



West Nile Virus Vector Mosquito Monitoring Report- 2019

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Summary

TRCA's Mosquito Surveillance Program

Toronto and Region Conservation Authority established the West Nile Virus (WNV) Larval Mosquito Surveillance and Monitoring Program in 2003. The program has a three-pronged approach, which includes larval mosquito monitoring, prevention through education and communication, and collaboration with regional public health units. The objective of the program is to identify WNV mosquito hotspots, take appropriate intervention measures to reduce risk for people, and ultimately to protect our wetlands. Traditionally, wetlands are considered mosquito-friendly habitats, therefore posing serious WNV threats. However, TRCA's long-term monitoring data have shown that wetlands generally do not support large vector mosquito populations. Nonetheless, occasionally hotspots have been detected through our surveillance program. TRCA takes appropriate control measures to eliminate mosquito larvae from these hotspots.

A WNV mosquito hotspot is recognized when over 30 larval mosquitoes of a vector species are collected at a site. Vector species is referred to the type of mosquito that is capable of transmitting the virus. Research results suggest that two key mosquito species, *Culex pipiens* and *Culex restuans*, are primarily responsible for spreading the virus to humans in Ontario. Both mosquito species are among the most common mosquitoes found in urban areas in the Greater Toronto Areas.

Forecasting a WNV outbreak is challenging, as mosquito population dynamics are influenced by unpredictable biological and environmental factors. Management strategies undertaken by the provincial and regional health agencies focus on prevention through raising awareness and mosquito source reduction.

Results of Surveillance Activities in 2019

The dynamics of the mosquito population in a given year depend heavily on seasonal temperature and precipitation. With a combination of sufficient precipitations and warm summer temperatures, 9,186 mosquito larvae were collected from 48 monitoring sites. Amongst the 11 different species of mosquitoes collected, the most dominant and widespread species overall was *Culex territans* (a non-vector species), which inhabited 41 of the 48 monitoring sites. The dominant species in wetland in 2019 was *Culex territans* (77%), and in stormwater management ponds (SWMPs), *Culex pipiens* (a main WNV vector) comprised 73% of the larvae collected.

Similar to previous years, monitoring results showed that most wetlands posed minimal risk for harbouring WNV vector mosquitoes. In total, four wetlands and two SWMPs were identified as hotspots. With the assistance of our regional health partners and TRCA's larvicide contractor, larvicide treatments were applied to reduce mosquito larvae at these sites.

Mosquitoes can only carry WNV after biting an infected bird. Mosquito larvae do not feed on blood, thus do not carry the virus. When a site is identified as a hotspot, it simply indicates the presence of vector species which could potentially spread WNV after they emerge as adult mosquitoes, not the presence of the virus itself.

Communication and Collaboration

In 2019, TRCA continued to increase public WNV related issue awareness by responding to public inquiry, providing relevant information and making the annual report available on TRCA website. We shared tips on personal protection against mosquito bites with staff and displayed posters in TRCA offices and Conservation Areas. In addition, complaints or inquiries regarding standing water or mosquito activities were addressed according to TRCA's Standing Water Complaint Procedure.

TRCA's collaboration efforts with our regional public health partners involved providing larval mosquito identification training, notification of hotspots and participating in WNV advisory committees. Collaboration with our partners is a crucial in effectively managing WNV on TRCA properties. City of Toronto, Peel Region, and York Region have assisted TRCA in applying larvicide treatments on selected TRCA properties in the past years.

Human West Nile Virus cases in Ontario

In 2019, a total of 19 human cases were reported in Ontario, dramatically lower than the number (137 cases) reported in 2018 (Public Health Ontario, 2019).

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INTRODUCTION

West Nile virus (WNV) was first discovered in the West Nile district of Uganda in 1937. Since then, WNV has spread into most parts of the world. In North America, WNV was first introduced into United States in 1999, and later appeared in Ontario in 2001. It primarily exists between birds and bird-biting mosquitoes. Humans can also be infected through the bite of a mosquito which had fed on infected birds. Most people who become infected with WNV will have no or mild symptoms. However, rare but severe cases of WNV illness, including the development of meningitis and encephalitis, can be fatal. To date, no human-to-human transmission of WNV through casual contact has been documented (World Health Organization, 2017).

Most mosquito species in Ontario do not pose serious WNV threat. Mosquito species that can carry and transmit WNV are referred to as vector species. The primary species that spread the disease into the human populations are *Culex pipiens* and *Culex restuans* (Kilpatrick et al. 2005; Hamer et al. 2009); both are among the most common mosquitoes found in urban areas in the Greater Toronto Area. In addition, a common flood-water mosquito, *Aedes vexans*, also has high capability of carrying and spreading WNV.

