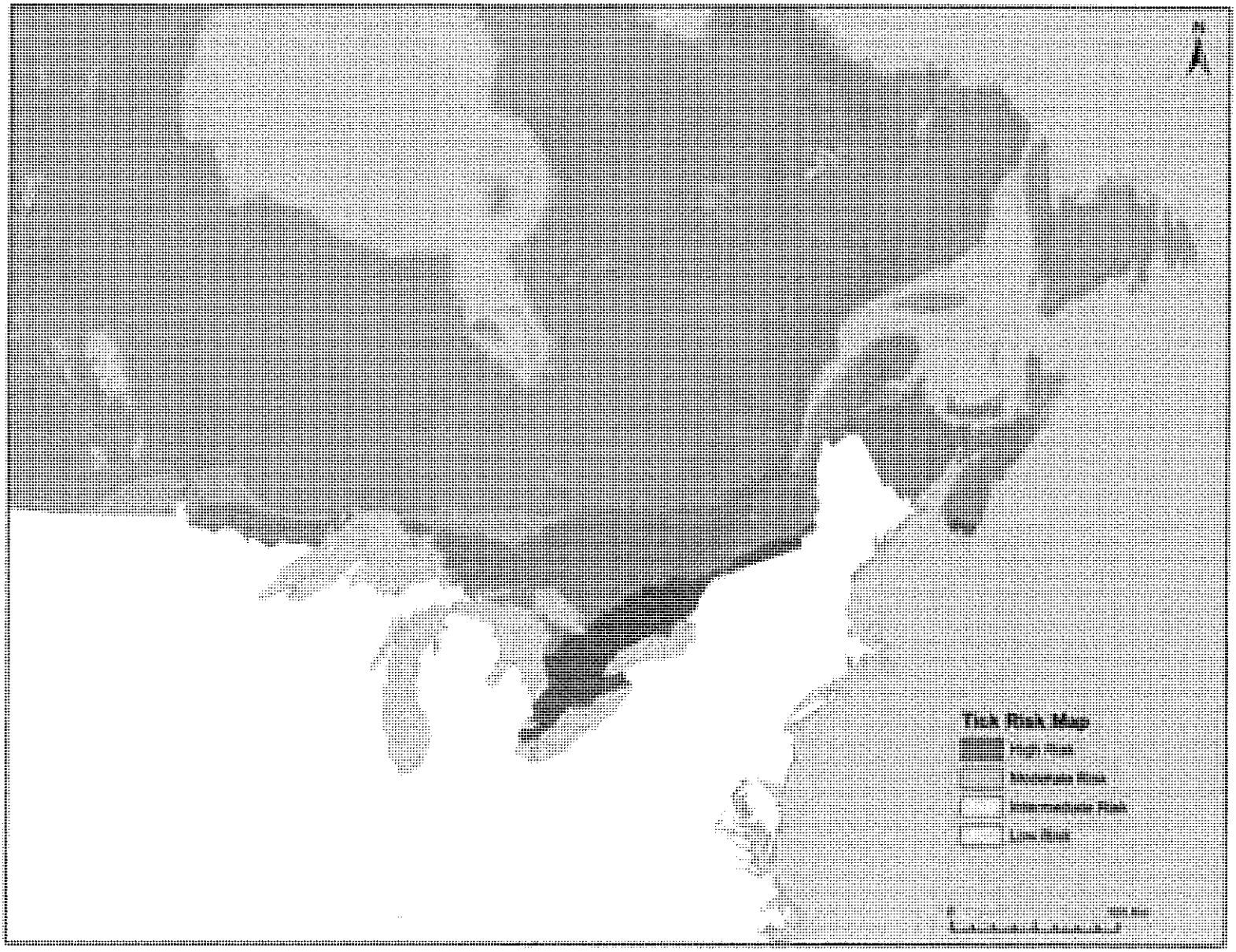
Figure 2. A map showing areas predicted to be at risk for emergence of Lyme endemic areas in eastern and (inset) central Canada.



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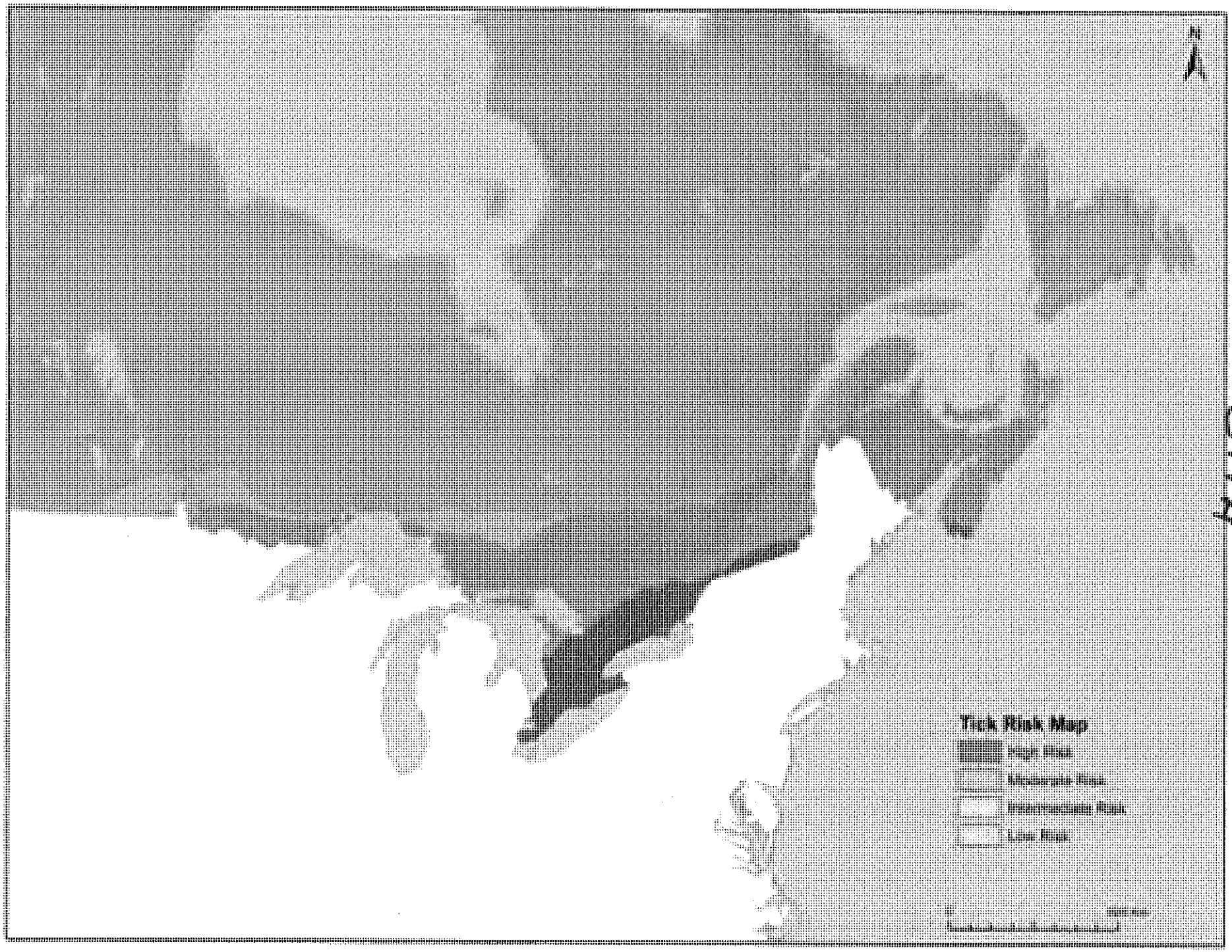

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Public Health Ontario
PARTNERS FOR HEALTH

Santé publique Ontario
PARTENAIRES POUR LA SANTÉ

Vector-Borne Diseases

2013 Summary Report

C 19.6

Public Health Ontario

Public Health Ontario is a Crown corporation dedicated to protecting and promoting the health of all Ontarians and reducing inequities in health. Public Health Ontario links public health practitioners, frontline health workers and researchers to the best scientific intelligence and knowledge from around the world.

Public Health Ontario provides expert scientific and technical support to government, local public health units and health care providers relating to the following:

- communicable and infectious diseases
- infection prevention and control
- environmental and occupational health
- emergency preparedness
- health promotion, chronic disease and injury prevention
- public health laboratory services

Public Health Ontario's work also includes surveillance, epidemiology, research, professional development and knowledge services. For more information, visit www.publichealthontario.ca

How to cite this document:
Ontario Agency for Health Protection and Promotion (Public Health Ontario). Vector-borne diseases 2013 summary report. Toronto, ON: Queen's Printer for Ontario; 2014.

ISBN 978-1-4606-2891-1 [PDF]

Public Health Ontario acknowledges the financial support of the Ontario Government.

C 19.7

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PHO assumes no responsibility for the results of the use of this document by anyone.

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Contents

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Purpose

The purpose of this report is to provide an overview of the epidemiology of Ontario's most significant endemic vector-borne diseases in 2013. 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), while malaria and yellow fever are travel-related diseases with no endemic transmission reported in Ontario.

Background

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. These 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*. *Cx. 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 symptoms 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 laboratory to confirm the diagnosis. Health care providers notify the public health unit (PHU) of confirmed and probable cases of WNV, which are then entered by the PHU into the integrated Public Health Information System (iPHIS) for 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 overall understanding of WNV epidemiology, with equine cases being reported to the Ontario Ministry of Agriculture and posted on their website[3].

[2] http://www.cdc.gov/westnile/symptoms/index.html
[3] http://www.omafra.gov.on.ca/english/livestock/horses/westnile.htm

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Since 2002, PHUs in Ontario have conducted WNV mosquito surveillance from June to October each year. Mosquito surveillance serves as an early warning system for WNV. 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 the PHU, and then sending the collected mosquitoes to service providers for species identification and viral testing. Only certain 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 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 increased activity; 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 determine the risk of EEEV in Ontario and gather baseline evidence for the extent of the virus in Ontario mosquitoes. The new order for viral testing 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 2013, making it difficult to compare 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 greatest risk, e.g. there were 20,064 mosquito pools viral tested in 2005 compared to 13,675 mosquito pools tested in 2012.

The results of mosquito surveillance include the observation that *Ochlerototus 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 detection of a very small number of *Ae. albopictus* (the Asian tiger mosquito) in 2005 and 2012, a vector of dengue and chikungunya. While this mosquito species is not established in Ontario and there is no endemic risk of these diseases, it is still important to note its occurrence and monitor its activity.

C 19.11

During the mosquito season PHO produces weekly reports on the status of WNV human cases, mosquitoes, and horses in the province.[4]

Eastern Equine Encephalitis

EEEV is also a mosquito-borne virus that circulates between birds and mosquitoes, with bridge vectors transferring the virus to humans and horses. It differs in that the main mosquito vector inhabits persistently flooded forests that tend to exist in rural areas. This makes EEEV a possible rural health risk. It is estimated that one third of all people infected with EEEV may have serious morbidity or mortality. EEEV has been present in the equine population in Ontario since 1938[5]. EEEV is not a reportable disease on its own, however it can be reported if a person develops encephalitis. Starting in 2009, mosquito surveillance data has detected the virus sporadically in the Ontario 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 increases in EEEV detection in horses and mosquitoes in surrounding jurisdictions. It should also be noted that as of January 1, 2013, under the reporting regulation O. Reg 277/12 of the *Animal Health Act* of Ontario, WNV and EEEV in animals is now notifiable based on a positive laboratory test to the Chief Veterinarian for Ontario[6]. This change could lead to a possible increase in reported WNV and EEEV equine infections.

To date, no human cases of EEEV have been reported in Ontario. However, while most infected people will be asymptomatic, the risk of death among those who develop neurological symptoms is higher than WNV case fatality rates.

The main enzootic vector for EEEV in Ontario and the eastern U.S. is *Culiseta 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 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.

[4] http://www.publichealthontario.ca/en/ServicesAndTools/SurveillanceServices/Pages/Vector-Borne-Disease-Surveillance-Reports.aspx

[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] www.Ontario.ca/animalhealth

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Lyme Disease

Lyme disease is a tick-borne bacterial disease transmitted to humans by the bite of an infected blacklegged tick (*Ixodes scopularis*). 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 the 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 are occurring in areas associated with the blacklegged tick populations.

The identification and reporting of human Lyme disease cases is similar to West Nile Virus cases. As above, when notified of a confirmed or probable case of Lyme disease, PHUs report cases via iPHIS as per provincial reporting requirements.

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Findings

West Nile Virus

In 2013, there were 56 confirmed and probable cases of WNV in humans (Figure 1)[7]. The three-month period from July to September accounted for 96 percent (54/56) of these cases, of which 32 percent (18/56) were reported in August (Figure 1). The majority of human cases were reported in the Golden Horseshoe area, with 53.6 percent of human WNV cases reported from the City of Toronto, Peel Region, Niagara Region, and City of Hamilton (Figure 2 and Table 1). The number and incidence of reported confirmed and probable WNV cases in humans had started to trend upwards in 2011, but declined in 2013 (Figure 3). The incidence in 2013 was the sixth lowest recorded year in Ontario.

The number of positive mosquito pools decreased by over half (n=198) from 2012 to 2013, after a greater than 1.5 times increase from 2011 to 2012 (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 that humans might be bitten by an infected mosquito. Conversely, fewer positive mosquitoes lead to fewer human cases. The decrease in positive mosquito pools in 2013 could be partially attributed to cooler summer temperatures (June, July, and August). Based on Environment Canada's temperature rankings between 1948 and 2013, the year 2013 was the 34th warmest summer (Figure 4)[8]. This contrasts with the higher summer temperatures in 2011 (9th warmest) and 2012 (4th warmest), and is similar to the low abundance of vector mosquitoes and WNV activity observed from 2007 (27th warmest) to 2009 (58th warmest).