Toronto and Region Conservation Authority (TRCA) owns over 17,000 hectares of land, including natural and constructed wetlands, woodland pools, reservoirs, and ponds. These aquatic ecosystems are 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). TRCA's WNV Surveillance and Monitoring Program was initiated in 2003 as a measure of due diligence, and at the request of our regional public health partners (Regions of Peel, York, Durham and the City of Toronto). TRCA monitors natural aquatic habitats (collectively referred to as "wetlands" in this report) and stormwater management ponds (SWMPs) in the summer months for the presence of mosquitoes. Data collected are used to identify sites of concern or vector mosquito hotspots, which may require following-up with appropriate management actions.

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

- Larval Mosquito monitoring: to identify sites of potential concern through larval mosquito monitoring and take appropriate control measures if deemed necessary.
- Communication: to respond to public inquiries on WNV related issues and address standing water complaints.
- Collaboration with regional public health units: to participate in WNV advisory committees and share information and data.

LARVAL MOSQUITO MONITORING

Methods

Monitoring Site Locations

The 2019 larval mosquito monitoring program began on June 4, sampling 42 wetlands and 6 SWMPs across TRCA's jurisdiction including: Durham Region (8 sites), Peel Region (10 sites), City of Toronto (12 sites), and York Region (18 sites) (Figure 1). Routine monitoring stations were selected initially based on their popularity with visitors and proximity to residential areas. These routine monitoring stations have remained mostly unchanged throughout the years. In 2019, one new station was added to monitor a recently restored wetland at the project manager's request.

Sampling and Identification of larval mosquitoes

Each monitoring station was sampled five times in approximately two to three-week intervals from June 3 to August 30. The waterbody at each station was divided into four comparatively equal quadrants, and one sample was taken within each quadrant. Each sample consisted of collecting with a standard mosquito dipper 10 times. During sampling, the field technician used several dipping techniques to ensure that different types of mosquito habitats were sampled. Collected mosquito larvae were taken back to the lab, enumerated, and reared until they reached maturity (fourth instar stage). The larvae were then preserved in 70% ethyl alcohol and identified under a dissecting microscope using mosquito taxonomic keys (Wood et al., 1979; Darsie and Ward, 2005). Larvae that died before reaching maturity were not identified.

WNV Risk Assessment

WNV risk ranking was assessed for each site based on the number of vector larvae found in a sample, 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;
- Sites with >31 vector larvae per 10 dips were ranked as "**High**" risk sites.

Risk ranking was applied to each species independently, instead of the cumulative number of all larvae found due to species variation in WNV transmission abilities. Sites with high risk ranking hotspots were addressed, the respective regional health unit was informed and if warranted, the sites were treated with larvicide by a licensed contractor

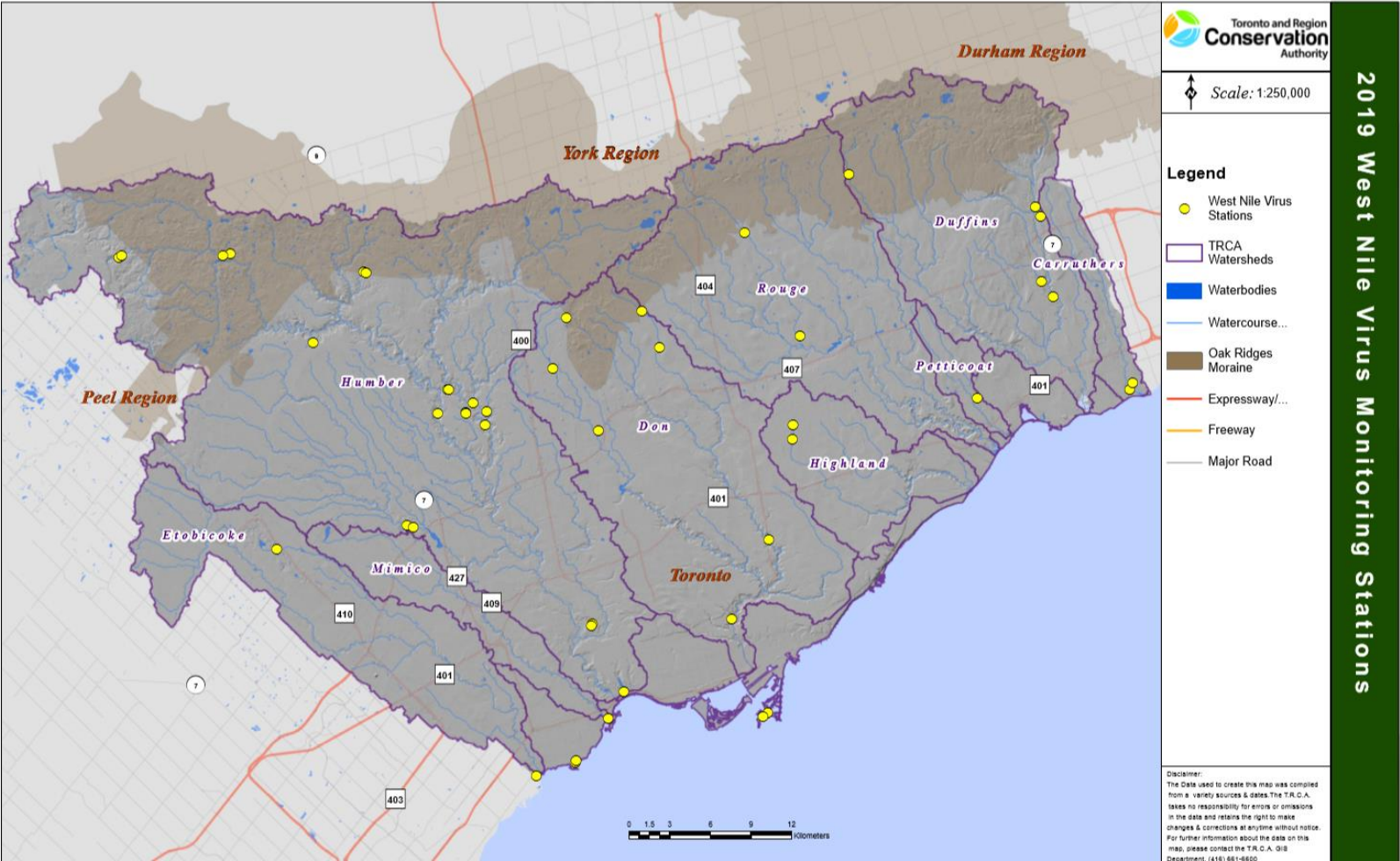


FIGURE 1 LOCATION OF WEST NILE VIRUS MONITORING STATIONS, 2019

Results

Overall Mosquito Species Diversity and Distribution

In total, 9,084 mosquito larvae representing 11 species were identified from 48 routine monitoring stations. Mosquito larvae that died prematurely (n=102; roughly 1%) were not identified, thus excluded from the analyses and risk assessment in the following sections. *Cx. territans* (a non-vector species for WNV) was the most abundant species among all sampled stations, followed by the two major WNV vectors, *Cx. pipiens* and *Cx. Restuans* (Figure 2). Similar to previous years, *Cx. territans* was not only the most dominant, but also the most widespread species, which inhabited 41 of the 48 (~85%) monitoring sites. The two key WNV vectors, *Cx. pipiens* and *Cx. Restuans* were found at 13 and 11 sites respectively.