In 2013, 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 the predominately urban areas of Ontario and have large numbers of catch basins with standing water, which are ideal development sites for the main mosquito vectors. Figure 6 shows the minimum infection rate (MIR), which is an estimation of the minimum number of positive mosquitoes in the environment. Stated as the number positive mosquitoes per 1000, 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 2013, the species of mosquitoes that tested positive for WNV included *Cx. pipiens/restuans, Aedes vexans, Ochlerotatus triseriatus/hendersoni, Anopheles punctipennis*, and *Oc. japonicus. Cx.*

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

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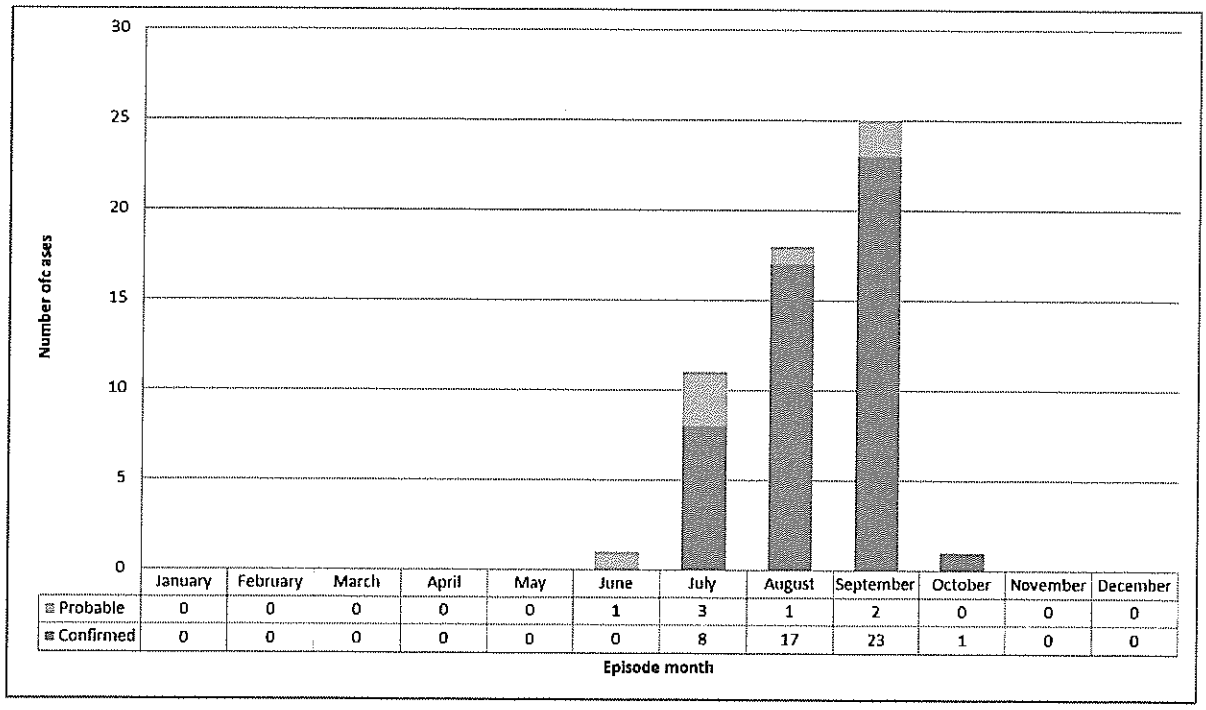
pipiens/restuans was the species that tested positive for WNV most frequently; however, *Cx. pipiens/restuans* are specifically targeted for WNV testing, as this is the vector primarily responsible for human cases.

Figure 1: Number of confirmed and probable West Nile Virus cases by episode month: Ontario, 2013

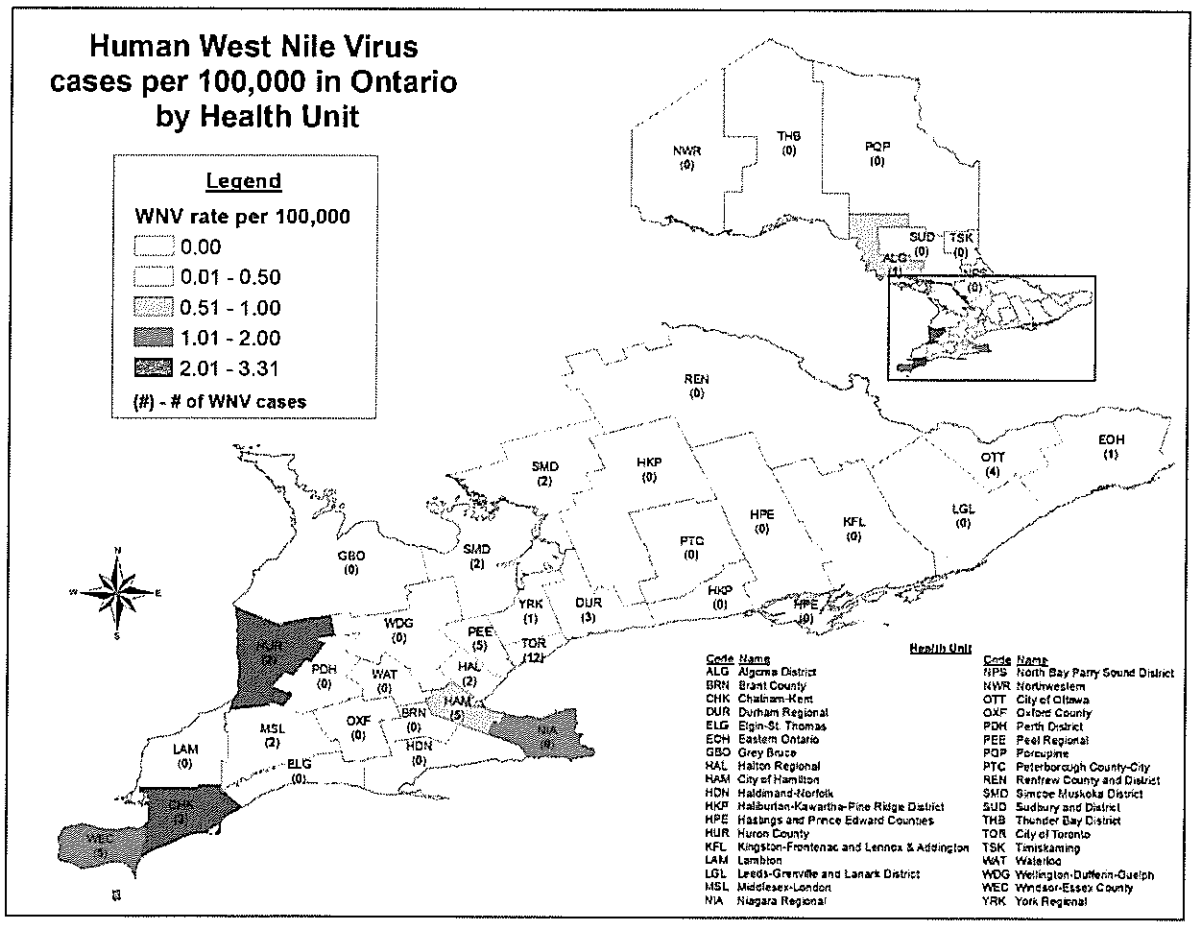


	January	February	March	April	May	June	July	August	September	October	November	December
Probable	0	0	0	0	0	1	3	1	2	0	0	0
Confirmed	0	0	0	0	0	0	8	17	23	1	0	0

Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2014/02/04].

C 19.15

Figure 2: Incidence rate per 100,000 population and number of confirmed and probable West Nile Virus cases by health unit of residence: Ontario, 2013



Data sources:

WNV cases: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2014/02/02].

Population estimates (for rate calculations): Ontario Ministry of Health and Long-term Care, IntelliHEALTH Ontario, extracted by Public Health Ontario [2013/09/16].

C 19.16

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, 2013

HEALTH UNIT	Confirmed	Probable	Total	Rate* (per 100,000)
Algoma District	1	0	1	0.86
Chatham-Kent	3	0	3	2.76
City of Hamilton	5	0	5	0.92
City of Ottawa	4	0	4	0.43
City of Toronto	12	0	12	0.43
Durham Regional	3	0	3	0.47
Eastern Ontario	1	0	1	0.50
Halton Regional	2	0	2	0.38
Huron County	0	2	2	3.31
Middlesex-London	1	1	2	0.43
Niagara Regional Area	6	2	8	1.79
Peel Regional	4	1	5	0.36
Simcoe Muskoka District	2	0	2	0.38
Windsor-Essex County	4	1	5	1.24
York Regional	1	0	1	0.09
Ontario Overall	**49**	**7**	**56**	**0.41**

Data sources:

*Rate based on total human cases (confirmed and probable combined)

WNV cases: Ontario Ministry of Health and Long-term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2014/02/04].

Population estimates (for rate calculations): Ontario Ministry of Health and Long-term Care, IntelliHEALTH Ontario, extracted by Public Health Ontario [2013/09/16]. NOTE: Population counts for 2012 are used to estimate health unit and provincial population counts for 2013.

Notes:

- Health unit (HU) refers to the HU where the case resided at the time of identification and not necessarily the place of disease exposure or acquisition.
- The data only represent confirmed and probable cases of West Nile Virus that were reported to public health units and recorded in iPHIS. Underreporting is assumed.
- iPHIS is a dynamic disease reporting system which allows ongoing updates to data previously entered. As a result, data extracted from iPHIS represent a snap shot at the time of extraction and may differ from previous or subsequent reports.

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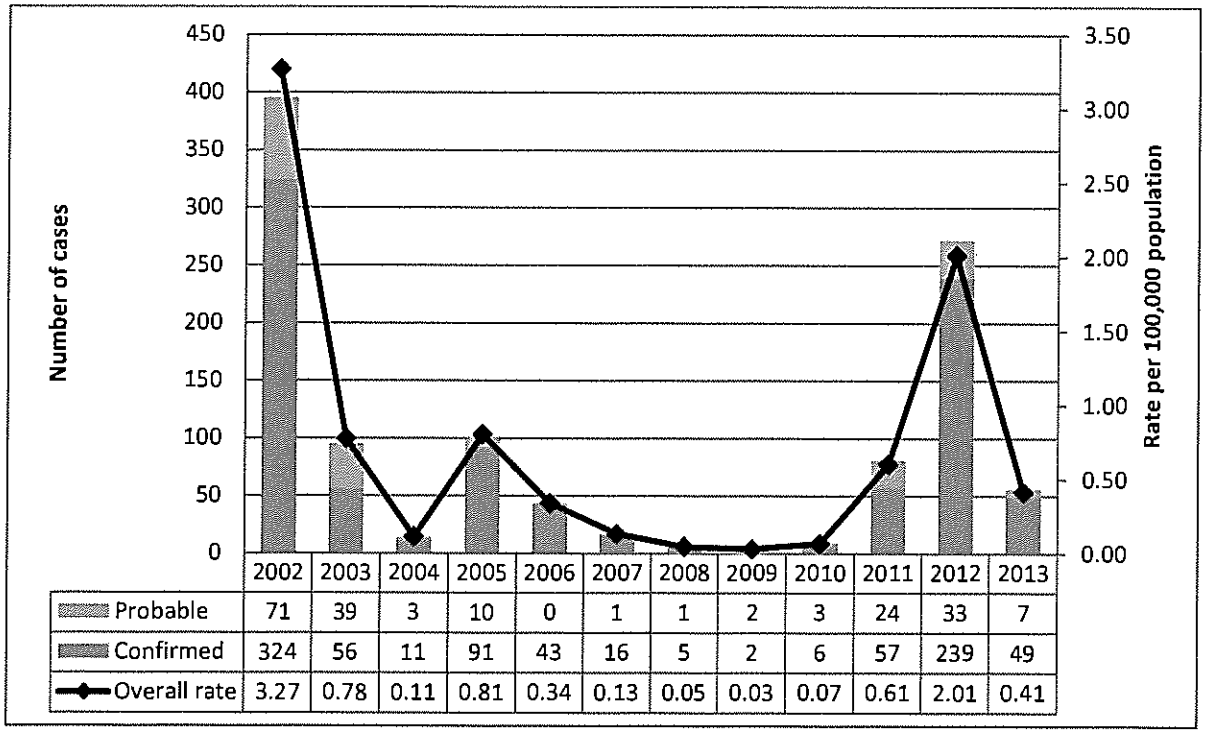
Figure 3: Number of confirmed and probable human West Nile Virus cases by year: Ontario, 2002–13



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Probable	71	39	3	10	0	1	1	2	3	24	33	7
Confirmed	324	56	11	91	43	16	5	2	6	57	239	49
Overall rate	3.27	0.78	0.11	0.81	0.34	0.13	0.05	0.03	0.07	0.61	2.01	0.41

Data Sources:

WNV cases: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2014/02/04].

Population estimates (for rate calculations): Ontario Ministry of Health and Long-term Care, IntelliHEALTH Ontario, extracted by Public Health Ontario [2013/09/16].

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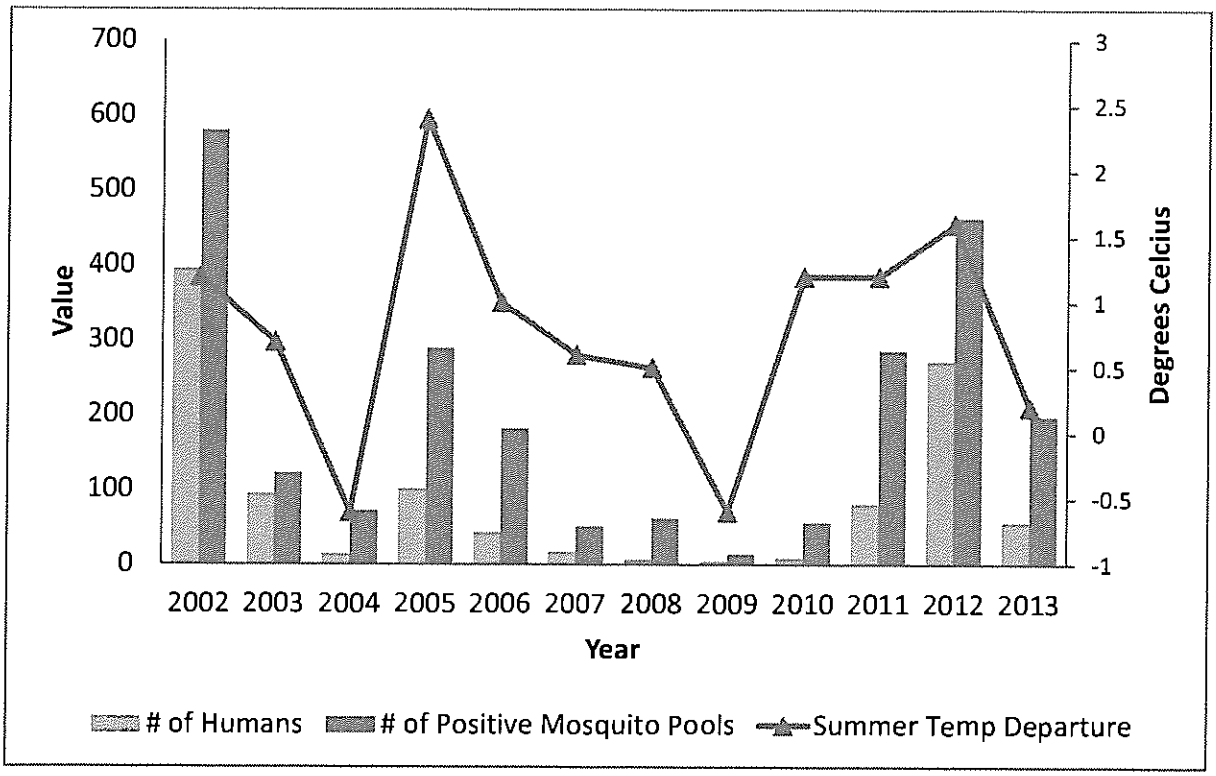
Figure 4: Number of reported West Nile Virus human cases and positive mosquito pools; and average summer temperature departures: Ontario, 2002–13



Data Sources:
WNV cases: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2014/02/04].
Mosquito data: PHO Mosquito Database [2014/02/21]
Weather Data: Environment Canada[9]
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.