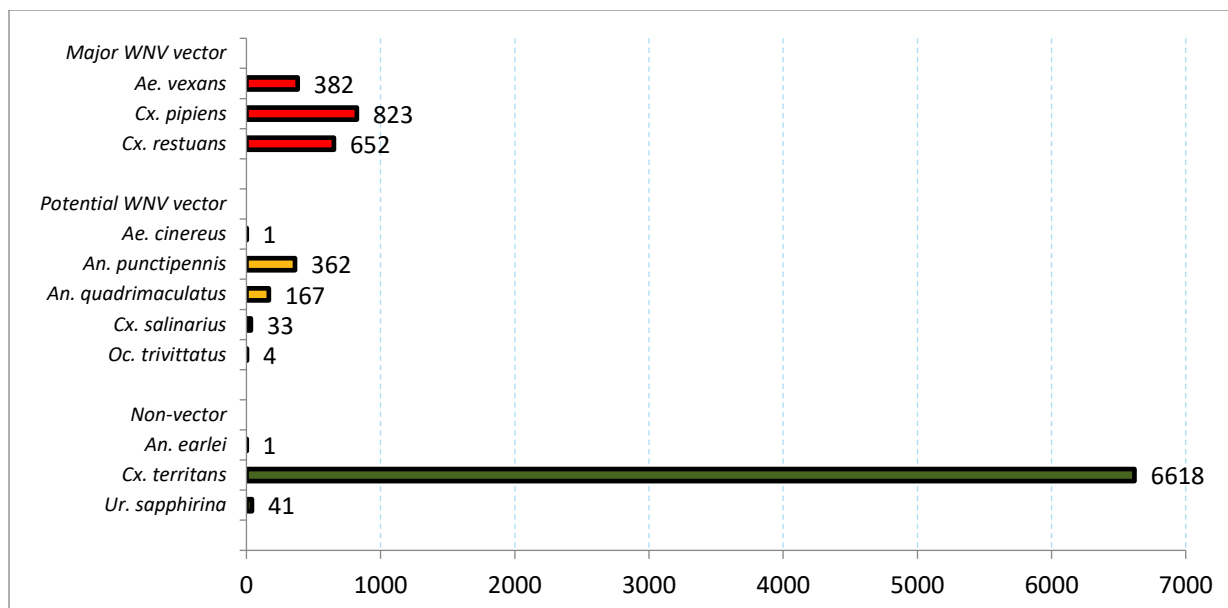


Figure 2. Mosquitoes species diversity and abundance in 2019

Wetlands

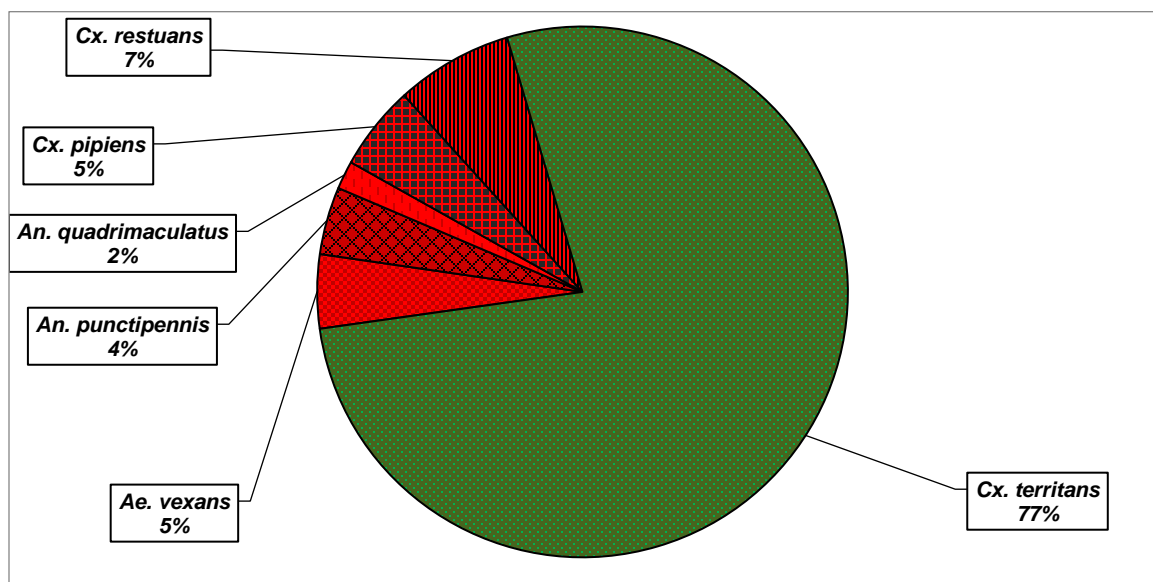
In total, 8,552 mosquito larvae of 11 species were identified from 42 wetlands. As in previous years, higher mosquito diversity was observed in wetlands compared to SWMPs. This finding may be attributed to the facts that more wetland sites were sampled, and wetlands generally provide more diverse habitats and shelter. *Culex territans*, a non-vector species continued to be the dominant species in wetlands, representing 77% of all the mosquitoes collected (Figure 4). The two most important WNV vectors, *Culex pipiens* and *Culex restuans*, represented 7% and 5% of the mosquitoes collected respectively (Figure 4).

Similar to previous years, monitoring results showed that most wetlands posed minimal risk for harbouring WNV vector mosquitoes. Nevertheless, isolated West Nile virus vector mosquito hotspots continued to occur. The four wetland hotspots identified in 2019 were: McMichael Wetland, Topham Pond, Woodland Pond, and one unnamed wetland in York Region.

Environmentally friendly larvicide, *Bacillus thuringiensis israelensis* (*Bti*) was used to treat the hotspots listed above. *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).