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

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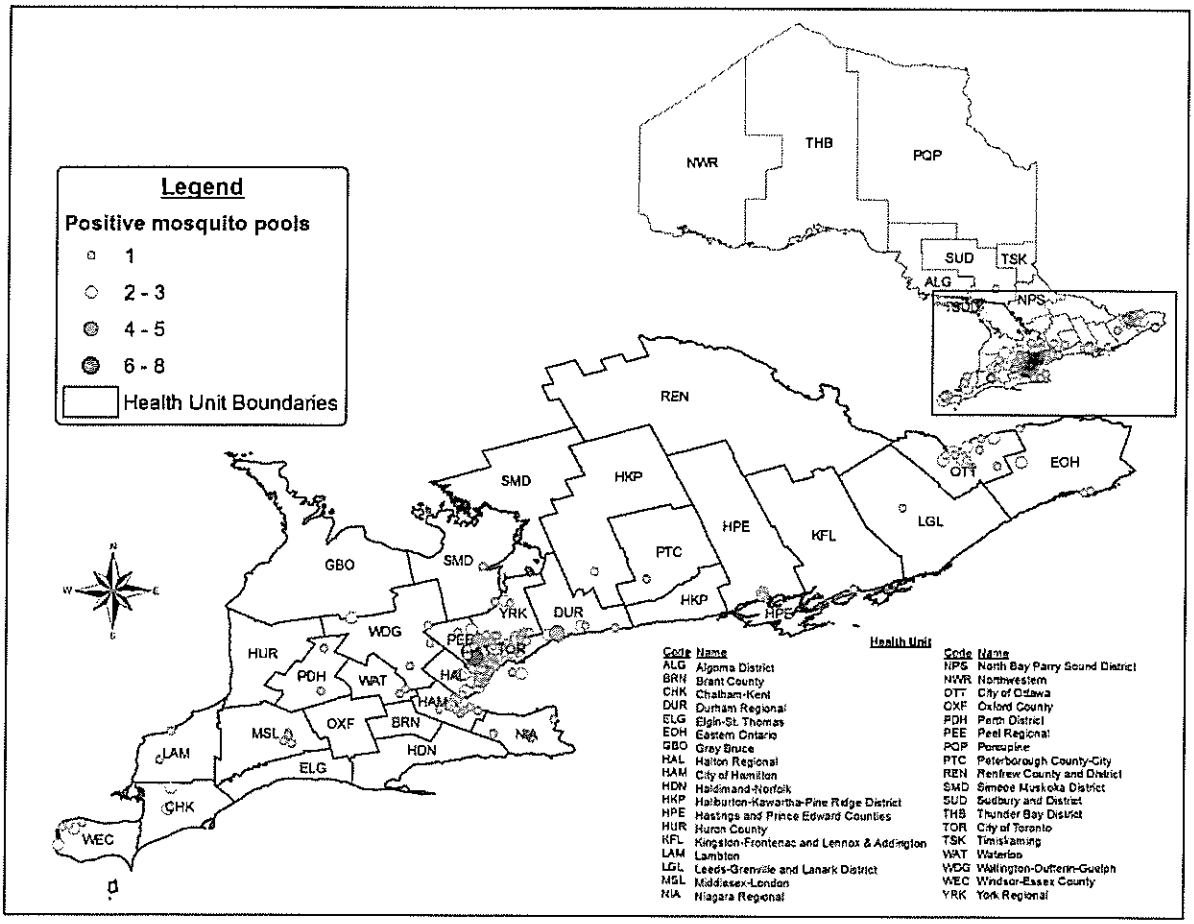
Figure 5: Location and number of mosquito pools positive for West Nile Virus: Ontario, 2013



Data source: PHO Mosquito Database [2014/02/19]

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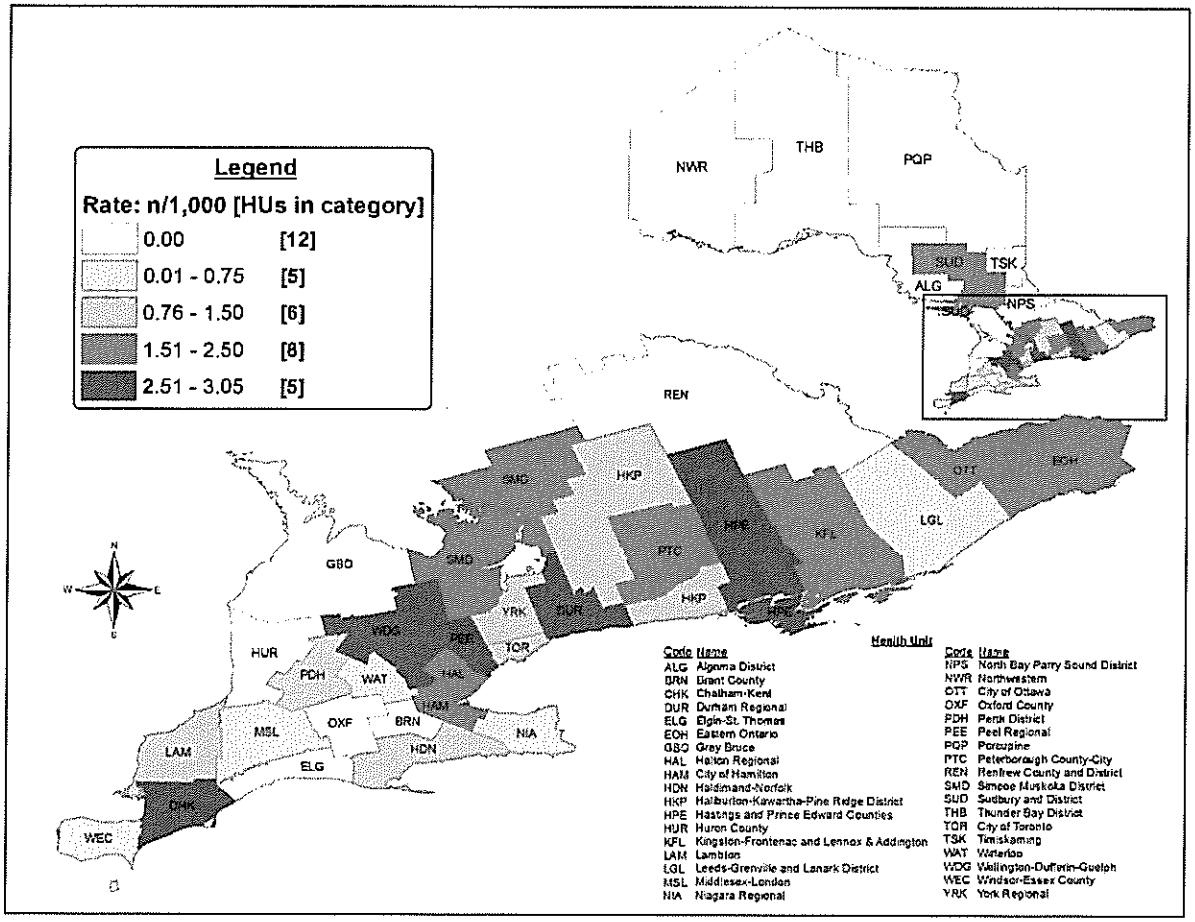
Figure 6: Minimum infection rate of positive mosquito pools: Ontario, 2013



Data source: PHO Mosquito Database [2014/02/19]

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Eastern Equine Encephalitis Virus

Ontario has yet to report a confirmed human case of EEEV. During the three year EEEV mosquito pilot testing period (2011-2013), there was 249,775 mosquitoes tested in 18,177 mosquito pools. Of those, 526 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, in the Eastern Ontario HU. Based on the low number of *Cs. melanura* identified and only one pool testing positive, PHO recommends that PHUs revert to the previous WNV testing order of preference that is listed in the ministry's 2010 *West Nile Virus Preparedness and Prevention Plan*. Health units can still opt to keep the EEEV order of testing if their risk assessments show a reason to continue testing for EEEV in their jurisdiction.

The first year that Ontario recorded EEEV positive mosquitoes was in 2009. These positive mosquitoes were found through Health Canada's First Nations and Inuit Health Branch's (FNIHB) WNV mosquito program, which mirrors Ontario's program (Table 2). The positive mosquitoes were identified in a First Nations community within Simcoe Muskoka District HU. 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.

Equine Surveillance

EEEV has been reported in Ontario in horses, emus, and pheasants dating back to 1938 (Table 2, Figure 7). In 2013, there was one EEEV equine cases reported by the Ontario Ministry of Agriculture and Food (OMAF) in Simcoe Muskoka District HU. 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.

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Table 2: Number of *Culiseta melanura* captured, EEEV-positive mosquito pools and EEEV horses: Ontario, 2002–13

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[10]	2
2010	218	3[11]	3
2011	222	0	4
2012	67	0	0
2013	245	1	1

Data sources:
Horse data: OMAF online from http://www.omafra.gov.on.ca/english/livestock/horses/westnile.htm#surveillance
Mosquito data: PHO Mosquito Database [2013/02/21]

[10] First Nations: 10 pools *Culiseta melanura* and 2 pools *Aedes vexans*.

[11] Health Units (NPS) 1 pool and First Nations 2 pools all *Culiseta melanura*

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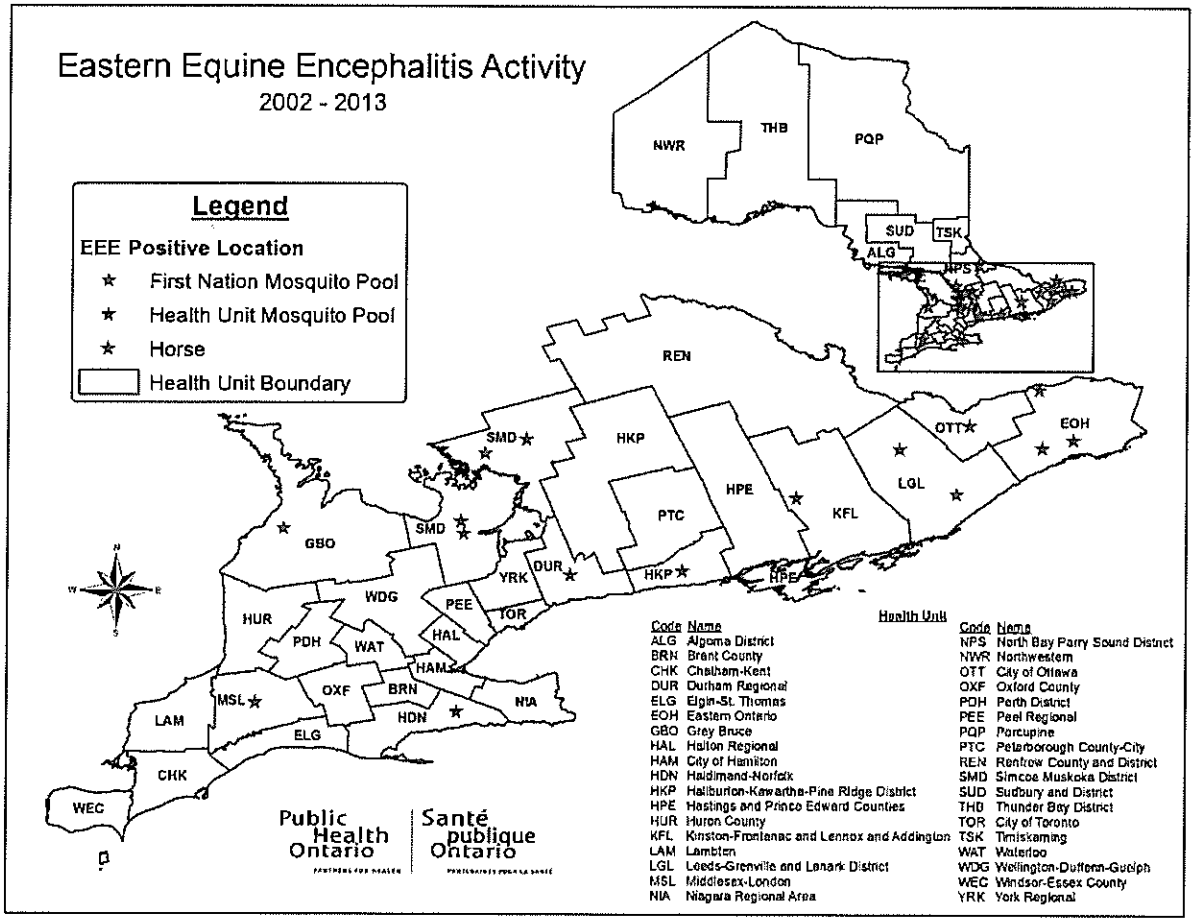
Figure 7: Eastern Equine Encephalitis Virus activity: Ontario, 2002–13



Data sources:
Horse data: OMAF online from
http://www.omafra.gov.on.ca/english/livestock/horses/westnile.htm#surveillance
Mosquito data: PHO Mosquito Database [2014/02/19]

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Lyme disease

In 2013, there were 317 human cases of Lyme disease reported in Ontario[12]. The overall incidence rate of confirmed and probable Lyme disease cases in Ontario in 2013 was 2.35 cases per 100,000 population (Figure 8). This is over one and a half times higher than the incidence rate of 1.41 case per 100,000 population reported in 2012 (Figure 8). Although the incidence rate of Lyme disease in Ontario has been steadily increasing since 2002, it is much lower than in the U.S. overall and New York State, which had incidence rates of 7.0 cases and 10.4 cases per 100,000 population, respectively, in 2012.[13]

The number of Lyme disease cases peaked from May to September 2013, with 74.4 percent of cases reported between June and August (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 increased human outdoor activities and presence of infectious nymphs in the environment. Feeding nymphs are much more difficult to detect than adults, which leads to the increased likelihood of longer attachment times for nymphs and a higher risk of Lyme disease transmission.

Of the 317 confirmed and probable Lyme disease cases reported in Ontario in 2013, there were 247 (77.9 percent) with exposure locations reported. Of the reported exposure locations, 186 (58.7 percent) indicated an Ontario exposure (i.e. infections were locally acquired) (Table 3).

Eight PHUs[14] reported 10 or more confirmed/probable cases of Lyme disease in 2013, which accounted for 77.3 percent (245/317) of all cases reported in the province (Table 4). No cases were reported by Ontario's northern-most PHUs. The top three PHUs with confirmed/probable cases in 2013 were all from eastern Ontario (KFL, LGL, and OTT) (Table 4). While the six eastern PHUs only account for 13 percent[15] of Ontario's population, they represent 59.6 percent (189/317) of the human cases. Of the cases in the eastern region with recorded exposures, 88.3 percent (121/137) were exposed in Ontario, while the remainder of health units with reported exposures had 59.1 percent (65/110) of exposures occurring in Ontario. Figure 10 shows the geographic distribution of Lyme disease exposure locations among locally-acquired cases in Ontario.

The locations in Ontario with higher incidence rates and Ontario exposure locations are primarily in the eastern region of Ontario. This is also the region in Ontario with the largest numbers of blacklegged tick submissions (Figure 11). In 2013, 2893 blacklegged ticks were submitted from locations where the

[12] 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.
For Lyme disease case definition see:
http://www.health.gov.on.ca/en/pro/programs/publichealth/oph_standards/infdispro.aspx
[13] Source: http://www.cdc.gov/lyme/stats/chartstables/incidencebystate.html
[14] Toronto; Leeds-Grenville and Lanark District; City of Ottawa; Kingston-Frontenac, Lennox and Addington; Eastern Ontario; York Region; Hastings and Prince Edward Counties; and Durham Region.
[15] Population Estimates 1986-2012, Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Date Extracted: 16-Sep-2013.

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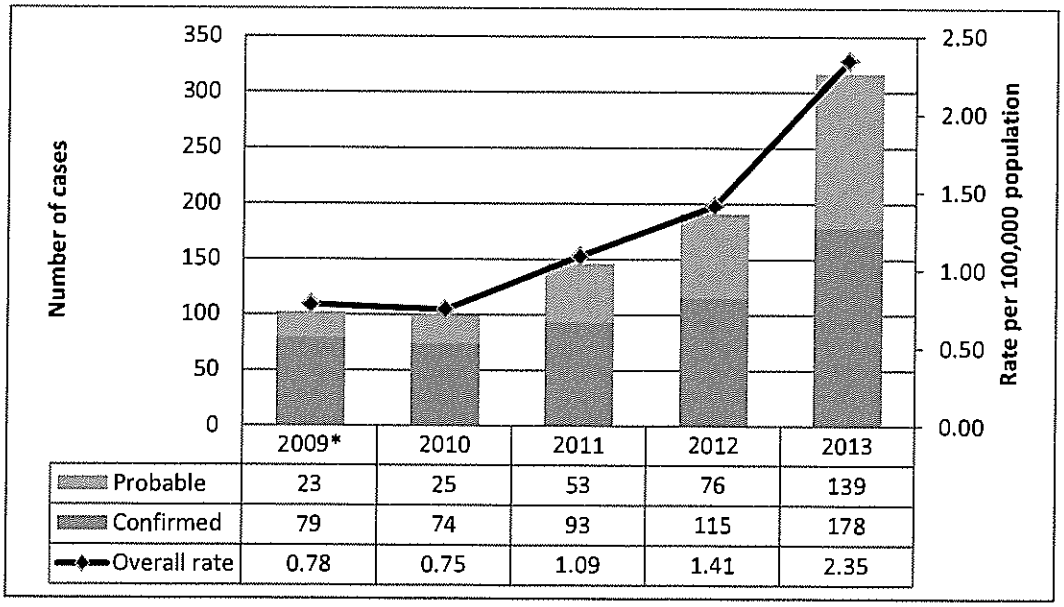
submitter's residence was known, with a total of 3039 blacklegged ticks submitted to PHO. To date, this is the highest number of blacklegged tick submissions to PHO (Table 3).

Figure 8: Number of cases of Lyme disease and incidence rate per 100,000 population: Ontario, 2009–2013



	2009*	2010	2011	2012	2013
Probable	23	25	53	76	139
Confirmed	79	74	93	115	178
Overall rate	0.78	0.75	1.09	1.41	2.35

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 [2014/02/04].
Population data obtained from IntelliHEALTH Ontario, retrieved by Public Health Ontario [2013/09/16].

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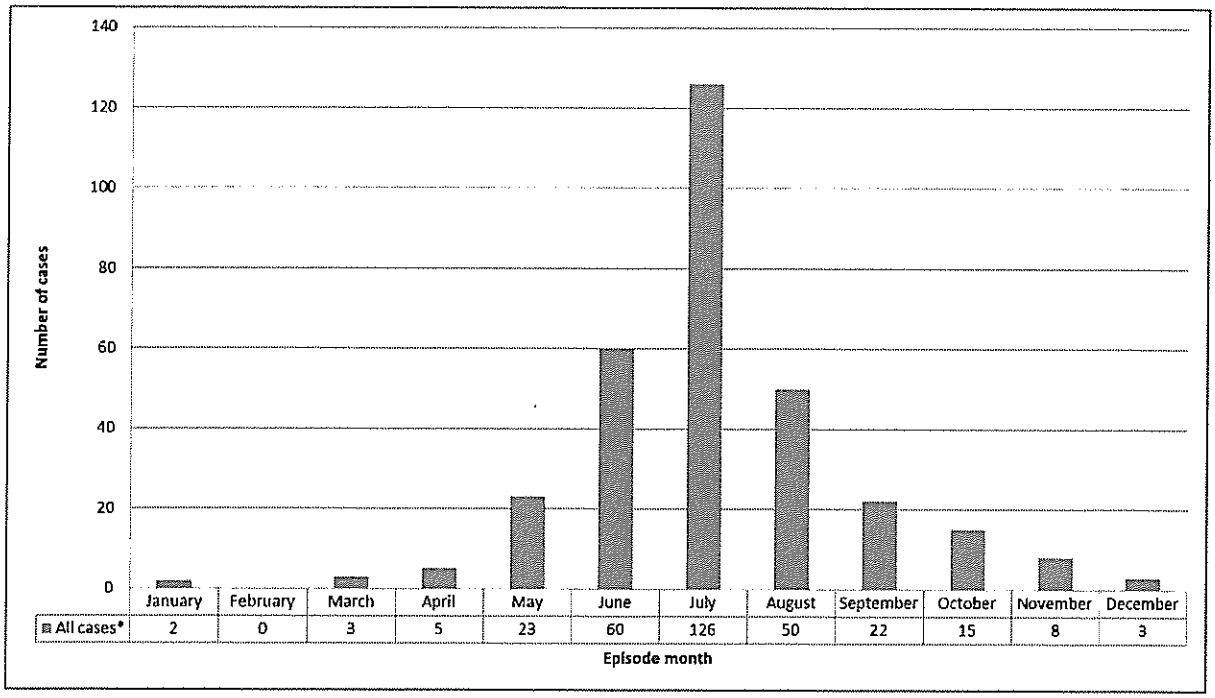
Figure 9: Distribution of Lyme disease cases* by month: Ontario, 2013



Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2014/02/04].

***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.

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Table 3. Lyme disease cases by exposure setting, and total number of I. scapularis submissions to PHO: Ontario, 2008–13

Exposure Location	Year											
	2008		2009		2010		2011		2012		2013	
	n	%	n	%	n	%	n	%	n	%	n	%
Ontario	55	56.1	47	46.1	41	41.4	98	67.1	119	62.3	186	58.7
Within Canada, outside Ontario	2	2.0	3	2.9	2	2.0	5	3.4	5	2.6	8	2.5
Outside Canada	35	35.7	34	33.3	32	32.3	34	23.3	39	20.4	51	16.1
Unknown	3	3.1	4	3.9	3	3.0	0	0.0	1	0.5	2	0.6
Missing	4	4.1	16	15.7	22	22.2	11	7.5	32	16.8	78	24.6
Total number of cases	98		102		99		146		191		317	
Total number of I. scapularis submissions	1452		580		956		2191		2535		3018	

Data source: Lyme Disease cases, Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2014/03/10] for 2008-2011, [2013/12/31] for 2012, and [2014/02/19] for 2013.
Tick Data, Public Health Ontario (PHO), extracted [2014/03/12]
Note: Cases can report multiple exposure locations; as a result proportions may not add to 100%.
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.
Missing data represents case not reporting any exposure information.
The high proportion of cases with missing exposure information in 2013 likely due in part to delayed reporting.
The total number of cases each year was used as the denominator to calculate proportions.
For cases reporting multiple exposure locations, only unique exposure locations were counted. For example, if a case reported multiple exposures in Ontario, the exposure was counted once.
For cases reporting both known and unknown exposure locations, only the known exposure location was counted. For example, if a case reported exposure location as "Ontario" and "Unknown", only the Ontario exposure was counted.
PHO stopped accepting ticks from non-humans in 2009.

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Table 4: Number and incidence rate (per 100,000 population) of reported confirmed and probable human cases of Lyme disease by health unit of residence: Ontario, 2013

Health Unit	Confirmed	Probable	Total	Rate* (per 100,000)
Algoma District	1	0	1	0.86
Brant County	1	0	1	0.71
Chatham-Kent	4	1	5	4.61
City of Hamilton	1	2	3	0.55
City of Ottawa	12	34	46	5.00
City of Toronto	22	7	29	1.04
Durham Regional	7	5	12	1.88
Eastern Ontario	9	20	29	14.41
Grey-Bruce	3	0	3	1.83
Haldimand-Norfolk	3	0	3	2.72
Haliburton-Kawartha-Pine Ridge District	2	4	6	3.34
Halton Regional	3	3	6	1.14
Hastings and Prince Edward Counties	10	6	16	9.90
Huron County	0	1	1	1.65
Kingston-Frontenac and Lennox and Addington	37	14	51	25.75
Lambton	0	2	2	1.53
Leeds, Grenville, and Lanark District	24	21	45	26.58
Middlesex-London	3	1	4	0.86
Niagara Regional Area	5	0	5	1.12
North Bay Perry Sound District	1	0	1	0.79
Oxford County	1	0	1	0.92
Peel Regional	5	2	7	0.50
Perth District	1	0	1	1.30

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Health Unit	Confirmed	Probable	Total	Rate* (per 100,000)
Peterborough County-City	1	4	5	1.58
Renfrew County and District	0	2	2	1.93
Simcoe Muskoka District	1	0	1	0.19
Waterloo	6	1	7	1.30
Wellington-Dufferin-Guelph	2	2	4	1.43
Windsor-Essex County	1	2	3	0.74
York Regional	12	5	17	1.57
Ontario Overall	172	139	311	2.35

Data sources:

*Rate based on total human cases (confirmed and probable combined)

Lyme disease cases: Ontario Ministry of Health and Long-term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2014/02/04].

Population estimates (for rate calculations): Ontario Ministry of Health and Long-term Care, IntelliHEALTH Ontario, extracted by Public Health Ontario [2013/09/16]. NOTE: Population counts for 2012are used to estimate health unit and provincial population counts for 2013.

Notes: Health unit (HU) refers to the HU where the case resided at the time of identification and not necessarily the place of disease exposure or acquisition. The data only represent confirmed and probable cases of Lyme disease that were reported to public health units and recorded in iPHIS. Underreporting is assumed. iPHIS is a dynamic disease reporting system which allows ongoing updates to data previously entered. As a result, data extracted from iPHIS represent a snap shot at the time of extraction and may differ from previous or subsequent reports.

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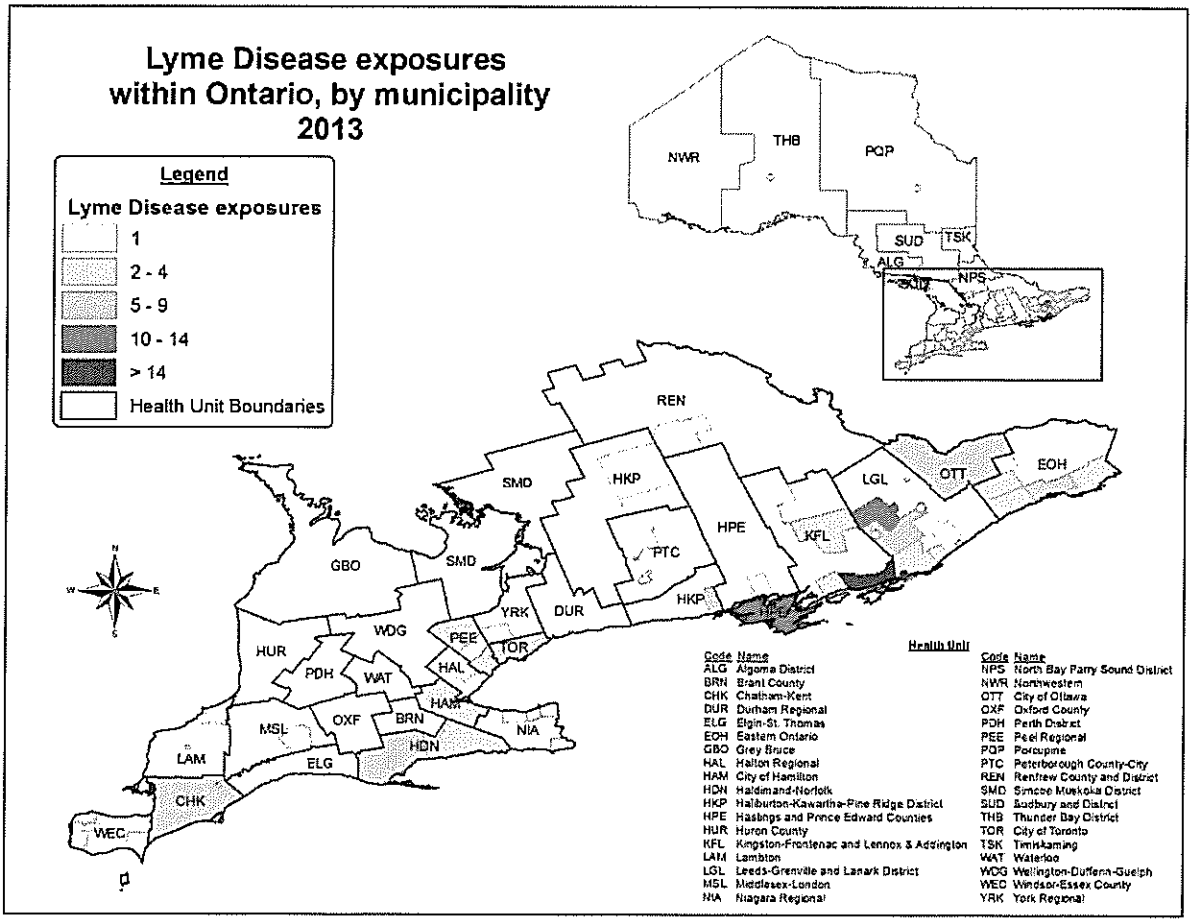
Figure 10: Municipalities identified as the most likely exposure location for locally acquired Lyme disease cases: Ontario, 2013



Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2014/02/19].