Since mosquitoes can only carry WNV after biting an infected bird, mosquito larvae do not feed on blood thus do not carry the virus. When a site is ranked as high-risk or a “hotspot”, it does not imply that the virus is present and poses immediate threat to the public. The risk ranking simply indicates the presence of vector mosquito species which could potentially spread WNV to human populations after they emerge as adult mosquitoes, not the presence of the virus.

Full larval mosquito monitoring risk assessment results for each monitoring station can be found in Appendix A.



Note: Other species collectively represented less than 1% of the mosquito collected, and are excluded from the chart.

FIGURE 3 MOSQUITO SPECIES COMPOSITION IN WETLANDS IN 2019 (NON-VECTOR SPECIES ARE IN GREEN AND VECTOR SPECIES ARE IN RED)

Stormwater Management Ponds (SWMPs)

From the six monitored SWMPs, we collected 532 mosquitoes, which consisted of 87% of vector species and 13% non-vector species (Figure 5). Similar to previous monitoring results, *Culex pipiens* was the dominant mosquito species (73%; Figure 5). L'Amoreaux Park - North Pond and Stormwater management Pond SWMP88.2 were identified as hotspots. Both sites received larvicide treatments and most mosquitoes were eliminated after multiple applications. TRCA will continue to monitor all the SWMPs in the future. Full mosquito monitoring risk assessment results for each SWMP station can be found in Appendix A.

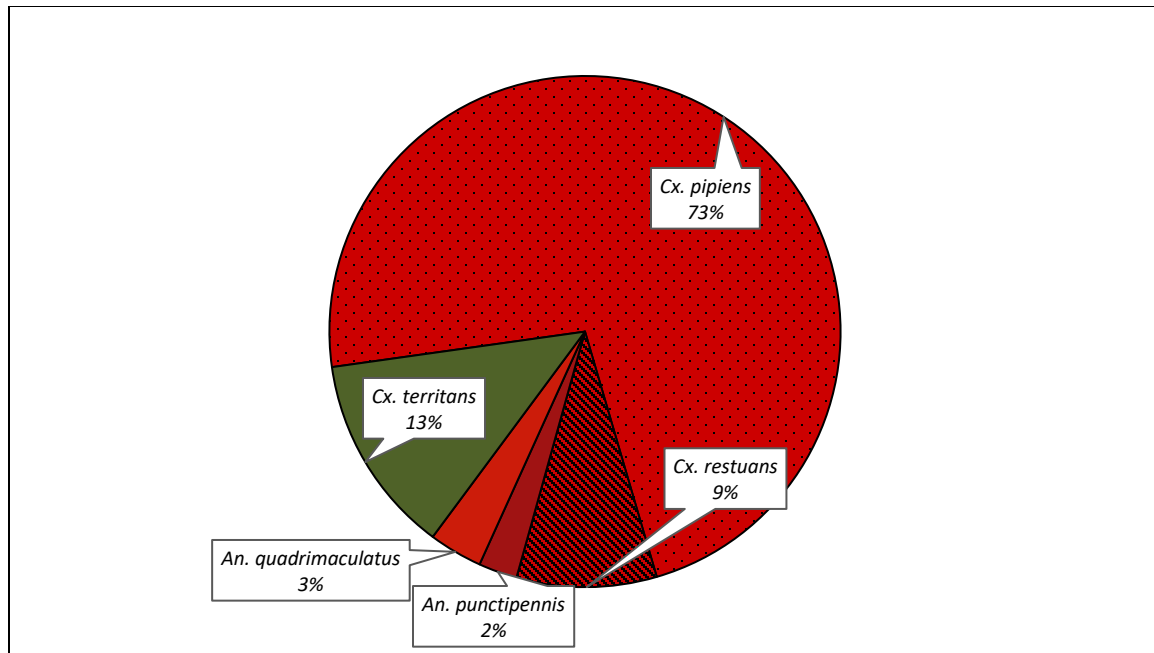


FIGURE 4 MOSQUITO SPECIES COMPOSITION IN STORMWATER MANAGEMENT PONDS, 2019 (NON-VECTOR SPECIES ARE IN GREEN AND VECTOR SPECIES ARE IN RED)

COMMUNICATION

In 2019, TRCA continued to increase public WNV related issue awareness by:

- Responding to media requests and presenting related information;
- Providing information, and making the annual reports available on TRCA website;
- Sharing tips on personal protection against mosquito bites with staff and displaying posters in TRCA offices and Conservation Areas.