Note: Includes confirmed and probable cases.

For cases reporting both known and unknown exposure locations, only the known exposure location was counted. For example, if a case reported exposure location as "Ontario" and "Unknown", only the Ontario exposure was counted. Cases can report multiple exposures.

Circles in southern Ontario represent small municipalities that would not be visible. Circles in northern Ontario represent unorganized areas that are not within a municipality.

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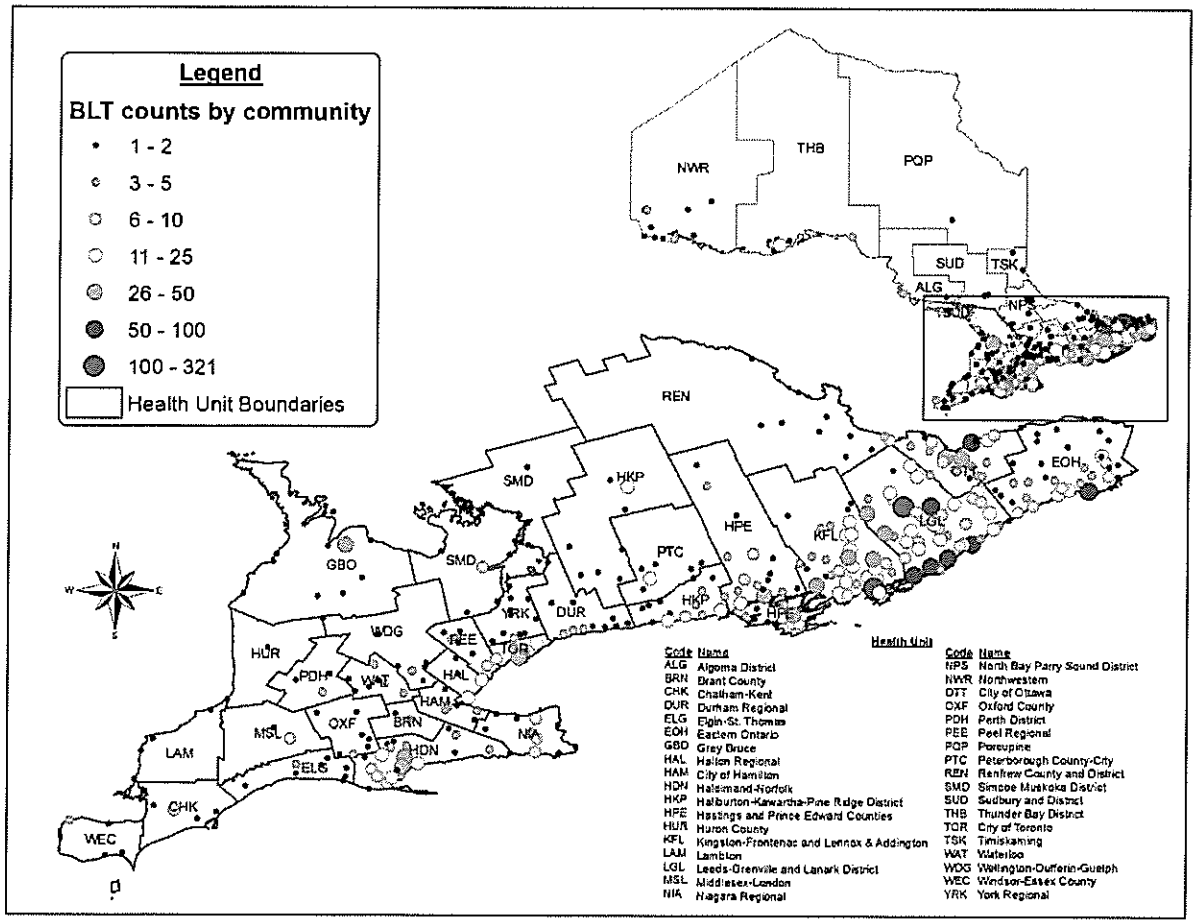
Figure 11: The location and number of blacklegged ticks submitted to Public Health Ontario, based on the submitter's community of residence: Ontario, 2013



Data source: Public Health Ontario (PHO), extracted [2014/03/12]

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Data Considerations and Limitations

- The data are current as of February 4, 2014 for Lyme disease and West Nile Virus case counts. Lyme disease exposures are current as of March 10, 2013 for 2008 to 2011, December 31, 2013 for 2012, and February 19, 2014 for 2013.
- 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 snap shot 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/Episode Status/Encounter 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 include only the following classifications: confirmed and probable.
- Orientation of case counts by geography is based on the diagnosing health unit (DHU). Cases for which the DHU was reported as MOHLTC (to signify a case that is not a resident of Ontario) or Muskoka Parry Sound (a health unit that no longer exists) have been excluded.
- Diagnosing 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.
- Exposures cannot be definitively attributed to illness, but are assumed to be possible sources of illness.
- The number of reported exposures may be underestimated because of missing data.
- Cases may report multiple exposures.

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Agence de protection et de promotion de la santé

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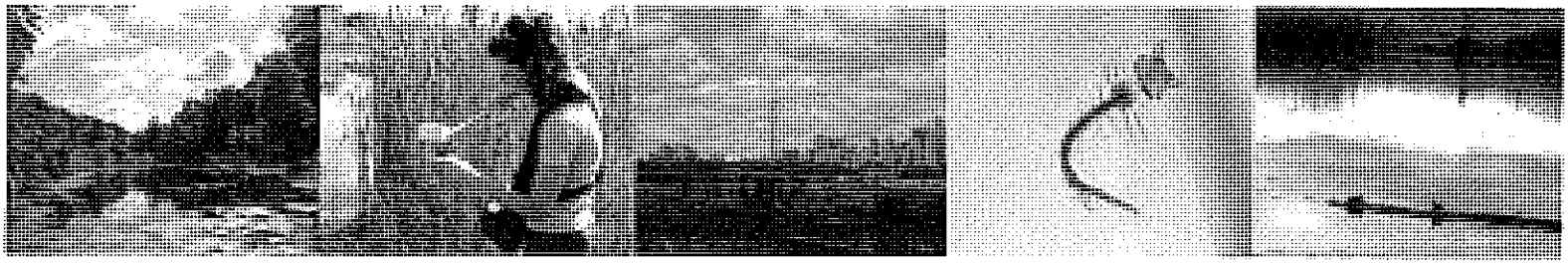

West Nile Virus Vector Larval Mosquito Monitoring Report - 2013

February 2014

Toronto and Region Conservation
for The Living City®

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Acknowledgements

TRCA recognizes the contributions from our staff: Danielle Dellandrea, Sarah Scharfenberg, and Paula Reynolds for their support in collecting and managing the data, Ming Guo for database development and Parth Sheth for his assistance in GIS mapping.

We would also like to thank our regional public health partners for their support in 2013.

The West Nile Virus Surveillance and Monitoring Program is a part of TRCA's Regional Watershed Monitoring and Reporting Program. It is funded by the following partners:

Region of Peel

DURHAM

York Region

TORONTO

Toronto and Region Conservation for The Living City

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Executive Summary

West Nile virus (WNV) is primarily a bird pathogen that first appeared in Ontario in 2001. Evidence suggests that two key vector mosquito species, *Culex pipiens* and *Culex restuans,* are primarily responsible for spreading the disease to humans in Ontario (Kilpatrick *et al.* 2005; Hamer *et al.* 2009). Toronto and Region Conservation Authority's (TRCA's) data show that *Culex pipiens*—an urban mosquito species, is the most abundant vector species within our jurisdiction. The vector population dynamics are influenced by biological and environmental factors. Forecasting an outbreak is difficult, therefore, WNV management strategies undertaken collectively by the provincial and regional health agencies in Ontario focus on prevention through education and mosquito control measures.

The number of human WNV case fluctuates annually. An increase in WNV activity occurred in 2011 and it persisted into 2012, making 2012 the second worst outbreak year since 2002 in Ontario. In 2013, a total of 108 human cases were reported in Canada compared to 450 cases in 2012. In the Greater Toronto Area (GTA), 19 human WNV cases were reported (Public Health Ontario, 2013).

The WNV Larval Mosquito Surveillance and Monitoring Program was established in 2003 as a measure of due diligence and at the request of TRCA's regional public health partners. The program has a three-pronged approach, which includes public education and communication, collaboration with regional public health units, and larval mosquito monitoring. The most important objective is to reduce WNV risk to residents and conservation area visitors. In 2013, this objective was achieved by identifying five WNV hotspots and taking appropriate intervention measures to reduce mosquito larvae, through public education, and through collaboration with regional public health partners.

Wetland habitats are conventionally considered mosquito-friendly habitats. However, monitoring data collected by TRCA since 2003 have shown that healthy functioning wetlands generally do not support large vector mosquito populations. When a WNV vector mosquito hot spot is detected, appropriate control measures can be taken to eliminate mosquito larvae if warranted.

Larval mosquito monitoring was undertaken in 45 sites across TRCA jurisdiction from June 3 to August 22 in 2013. In total, 7146 mosquito larvae were collected, including 6650 larvae from 39 wetlands and 496 larvae from 6 stormwater management ponds (SWMPs). Although most mosquitoes were collected from wetlands, higher concentrations of vector mosquito larvae were collected in SWMPs.

In total, 11 mosquito species including 7 WNV vector species and 4 non-vector species were identified. The most widespread species was *Culex territans,* which inhabited 38 of the 45 sites. The two key vectors, *Culex pipiens* and *Culex restuans,* were found at 15 and 8 sites respectively. Similar to the results from previous years, vector species at SWMPs comprised 94% of the mosquito larvae collected, while *Culex territans,* the only non-vector species made up the remaining 6%. *Culex pipiens* was the predominant species (73.6%) found in the SWMPs. The other key vector species *Culex restuans* represented 3.8% of the larvae collected in the SWMPs.

Although most mosquitoes were collected from wetlands, higher concentrations of vector larvae were collected in SWMPs.

Five sites were identified as having high numbers of vector species larvae in 2013: Grenadier Pond in High Park, L'Amoreaux North Pond, Topham Pond, Goldfish Pond in Tommy Thompson Park, and an unnamed wetland in Vaughan. Each of these sites received larvicide treatment by the regional health units to proactively address WNV concerns.

One standing water complaint was investigated. The pond at Archetype House in Kortright Centre was drained and stocked with fish for mosquito control. The control method was effective, no mosquito larvae were found in subsequent visits.

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Appendices

1. Introduction

This report provides an overview of Toronto and Region Conservation Authority's (TRCA) West Nile virus (WNV) vector larval mosquito monitoring program for 2013. WNV primarily exists between birds and bird-biting mosquitoes. The virus transmits to humans through the bite of an infected mosquito which had fed on infected birds. Humans are considered dead-end hosts whereby humans can be infected with the virus, but do not spread it. For people who become infected, the majority will have no symptoms or only mild flu-like symptoms. Severe cases of WNV, including the development of meningitis and encephalitis, are extremely rare but can be fatal.

Mosquito species that are capable of carrying and transmitting WNV are referred to as *vector* species. Species that do not transmit the virus are *non-vector* species. There are 57 mosquito species in Ontario, of which only 13 species are WNV vectors. Studies (Kilpatrick *et al.* 2005; Hamer *et al.* 2009) suggested that *Culex pipiens* and *Culex restuans* are not only the primary species in spreading the disease among birds, but also the most responsible species for spreading the virus into humans. Most other mosquito species do not pose serious WNV threats and their larvae are important food sources for fish and other predatory aquatic organisms.

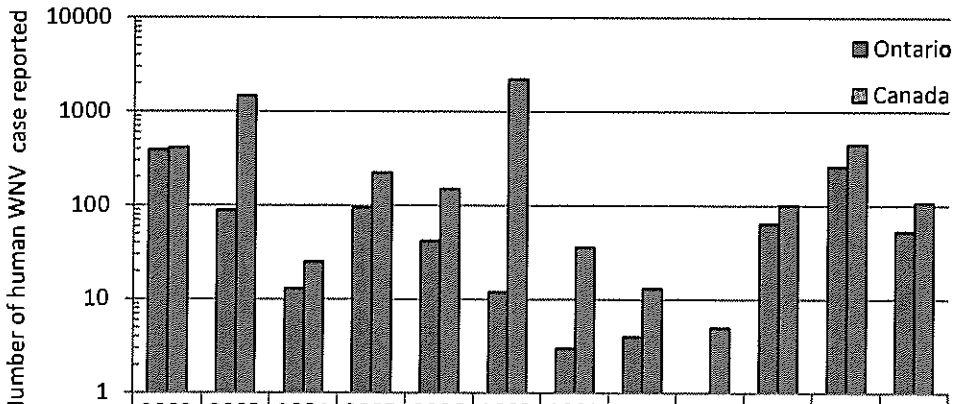
TRCA manages over 40,000 acres of properties, including natural and constructed wetlands, woodland pools, reservoirs, and ponds. These aquatic ecosystems have been considered "mosquito friendly" as a result of the permanent availability of standing water (Knight *et al.* 2003; Gingrich *et al.* 2006; Rey *et al.* 2006). The WNV Surveillance and Monitoring Program was initiated in 2003 as a measure of due diligence, and at the request of TRCA's Regional Public Health partners (Regions of Peel, York, Durham and the City of Toronto). Mosquito populations in selected natural habitats (collectively referred to as "wetlands" in this report) and stormwater management ponds (SWMPs) have been monitored throughout the summer months since the launch of the program. The data collected were used to identify sites of potential concern or vector mosquito "hot spots" and then follow up with appropriate management actions.

The objectives of the WNV Vector Mosquito Larval Monitoring and Surveillance Program are to reduce WNV risk on TRCA properties through the following approaches:

- **Monitoring and Surveillance:** to identify sites of WNV concern through larval mosquito monitoring, and take appropriate control measures if deemed necessary;
- **Public Education and Communication:** to respond to public inquiries on WNV related issues and address standing water complaints; and
- **Collaboration with Regional Health Units:** to participate in WNV advisory committees and share WNV related information and data.

In Canada, the number of human WNV cases fluctuates annually, driven by complex environmental and biological factors. An increase in WNV activity occurred in 2011 and it persisted into 2012, making 2012 the second worst outbreak year since 2002 in Ontario (Figure 1). In 2013, a total of 108 human cases were reported from 5 provinces: Ontario – 53, Quebec – 29, Alberta – 21, Saskatchewan – 6, and Manitoba – 2 (Public Health Agency of Canada, 2013). In the Greater Toronto Area (GTA), 19 human WNV cases were reported: City of Toronto – 11, Peel Region – 3, Durham Region – 2, Halton Region – 2, and York Region –1 (Public Health Ontario, 2013).

Figure 1. Human West Nile virus cases in Ontario and Canada, 2002 - 2013



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Ontario	394	89	13	95	42	12	3	4	1	64	259	53
Canada	414	1481	25	225	151	2215	36	13	5	101	450	108

In 2013, Ontario's provincial and regional health agencies continued to monitor numbers of dead birds, adult mosquitoes, larval mosquitoes and human cases as part of the WNV surveillance programs. Adult mosquitoes monitoring is crucial for determining the immediate risk of humans contracting WNV. Larval mosquito surveillance provided information allowing Regional Public Health Units to eliminate/reduce mosquito larvae through larvicide application.

2. Public Education and Communication

One of TRCA's WNV management approaches is to focus on prevention through increasing public awareness and to deal with standing water concerns on TRCA properties.

2.1 Increasing public awareness of West Nile virus

In 2013, TRCA continued to increase public awareness of WNV by:

- sharing tips on personal protection against mosquito bites, reminding the public to perform good housekeeping practices, and making the latest WNV program annual

reports available on TRCA website (http://trca.on.ca/protect/monitoring/west-nile-virus-monitoring-program.dot);
- reminding staff the importance of personal protection against WNV, and providing the latest WNV monitoring program and regional WNV status; and
- displaying posters with WNV information in TRCA offices and Conservation Areas.

2.2 Standing Water Complaints

2.2.1 Standing Water Complaint Procedure

Complaints from the public or staff regarding standing water or mosquito activities were addressed according to TRCA's Standing Water Complaint Procedure (Appendix A). The procedure includes the following steps:

1. Acquired background information (location, name of the complainant, contact information, and the nature of the complaint).

2. Evaluated the location for its proximity to a routine WNV sampling station, and the sensitivity of the area.

3. TRCA's Finance and Business Services Division and Planning and Development Division were consulted to review property ownership, management agreements and land regulation information.

4. For non-TRCA property or property under management agreement, the respective regional public unit was notified. For TRCA properties, if deemed necessary, were monitored following the methods described in *Section 4*: mosquito larval collection and identification and WNV risk assessment.

5. When a potential hotspot was identified, and if larviciding was deemed appropriate, the following agencies were notified:
   - respective regional public health unit
   - Manager and Director at TRCA – for approval to proceed with the larvicide treatments
   - The Ministry of the Environment (MOE) – to obtain the permit for larviciding
   - The Ministry of Natural Resources (MNR) – to review the sensitivity of the area

6. Notified the complainant the results of the investigation.

2.2.2 Standing Water Complaint Sites

In 2013, TRCA staff dealt with one standing water concern. The pond located at the back of the Archetype House in Kortright Centre for Conservation was identified as a WNV vector mosquito hot spot. The pond was drained, re-filled and stocked with fish (koi). The original plan was to stock the pond with native fish species, however due to permitting issues, non-native koi were

stocked instead. The control method (fish stocking) appeared to be effective. No mosquito larvae were found during all the follow-up (four) visits.

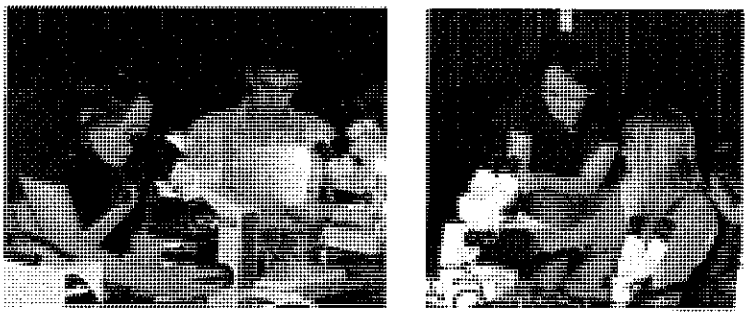
Three additional complaints were received, but these sites were not located on TRCA property. The files were forwarded to responsible public health unit.

3. Collaboration with Regional Health Units

The collaboration efforts with our regional public health partners involved notification of vector mosquito hot spots, and participation in advisory committees. TRCA also provided larval mosquito identification training to Durham Public Health staff. The participants of the training workshop learned to identify mosquito larvae commonly found in Southern Ontario.

In addition, an Order was issued to TRCA to assist with the implementation of control measures to reduce the number of mosquito larvae in the Heart Lake Wetland Complex in Brampton by the Medical Officer of Peel Regional under the *Health Protection and Promotion Act*, R.S.O. 1990, c. H.7.

Figure 2. Mosquito larval identification workshop hosted by TRCA



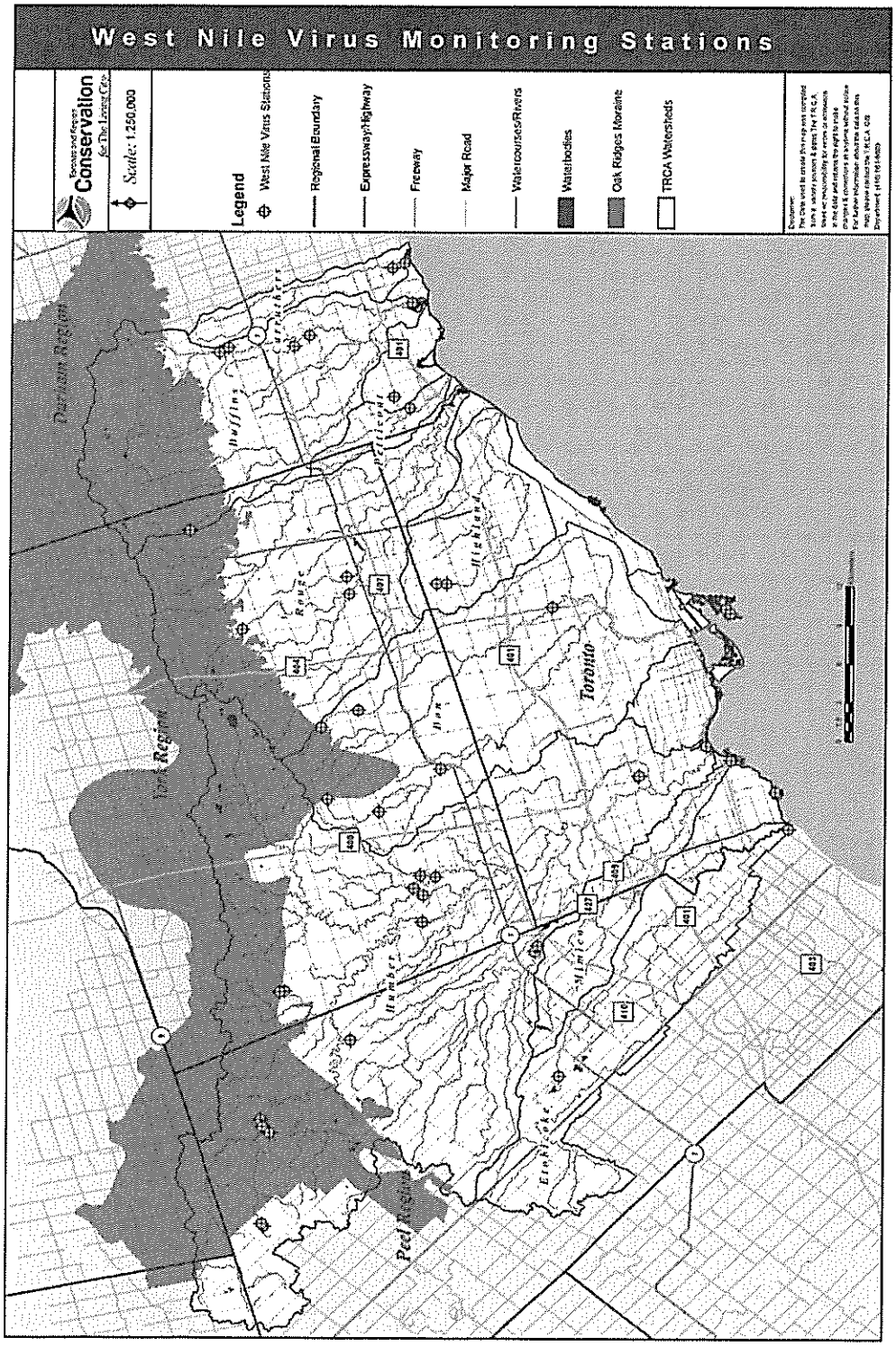
4. Larval Mosquito Monitoring

4.1 Methods

4.1.1 Monitoring Site Locations

The 2013 larval mosquito monitoring program began on June 3, and it covered 39 wetlands and 6 SWMPs across TRCA's jurisdiction (Figure 2). The monitoring stations remained unchanged from 2012. Additionally, the newly constructed Kortright Earth Rangers wetland became a routine monitoring station in 2013. Kortright Earth Rangers wetland was a concern for WNV, due to its proximity to the Earth Rangers building, which houses valued bird species as part of their education program (as animal ambassadors).

Figure 3. Location of West Nile virus monitoring sites, 2013



4.1.2 Collection and identification

Field technicians used several dipping techniques to ensure that all types of potential mosquito habitats were sampled (Figure 3). Samples were not collected during a rain event because raindrops disturb the water surface and consequently cause mosquito larvae to disperse (O'Malley, 1995).

Collected mosquito larvae were reared in rearing chambers until they reached maturity (fourth instar stage). The larvae were then preserved in 70% ethyl alcohol. Mosquito larvae were identified to species under a dissecting microscope using mosquito taxonomic keys (Wood *et al.*, 1979; Darsie and Ward, 2005). The larvae that died before reaching maturity were not identified.

Figure 4. Field technician sampling with a standard mosquito dipper

Previously, TRCA collected *in situ* water quality data (pH, water temperature, conductivity, and dissolved oxygen) during site visits to help understand the correlation between water quality and mosquito larvae abundance. However, no conclusive correlations could be made. Consequently, *in situ* water quality data collection was terminated at the end of the 2012 field season. Without having to collect *in situ* water quality data, the field technicians were able to complete an additional (fifth) sampling event, compared to four sampling events in the previous years.

4.1.3 WNV Risk Assessment

A WNV risk ranking was assessed for each site based on the number of vector larvae found in samples, according to the modified Wada's method of ranking (Wada, 1956):

- Sites with no vector larvae were ranked as "***Nil***" risk;
- Sites with <2 vector larvae per 10 dips were ranked as "***Low***" risk;
- Sites with 2 - 30 vector larvae per 10 dips were ranked as "***Moderate***" risk; and
- Sites with >31 vector larvae per 10 dips were ranked as "***High***" risk sites.
-

Risk ranking was applied to each vector species independently, instead of the cumulative number of vector larvae found at each site due to species variation in biology, host preference and the efficiency of each vector species to transmit WNV.

Sites with "high" risk ranking or vector hot spots were addressed, the respective regional health unit was informed and if warranted, the sites were treated with larvicide.

Take into consideration that when a site is ranked as high-risk, it does not imply that the virus is present at that site and poses immediate threat to the public. Mosquitoes only carry the virus after biting an infected bird. Mosquito larvae do not need blood meals thus do not carry the virus. The risk ranking merely indicates the presence of vector mosquito species which could potentially spread WNV to human populations, not the presence of the virus.

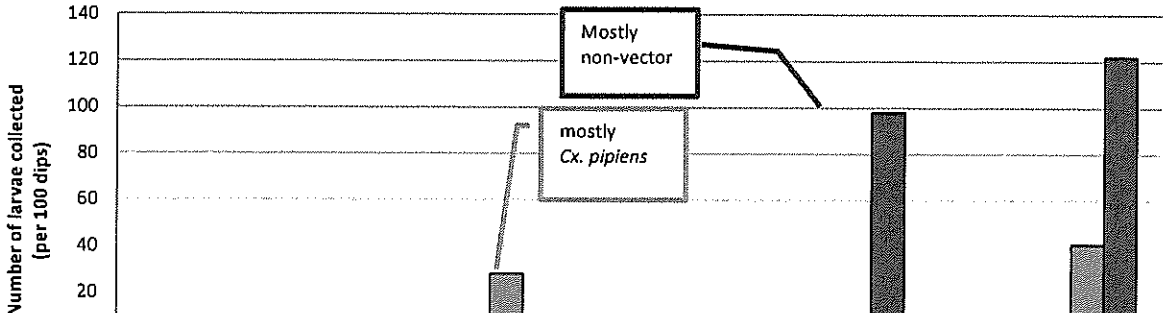
4.2 Results

4.2.1 Mosquito composition and West Nile virus Risk Assessment

In total, 7146 mosquito larvae representing 11 species were collected in 2013. Larval mortality during the rearing process remained low at 8%. Mosquito larvae that died prematurely were not identified to species, thus excluded from the analyses and risk assessment in the following sections. The identified larvae included 6650 larvae from wetlands and 496 larvae from SWMPs.

Almost 80% of our sampling sites are wetlands. Therefore, a standardized measure of effort (i.e. larvae collected per 100 dips) was established to compare the mosquito larvae compositions between wetlands and SWMPs. Overall, mosquito larvae were more abundant in wetlands, 122 larvae were collected per 100 dips from wetlands compared to only 41 larvae from SWMPs (Figure 5). In wetlands, 13 vector mosquito larvae were collected per 100 dips; in SWMPs, 35 larvae, including 28 *Culex pipiens larvae*, were collected with the same amount of effort. This finding, most of the vector mosquito larvae inhabited SWMPs, is consistent with the results from previous years.

Figure 5. Number of Larvae collected per 100 dips, 2013



	Ae. vexans	An. punctipennis	An. quadrimaculatus	Cx. pipiens	Cx. restuans	Oc. trivittatus	Non-vector	Missing	Total
SWMPs	1	4	0	28	2	0	2	4	41
Wetland	3	2	2	1	2	3	98	10	122

The species collected included four non-vector species (*Culex territans*, *Psorophora ferox*, *Anopheles earlei*, *and Uranotaenia sapphirina)* and seven WNV vector species (*Aedes vexans*, *Anopheles punctipennis, Anopheles quadrimaculatus, Culex pipiens*, *Culex restuans*, *Culex salinarius, and Ochlerotatus trivittatus)*. The most widespread species was *Culex territans,* which inhabited 38 of the 45 (84%) monitoring sites. Two key WNV vectors, *Culex pipiens* and *Culex restuans,* were found at 15 (33%) and 8 (18%) of the sampled sites respectively.