In addition, complaints or inquiries regarding standing water or mosquito activities were addressed according to TRCA's Standing Water Complaint Procedure. In 2019, TRCA received three standing water complaints. After investigation, one site was deemed a hotspot and was treated by TRCA's larvicide contractor.

COLLABORATION

The collaborative efforts with our regional public health partners involved providing training, notification of hot spots and participating in WNV advisory committees. TRCA provided larval mosquito identification training to Durham Region Public Health, Halton Region Public Health, and City of Hamilton Public Health Units. Throughout our monitoring season, when a hotspot was identified, the respective public health unit was notified of our findings. Participation in regional West Nile virus advisory committees is an important part of liaising with public health partners. In addition, an Order from the Peel Region Medical Officer has been issued to TRCA annually under

the *Health Protection and Promotion Act*, R.S.O. 1990, c. H.7 to facilitate all mosquito reduction activities within the Heart Lake Wetland Complex in Brampton.

WEST NILE VIRUS IN THE GTA AND IN ONTARIO

Ontario's provincial and regional health agencies continue to monitor 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 provides information allowing regional public health units to eliminate/reduce mosquito larvae through larvicide application. Human surveillance information is used to alert the health care professionals of an outbreak and provides clues about who may be at higher risk for serious health effects from WNV. The dead bird surveillance program had been terminated since 2009 in Ontario, but The Canadian Wildlife Health Cooperative continues to test dead birds for WNV in collaboration with Ontario laboratories and The National Microbiology Laboratory in Winnipeg. Most human cases were reported in urban areas in Ontario because of the large numbers of catch basins, which are the preferred development site for the *Culex* mosquito species. Public Health Units continued to treat these catch basins on a regular basis in the summer months (4-5 treatments to be repeated at 3-week intervals).

In Ontario, the number of human WNV cases fluctuates annually, driven by complex environmental and biological factors. In 2019, number of WNV human cases dropped significantly to 19 cases from 137 cases in 2018 in Ontario (Figure 6).

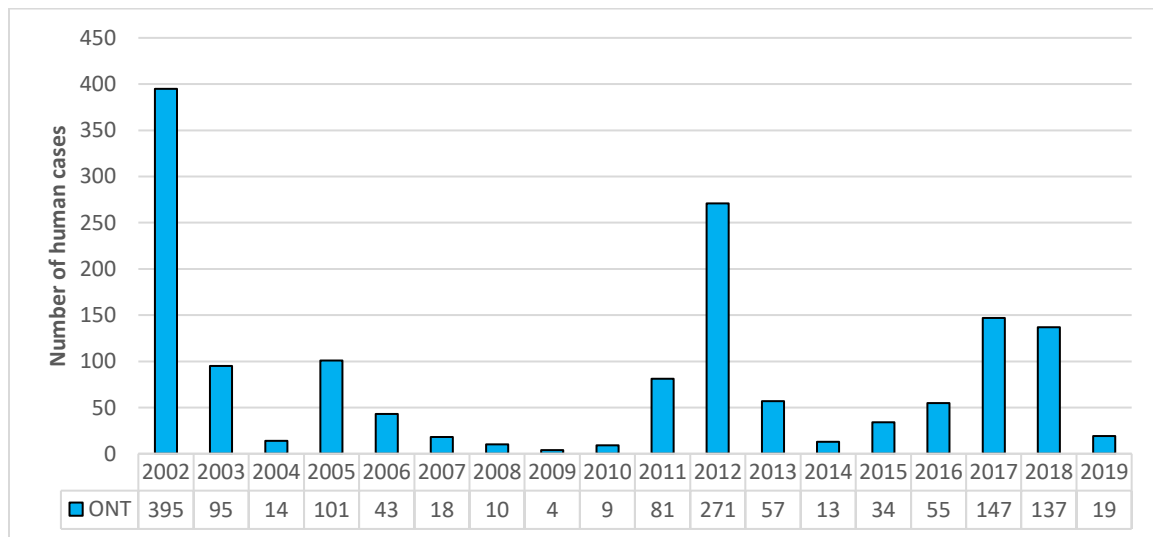


FIGURE 5 HUMAN WEST NILE VIRUS CASES IN ONTARIO, 2002 – 2019

CONCLUSIONS

The results from the 2019 program supported the findings from the previous TRCA studies. Generally, wetlands do not pose threats of WNV transmission. Monitoring results showed that most wetlands posed minimal risk for harbouring WNV vector mosquitoes. Nevertheless, West Nile virus vector hotspots continued to occur. In total six hotspots, including four wetlands were detected and treated with the assistance provide by TRCA's pesticide contractor, the City of Toronto Public Health, and York Region Public Health. Collaboration with Regional Public Health units is crucial in managing WNV vector hotspots in a timely manner. As vector mosquito hotspots continued to occur in our jurisdiction, TRCA staff should continue to monitor in wetlands and SWMPs, to address standing water complaints from the public, and to take appropriate control measure if deem necessary.