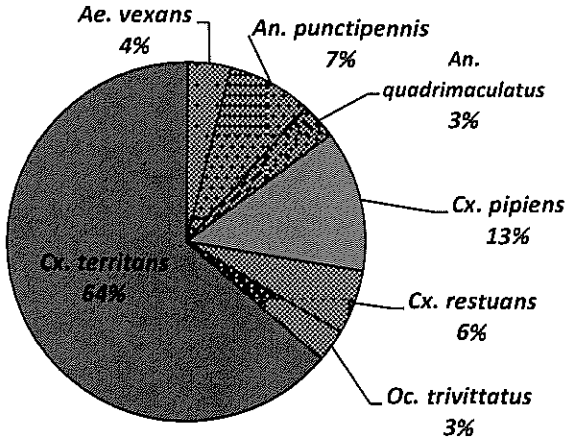
Mosquito monitoring results by site and by Region are listed in Appendix B-1 to B-4.

4.2.2 Wetlands

In total, 6094 mosquito larvae were identified to species for 39 wetlands. Similar to the findings from previous years, non-vector mosquito species, namely *Culex territans* dominated wetland habitats (Figure 5). In total, 11 mosquito species were collected in wetlands. The predominant non-vector species was *Culex territans* (64%), and the predominant vector species was *Culex pipiens* (13%) (Figure 5). As in previous years, higher mosquito diversity was observed in wetlands compared to SWMPs. The finding could be attributed to the facts that more wetland sites were sampled, and wetlands generally provide more diverse habitat.

Figure 6. Mosquito species composition in wetlands in 2013

(non-vector species are indicated in green and vector species are indicated in red)



Note: *Cx. salinarius*, *Ps. ferox, Ur. sapphirina,* and *An. earlei* collectively represented 0.25% of the mosquito collected, therefore were excluded from the figure.

Monitoring results showed that most wetlands posed minimal risk for WNV vector mosquitoes. All monitored Conservation Areas (Albion Hills, Altona Forest, Boyd, Bruce's Mill, Claireville, Glen Haffy, Heart Lake, and Kortright Centre) had very limited number of vector mosquito larvae present. Only 13 *Anopheles quadrimaculatus* were collected at the new Earth Rangers Wetland site throughout the season in 2013.

The environmentally friendly larvicide, *Bacillus thuringiensis israelensis* (Bti) was used to treat the hot spots identified. Bti is a bacterium found naturally in soils, and since 1982, it has been used successfully worldwide as a biological pest control agent to combat mosquitoes and black flies (Health Canada 2011). The pest control contractor displayed signs (Figure 6) to notify the public prior and during the larvicide treatments. The four identified hot spots were:

1) Grenadier Pond in High Park

In 2011 and 2012, large numbers of *Culex pipiens* were found here. Once again, Grenadier Pond was identified as a hot spot for *Culex pipiens* on June 27, 2013. Toronto Public Health was informed of this finding. The site was treated with larvicide after the Public Health staff visited the station and determined that treatment was necessary. The larvicide treatment was effective, no mosquitoes were found during the subsequent sampling event (July 15). The site continued to be monitored and treated until the end of the summer season. Later in the season, mosquito larvae re-appeared in the pond, however not in large numbers.

Figure 7. Larvicide treatment notification display

2) Topham Pond in Eglinton Flats

Topham Pond was identified as a hot spot for *Culex pipiens* on July 29, 2013. Toronto Public Health staff was informed, and the pond was treated with larvicide after the City staff investigated the site. During the subsequent visit (August 14), the number of vector mosquito larvae was reduced from 171 to 61, thus the risk ranking was lowered to "Moderate". Toronto Public Health staff indicated that the treatment was on-going and would be continued until the end of the season.

3) Goldfish Pond in Tommy Thompson Park

Goldfish Pond was identified as a hot spot for *Culex pipiens* on August 13, 2013. Goldfish Pond is known for its environmental sensitivity (presence of species at risk); although larvicide treatments were undertaken in accordance with the City of Toronto Public Health policies and TRCA's standing water procedures in this case. Field technicians were able to direct the City staff to the spot where high densities of vector mosquito larvae were found to minimize the use of pesticide at this site. Biologists at the Ministry of Natural Resources were informed prior to treatment.

4) Unnamed wetland in Vaughan

In 2009, a standing water complaint was filed about a floodplain in Vaughan near Highway 27 and Major Mackenzie Drive. Since then, it has been a routine monitoring station. On July

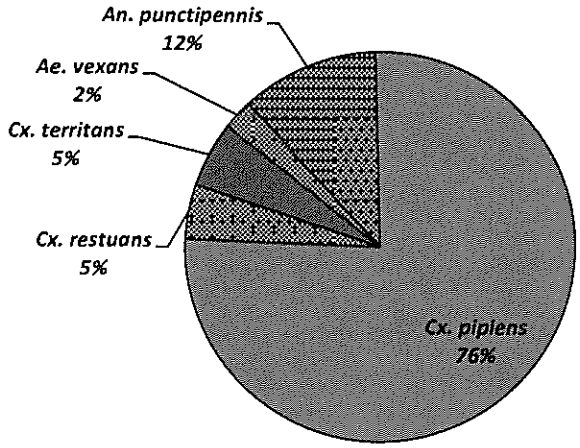
8, the GTA region received record rainfall of 126 mm in 2 hours (Environment Canada, 2013). The downpour caused major flooding in the region. Because this site had been a concern after major storm events in the past, it was visited soon after the storm on July 10. The results showed that it had become a hot spot for flood water vector mosquitoes such as *Aedes vexans* (n=167) and *Ochlerotatus trivittatus* (n=163) just two days after the storm. York Region Public Health Unit was informed and took immediate action. The site was treated on July 11. The treatment was effective; only three mosquito larvae were found when the site was re-visited on July 19.

4.2.3 Stormwater Management Ponds

From the 6 SWMP monitoring sites, 450 mosquito larvae were identified, which consisted of 426 (95%) vector mosquito species larvae and 24 (5%) non-vector (Figure 7). The vector species to non-vector species ratio observed was similar to previous years. The number of larvae collected dropped from 1317 in 2012 to 496 in 2013. This was likely due to the fact that L'Amoreaux Park North Pond has been a hot spot for the past number of years and the City of Toronto Public Health took proactive approach and started larvicide treatment at this site early in the season.

Figure 8. Mosquito species composition in stormwater management ponds, 2013.

The vector species were indicated in red and the non-vector species was in green



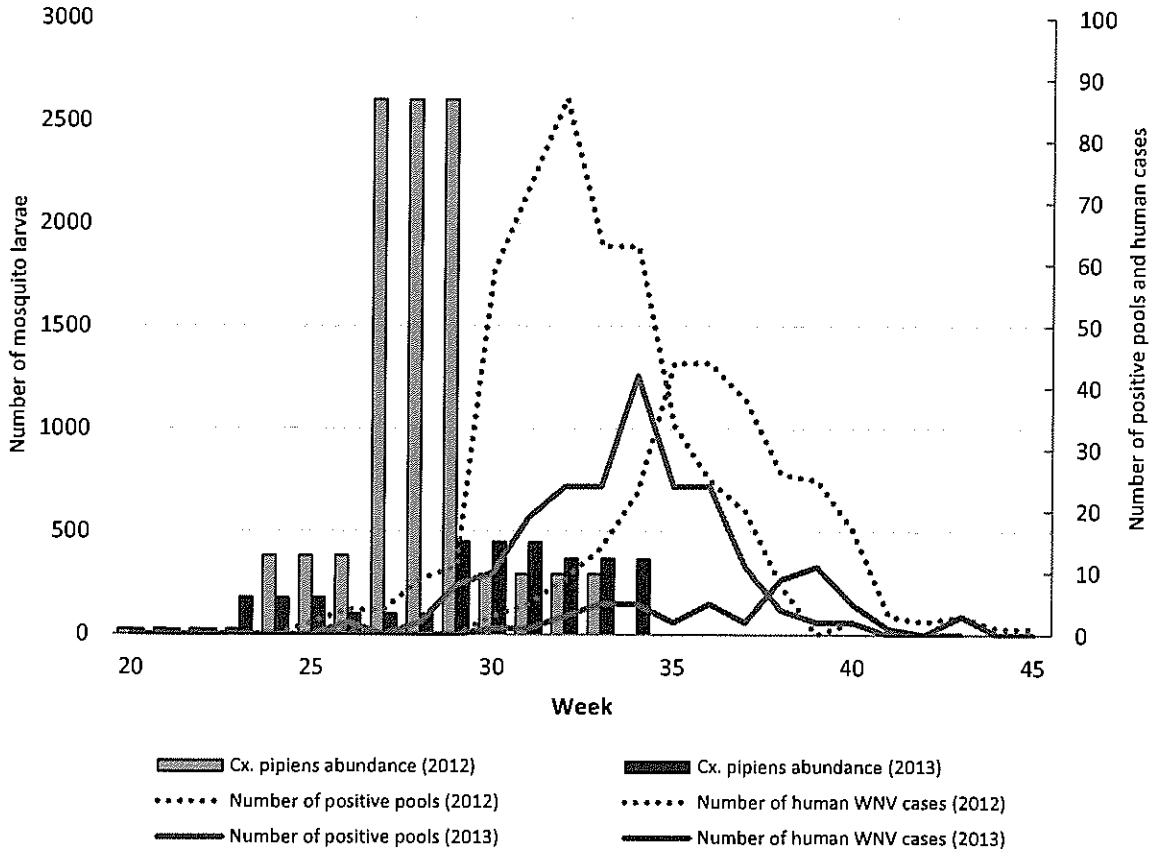
4.3 Vector Mosquito Larvae Abundance and the Spread of WNV

Culex pipiens and Culex restuans are thought to be responsible for 80% of human WNV infection in the north-eastern United States (Kilpatrick et al. 2005). Jurisdictionally, *Culex pipiens* is the dominant vector species. In 2012, *Culex pipiens* abundance peaked in Week 27-29, subsequently the numbers of WNV positive mosquito pools started to increase. Three weeks later, the increase in human WNV cases coincided with the highest numbers of positive mosquito pools (Figure 8). A *mosquito pool* is a collection of mosquitoes (usually about 50) of any particular species that are likely to carry a virus. A WNV positive mosquito pool hence is a pool that has been tested positive for the WNV in the lab. Figure 8 showed that larvae surveillance is not only used to detect location, species, and abundance of mosquitoes to

enable timely management, but also vital in predicting adult mosquito emergence and the potential of human contacting the virus.

In 2013, perhaps as a result of the cooler summer temperature, *Culex pipiens* abundance peaked slightly later in the week of 29-31. This was also followed by the steady increase of the WNV positive pools. Due to the larvicide applications in selected sites, "*Culex pipiens* abundance" numbers in the chart represents only a fraction of the potential numbers. Figure 8 shows that the degree and timing of human WNV outbreak is closely related to the number of vector larvae and the number of positive pools.

Figure 9. Numbers of vector larvae, positive pools, and human cases, 2013



5. Conclusions

The results from the 2013 program supported the findings from the previous TRCA WNV mosquito larval studies. Generally, functioning wetlands do not pose threats of WNV due to the low numbers of vector larvae present. No vector mosquito hot spots were found in surveyed Conservation Areas (Albion Hills, Altona Forest, Boyd, Bruce's Mill, Claireville, Glen Haffy, Heart Lake, and Kortright Centre). On the contrary, the majority of the larvae collected in SWMPs were WNV vector species. The storm on July 8, 2013 caused a surge in number of flood water vector mosquitoes collected in the region. The eggs of flood water mosquito species can hatch and start developing just a few days after a flood. Consequently, all sites with flood potential should be monitored closely after major storm events.

Compared to 2012, the cooler summer might have slowed the development of *Culex pipiens* larvae. Five hot spots were detected and treated through TRCA's larval mosquito monitoring program. The ability to detect hot spots, and subsequently take appropriate control measures highlighted the importance of regular and continuous seasonal monitoring of wetlands and SWMPs. TRCA addressed one standing water concerns associated with TRCA properties as per TRCA's Standing Water Complaints Procedure.

Collaboration with Regional Public Health units and TRCA's management team is crucial in managing WNV vector hot spots in a timely manner on TRCA properties. In 2013, the City of Toronto Public Health and York Public Health assisted TRCA in treating identified WNV hot spots identified. Jurisdictionally, *Culex pipiens* abundance were the highest in the City of Toronto compared to the Regions of Peel, Durham, and York. The number of WNV positive mosquito pools and the number of human cases showed the same trend. Data from each region should be further analysed and compared. TRCA's data are valuable for the regional public Health partners to use as a tool in predicting the emergence of vector species adult mosquitoes and the WNV risk in the human population.

More analyses on the data also have to be done to evaluate how much a small scale (i.e. 45 monitoring sites) larval mosquito monitoring program can contribute to research. For example, contributing to the development of a model (by LAMPS – York University), which could be capable of predicting the timing and intensity of the spread of WNV into the human populations in a particular year.

6. References

Darsie, R.F. and R.A. Ward, 2005. Identification and Geographical Distribution of the Mosquitoes of North America, North of Mexico. University Press of Florida, Gainesville, Florida, 383 pp.

Gingrich, J.B., D. Robert, G.M. Williams, L. O'Connor and K. Harkins, 2006. SWMPs, constructed wetlands, and other best management practices as potential breeding sites for West Nile Virus vectors in Delaware during 2004. *J. Amer. Mos. Con. Asso.*, 22 (2): 282 -291.

Hamer, G.L, Kitron, U.D, Goldberg TL, Brawn, J.D, Loss, S.R. 2009. Host selection by *Culex pipiens* mosquitoes and West Nile Virus amplification. Am J Trop Med Hyg 80: 268–278.

Health Canada. 2011. Bti – Bacillus *thuringiensis subspecies israelensis.* http://www.hc-sc.gc.ca/cps-spc/alt_formats/pdf/pubs/pest/_fact-fiche/bti-eng.pdf (Accessed January, 2013)

Kilpatrick, A.M., L.D. Kramer, S. Campbell, E.O. Alleyne, A.P. Dobson, P. Daszak. 2005. West Nile virus risk assessment and the bridge vector paradigm. Emerging Infectious Diseases., 11(3) 425-429.

Knight, R. L., W. E. Walton, G. F. O'Meara, W. K. Reisen and R. Wass. 2003. Strategies for effective mosquito control on constructed treatment wetlands. Ecol. Eng., Vol 21: 211-232.

O'Malley, C. 1995. Seven ways to a successful dipping career. Wing Beats. 6:23-24.

Public Health Agency of Canada, 2013. West Nile Virus MONITOR. Weekly Up Dates: Human and Dead Bird Surveillance. http://www.phac-aspc.gc.ca/WNV-vwn/index.html. (Accessed: February 6, 2014)

Public Health Ontario, 2013. http://www.oahpp.ca/resources/vector-borne-disease-surveillance-reports.html (Accessed: January 30, 2014)

Rey, J. R., G. O'Meara, S. M. O'Connell and M. M. Cutwa-Francis, 2006. Mosquito production from four constructed treatment wetlands in peninsular Florida. *J. Amer. Mos. Con. Asso.*, 22 (2): 198 - 205.

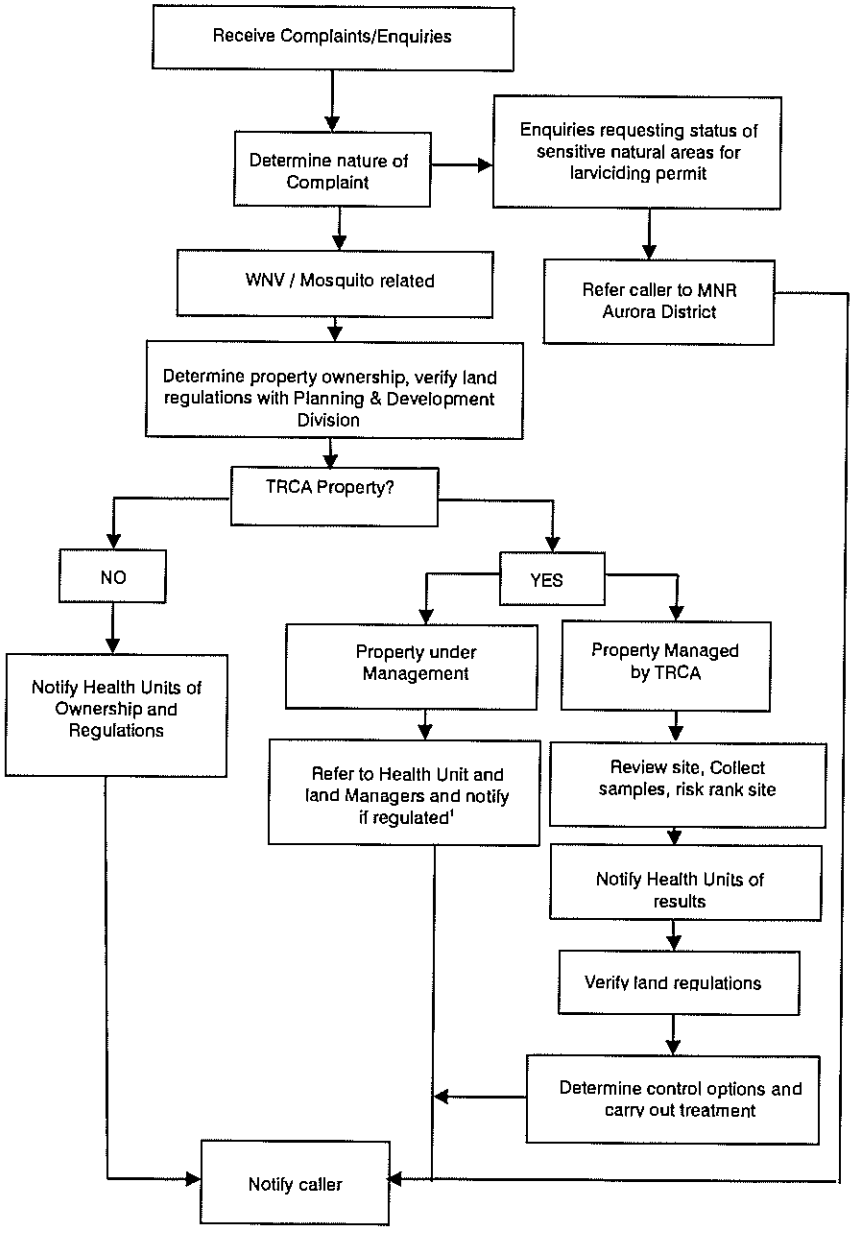
Wada, Y., 1956. Population Studies on Edmonton Mosquitoes. Questions Ent. 1: 187- 222.

Wood, D.M., P.T. Dang and R. A. Ellis, 1979. The Insects and Arachnids of Canada. Part 6: The Mosquitoes of Canada Diptera: Culicidae. Publication 1686, Agriculture Canada, 361 Pages.

Appendices

C 19.53

Appendix A. TRCA Standing Water Complaint Procedure



C 19.54

Appendix B-1 Monitoring and Risk Assessment Results in Durham Region - 2013

Sites with no vector larvae were ranked as "***Nil***" risk; sites with <2 vector larvae per 10 dips were ranked as "***Low***" risk; sites with 2 - 30 vector larvae per 10 dips were ranked as "***Moderate***" risk; and sites with >31 vector larvae per 10 dips were ranked as "***High***" risk.

Site	Sampling Event	*Ae. vexans*	*An. punctipennis*	*An. quadrimaculatus*	*Cx. pipiens*	*Cx. restuans*	*Oc. trivittatus*
Altona Forest	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Low	Nil	Low	Nil	Nil
	4	Nil	Moderate	Low	Nil	Nil	Nil
	5	Nil	Moderate	Nil	Nil	Nil	Nil
Carruthers Swamp Complex	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Low	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Nil	Nil	Nil
	5	Moderate	Moderate	Nil	Low	Nil	Nil
Claremont Wetland-1	1	Nil	Low	Nil	Nil	Nil	Nil
	2	Nil	Low	Nil	Nil	Nil	Nil
	3	Nil	Low	Low	Nil	Nil	Nil
	4	Nil	Moderate	Low	Low	Nil	Nil
	5	Nil	Moderate	Nil	Nil	Nil	Nil
Claremont Wetland-2	1	Nil	Low	Low	Nil	Nil	Nil
	2	Nil	Low	Low	Nil	Nil	Nil
	3	Nil	Low	Low	Nil	Nil	Nil
	4	Nil	Low	Moderate	Nil	Nil	Nil
	5	Nil	Low	Moderate	Nil	Nil	Nil
Frenchman's Bay Promenade	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Low	Nil	Nil	Nil	Nil
	4	Nil	Low	Nil	Nil	Nil	Nil
	5	Nil	Low	Nil	Nil	Nil	Nil
Greenwood Marsh	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Low	Nil	Nil	Nil	Nil
	3	Nil	Low	Nil	Nil	Nil	Nil
	4	Nil	Low	Nil	Nil	Nil	Nil
	5	Nil	Low	Nil	Nil	Nil	Nil
Greenwood Pond	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Low	Nil	Nil	Nil	Nil
	3	Nil	Low	Nil	Nil	Nil	Nil
	4	Nil	Low	Nil	Nil	Nil	Nil
	5	Nil	Low	Low	Nil	Nil	Nil
Lower Duffins	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Low	Nil	Nil	Nil	Nil
	4	Nil	Low	Nil	Nil	Nil	Nil
	5	Nil	Low	Nil	Nil	Nil	Nil

C19·55

Appendix B-2 Monitoring and Risk Assessment Results in Peel Region - 2013

Sites with no vector larvae were ranked as "***Nil***" risk; sites with <2 vector larvae per 10 dips were ranked as "***Low***" risk; sites with 2 - 30 vector larvae per 10 dips were ranked as "***Moderate***" risk; and sites with >31 vector larvae per 10 dips were ranked as "***High***" risk.

Site	Sampling Event	*Ae. vexans*	*An. punctipennis*	*An. quadrimaculatus*	*Cx. pipiens*	*Cx. restuans*	*Oc. trivittatus*
Albion Hills Pond-1	1	Nil	Low	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Nil	Nil	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
Albion Hills Pond-2	1	Nil	Low	Nil	Nil	Nil	Nil
	2	Nil	Low	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Nil	Nil	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
Albion Hills Pond-4	1	Nil	Low	Nil	Nil	Nil	Nil
	2	Nil	Moderate	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Moderate	Low	Nil	Nil	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
Claireville Wetland-1	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Low	Nil	Nil	Nil	Nil
	3	Nil	Low	Nil	Nil	Nil	Nil
	4	Nil	Moderate	Nil	Nil	Nil	Nil
	5	Nil	Low	Nil	Nil	Nil	Nil
Claireville Wetland-2	1	Nil	Low	Nil	Nil	Nil	Nil
	2	Moderate	Moderate	Nil	Nil	Nil	Low
	3	Nil	Moderate	Nil	Low	Nil	Nil
	4	Nil	Low	Nil	Nil	Nil	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
Glen Haffy Trout Pond-1	1	Nil	Low	Nil	Nil	Nil	Nil
	2	Nil	Moderate	Low	Nil	Nil	Nil
	3	Nil	Low	Low	Nil	Nil	Nil
	4	Nil	Moderate	Moderate	Nil	Nil	Nil
	5	Nil	Moderate	Low	Nil	Nil	Nil
Glen Haffy Trout Pond-2	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Low	Low	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Moderate	Nil	Nil	Nil	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
Heart Lake	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Nil	Nil	Nil
	5	Nil	Low	Nil	Nil	Nil	Nil
Marie Curtis	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Low	Nil	Nil	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
SWMP-174	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Low	Nil	Nil	Nil	Nil
	3	Nil	Low	Nil	Nil	Nil	Nil
	4	Nil	Low	Nil	Nil	Nil	Nil
	5	Nil	Moderate	Low	Nil	Nil	Nil

C19.56

Appendix B-3 Monitoring and Risk Assessment Results in Toronto - 2013

Sites with no vector larvae were ranked as "***Nil***" risk; sites with <2 vector larvae per 10 dips were ranked as "***Low***" risk; sites with 2 - 30 vector larvae per 10 dips were ranked as "***Moderate***" risk; and sites with >31 vector larvae per 10 dips were ranked as "***High***" risk.

Site	Sampling Event	*Ae. vexans*	*An. punctipennis*	*An. quadrimaculatus*	*Cx. pipiens*	*Cx. restuans*	*Oc. trivittatus*
Col. Samuel Smith Main Pond	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Nil	Nil	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
Col. Samuel Smith Mini Pond	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Moderate	Low	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Low	Nil	Nil
	5	Nil	Nil	Nil	Low	Nil	Nil
High Park Grenadier Pond	1	Nil	Nil	Nil	Moderate	Moderate	Nil
	2	Nil	Nil	Low	High	Moderate	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Moderate	Moderate	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
L'Amoreaux North Pond	1	Low	Nil	Nil	Nil	Low	Nil
	2	Nil	Nil	Nil	Nil	Low	Nil
	3	Low	Nil	Nil	Moderate	Moderate	Nil
	4	Low	Nil	Nil	High	Low	Nil
	5	Nil	Low	Nil	Moderate	Low	Nil
L'Amoreaux South Pond	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Nil	Nil	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
Milne Hollow	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Nil	Nil	Nil
	5	Nil	Low	Nil	Nil	Nil	Nil
Mimico Amphibian Pond	1	Nil	Nil	Nil	Nil	Low	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Low	Nil	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
Topham Pond	1	Nil	Nil	Nil	Moderate	68	Nil
	2	Nil	Nil	Nil	Moderate	Low	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	High	Moderate	Nil
	5	Nil	Nil	Nil	Moderate	Moderate	Nil
TTP Goldfish Pond	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Moderate	Moderate	Nil	Nil
	5	Nil	Low	Nil	High	Nil	Nil
TTP Tri-Pond	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Low	Nil	Nil	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
Woodland Pond	1	Nil	Nil	Nil	Low	Moderate	Nil
	2	Nil	Nil	Nil	Moderate	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Low	Low	Nil
	5	Nil	Low	Nil	Moderate	Nil	Nil

C 19.57

Appendix B-4 Monitoring and Risk Assessment Results in York Region - 2013

Sites with no vector larvae were ranked as "***Nil***" risk; sites with <2 vector larvae per 10 dips were ranked as "***Low***" risk; sites with 2 - 30 vector larvae per 10 dips were ranked as "***Moderate***" risk; and sites with >31 vector larvae per 10 dips were ranked as "***High***" risk.

Site	Sampling Event	*Ae. vexans*	*An. punctipennis*	*An. quadrimaculatus*	*Cx. pipiens*	*Cx. restuans*	*Oc. trivittatus*
Boyd Conservation Area	1	Nil	Low	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Low	Nil	Nil
	3	Nil	Low	Nil	Low	Nil	Nil
	4	Nil	Low	Nil	Low	Nil	Nil
	5	Nil	Moderate	Nil	Moderate	Nil	Nil
Bruce's Mill	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Low	Nil	Nil	Nil	Nil
	3	Nil	Nil	Low	Low	Nil	Nil
	4	Nil	Low	Low	Low	Nil	Nil
	5	Nil	Low	Low	Nil	Nil	Nil
Cold Creek Pond	1	Nil	Low	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Low	Low	Nil	Nil	Nil
	4	Nil	Low	Low	Nil	Nil	Nil
	5	Nil	Moderate	Low	Nil	Nil	Nil
Earth Rangers	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Low	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Nil	Nil	Nil
	5	Nil	Nil	Moderate	Nil	Nil	Nil
Granger Wetland South	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Low	Nil	Nil	Nil
	4	Nil	Nil	Nil	Nil	Nil	Nil
	5	Nil	Low	Low	Nil	Nil	Nil
Keffer Marsh	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Low	Nil	Nil	Nil
	4	Nil	Low	Low	Nil	Nil	Nil
	5	Nil	Low	Low	Nil	Nil	Nil
Killian Lamar	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Nil	Nil	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
Kortright Centre Marsh	1	Nil	Low	Moderate	Nil	Nil	Nil
	2	Nil	Low	Low	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Nil	Nil	Nil	Nil
	5	Nil	Moderate	Nil	Nil	Nil	Nil
Stouffville Reservoir	1	Nil	Nil	Low	Nil	Nil	Nil
	2	Nil	Nil	Low	Nil	Nil	Nil
	3	Nil	Low	Low	Nil	Nil	Nil
	4	Nil	Nil	Nil	Nil	Nil	Nil
	5	Nil	Low	Moderate	Nil	Nil	Nil
Toogood Pond	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Low	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Nil	Low	Nil	Nil	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
un-named wetland - Vaughan	1	Nil	Moderate	Nil	Nil	Moderate	Nil
	2	Low	Low	Nil	Moderate	Moderate	Nil
	3	High	Low	Nil	Moderate	Moderate	High
	4	Moderate	Low	Nil	Nil	Nil	Moderate
	5	Nil	Nil	Nil	Nil	Nil	Nil
Un-name Wetland 1	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Low	Nil	Nil	Nil	Nil
	5	Nil	Low	Nil	Nil	Nil	Nil
un-named Wetland 2	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Low	Low	Nil	Nil	Nil
	5	Nil	Low	Nil	Nil	Nil	Nil
SWMP-88.2	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Low	Low	Nil
	4	Nil	Nil	Low	Low	Low	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil
SWMP-139	1	Nil	Nil	Nil	Nil	Nil	Nil
	2	Nil	Nil	Nil	Nil	Nil	Nil
	3	Nil	Nil	Nil	Nil	Nil	Nil
	4	Nil	Low	Nil	Nil	Nil	Nil
	5	Nil	Nil	Nil	Nil	Nil	Nil