It is difficult to predict the level of WNV activity in a given year, therefore the ability to detect hotspots, and subsequently take appropriate control measures continue to highlight the importance of regular and continuous seasonal monitoring of mosquito abundance. Larval surveillance and control is the most effective method of controlling mosquito populations. When mosquitoes are eliminated prior to becoming adults, they cannot pose a nuisance or disease problem.

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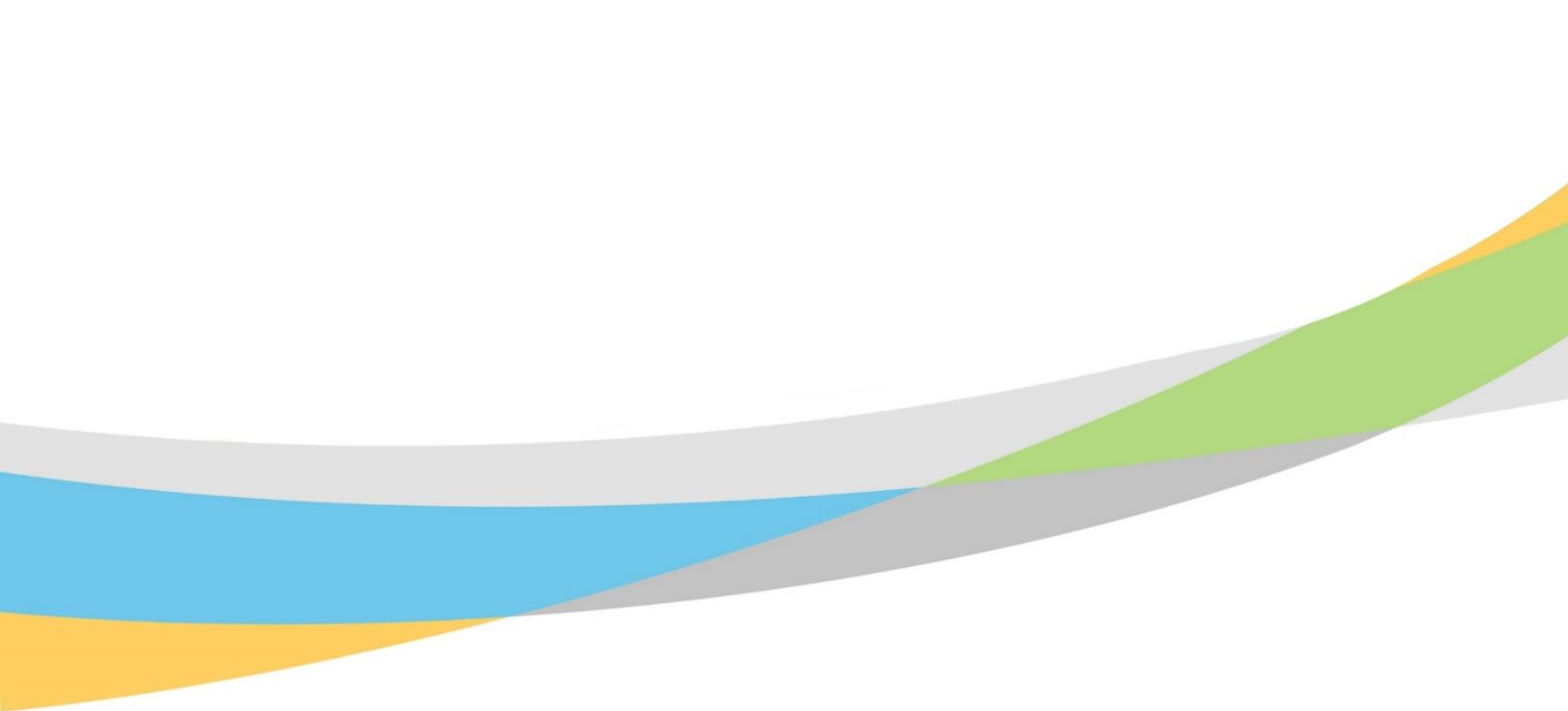
<http://www.who.int/mediacentre/factsheets/fs354/en/> (Accessed: March 12, 2018)

APPENDICES

Appendix A Monitoring and Risk Assessment Results - 2019

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.

Region	Site Name	<i>Ae. vexans</i>	<i>An. punctipennis</i>	<i>An. quadrimaculatus</i>	<i>Cx. pipiens</i>	<i>Cx. restuans</i>
Durham	Altona Forest	Nil	Moderate	Moderate	Nil	Nil
Durham	Carruthers Swamp Complex	Nil	Low	Nil	Nil	Nil
Durham	Claremont Wetland-1	Nil	Moderate	Low	Nil	Moderate
Durham	Claremont Wetland-2	Nil	Moderate	Moderate	Nil	Nil
Durham	Frenchman's Bay	Nil	Low	Moderate	Nil	Nil
Durham	Greenwood Marsh	Nil	Low	Nil	Nil	Nil
Durham	Greenwood Pond	Nil	Low	Nil	Low	Nil
Durham	Shoal Point	Moderate	Nil	Nil	Moderate	Moderate
Peel	Albion Hills Pond-1	Nil	Low	Nil	Nil	Nil
Peel	Albion Hills Pond-2	Nil	Nil	Low	Nil	Nil
Peel	Castlemore Park	Nil	Nil	Low	Low	Nil
Peel	Claireville Wetland-1	Nil	Moderate	Nil	Nil	Nil
Peel	Claireville Wetland-2	Nil	Nil	Nil	Nil	Nil
Peel	Glen Haffy Trout Pond-1	Nil	Moderate	Moderate	Nil	Nil
Peel	Glen Haffy Trout Pond-2	Nil	Moderate	Low	Nil	Nil
Peel	Heart Lake New	Nil	Nil	Nil	Nil	Nil
Peel	Marie Curtis	Nil	Nil	Moderate	Nil	Nil
Peel	SWMP 174	Nil	Low	Moderate	Nil	Nil
Toronto	Brickworks Pond	Nil	Nil	Nil	Nil	Nil
Toronto	Col. Samuel Smith Main Pond	Nil	Nil	Nil	Nil	Nil
Toronto	Col. Samuel Smith Mini Pond	Nil	Low	Nil	Moderate	Nil
Toronto	High Park Grenadier Pond	Nil	Nil	Nil	Moderate	Moderate
Toronto	L'Amoreaux North Pond	Nil	Nil	Nil	High	Moderate
Toronto	L'Amoreaux South Pond	Nil	Low	Nil	Nil	Nil
Toronto	Milne Hollow	Nil	Nil	Nil	Nil	Nil
Toronto	Mimico Amphibian Pond	Nil	Nil	Low	Nil	Nil
Toronto	Topham Pond	Nil	Low	Nil	Moderate	High
Toronto	TTP Goldfish Pond	Nil	Nil	Nil	Nil	Nil
Toronto	TTP Triangle Pond	Nil	Nil	Nil	Nil	Nil
Toronto	Woodland Pond	Nil	Nil	Nil	High	Moderate
York	Boyd Conservation Area	Nil	Low	Nil	Nil	Nil
York	Boyd Granger Wetland North	Nil	Moderate	Low	Nil	Nil
York	Boyd Granger Wetland South	Nil	Moderate	Low	Nil	Nil
York	Bruce's Mill	Nil	Nil	Low	Nil	Nil
York	Cardish st	Moderate	Moderate	Nil	Nil	Nil
York	Cold Creek Pond	Nil	Low	Nil	Nil	Nil
York	Cold Creek Wetland	Nil	Nil	Low	Nil	Nil
York	Earth Rangers Wetland	Low	Moderate	Moderate	Nil	Nil
York	Elgin Mills Dr.	Moderate	Low	Nil	Moderate	High
York	Hwy. 27	Nil	Nil	Nil	Nil	Nil
York	Keffer Marsh	Nil	Low	Low	Moderate	Low
York	Killian Lamar	Nil	Nil	Nil	Nil	Nil
York	Kortright Centre Marsh	Nil	Nil	Nil	Nil	Nil
York	McMichael Wetland	High	Moderate	Nil	Nil	Low
York	Salamander Ct.	Nil	Nil	Nil	Nil	Nil
York	Stouffville Reservoir	Nil	Moderate	Low	Nil	Nil
York	SWMP 139	Nil	Low	Nil	Moderate	Low
York	SWMP 88.2	Low	Low	Moderate	High	Moderate
York	Toogood Pond	Nil	Nil	Nil	Nil	Nil



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