



WEST NILE VIRUS IN THE REGION OF PEEL 2003

A PEEL HEALTH STATUS REPORT

 Region of Peel
Working for you
Peel Health

ACKNOWLEDGEMENTS

This report was authored by: Karen Funnell, Health Analyst; Dr. Howard Shapiro, Associate Medical Officer of Health; Kit Ping Wong, Health Analyst; and Andrea Smith, Senior Epidemiologist (Acting).

Considerable input into other aspects of this report was also provided by the following staff:

Dr. David McKeown, Medical Officer of Health
Howard Beatty, Manager, Environmental Health
Paul Proctor, Supervisor, Environmental Health
Liz Van Horne, Infection Control Specialist
Paul Callanan, Director, Environmental Health
Maurizio Colarossi, Epidemiologist
Cathy Fisher, Administrative Assistant, Epidemiology
Noel Saraza, Supervisor, Communicable Diseases
Nancy Lotecki, Supervisor, Communicable Diseases
Kathy Jovanovic, Health Promotion Officer
Deepy Singh, Health Promotion Officer



TABLE OF CONTENTS

i	Executive Summary
1	Introduction
3	Dead Bird Surveillance
3	Introduction
3	Methods
4	Results
9	Summary
11	Adult Mosquito Surveillance
11	Introduction
11	Methods
14	Results
23	Summary
25	Larval Mosquito Surveillance
25	Introduction
25	Methods
26	Results
33	Summary
35	Larval Mosquito Control and Environmental Monitoring
35	Introduction
36	Methods
37	Results
40	Summary
41	Human Case Surveillance
41	Introduction
42	Methods
43	Results
47	Summary
49	Comparison of the Timing of Dead Crow Sightings, Positive Mosquito Batches and Human Cases in Mississauga
51	Other Animal Surveillance
53	Conclusion
55	Limitations
59	References



LIST OF TABLES

- 15 Table 1**
Estimated Number of Female Adult Mosquitoes Collected by Species and Municipality, Region of Peel, 2003
- 18 Table 2**
Minimum Infection Rates by Mosquito Species and Municipality, Region of Peel, 2003
- 19 Table 3**
First Notification of Positive WNV Viral Test Results by Species, Location and Dates Collected, Region of Peel, 2002 and 2003
- 21 Table 4**
Comparison of the Top 12 Mosquito Species Collected from Common Trap Sites and Time Periods, Region of Peel, 2002 and 2003
- 22 Table 5**
Proportion of Culex Group Mosquitoes Collected per Trap Event at Common Sites, Region of Peel, 2002 and 2003
- 32 Table 6**
Mosquito Larvae Identification, Region of Peel, 2003
- 38 Table 7**
Number of Catch Basin Treatments Using Altosid Pellets, Region of Peel, 2003
- 46 Table 8**
Confirmed and Probable Human WNV Cases by Reported Symptoms, Region of Peel, 2003



LIST OF FIGURES

- 5** **Figure 1**
Dead Crow Sightings by Week, Region of Peel, 2002 and 2003
- 5** **Figure 2**
Dead Crow Sightings by Municipality, Region of Peel, 2003
- 8** **Figure 3**
Locations of Dead Crow Sightings, Region of Peel, 2003
- 9** **Figure 4**
Density of Dead Crows Reported by Forward Sortation Area, Region of Peel, 2003
- 13** **Figure 5**
Locations of Mosquito Traps and Traps with WNV-Positive Results, Region of Peel, 2003
- 16** **Figure 6**
WNV-Positive Mosquito Batches by Week of Collection and Municipality, Region of Peel, 2003
- 17** **Figure 7**
WNV-Positive Mosquito Batches by Species Group, Region of Peel, 2003
- 20** **Figure 8**
Proportion of *Culex* Species to Total in Selected Sites, Region of Peel, 2002 and 2003
- 27** **Figure 9**
Locations of Mosquito Breeding Sites, Sites with Larvae and Vector Larvae, Region of Peel, 2003
- 28** **Figure 10**
Proportion of Potential Surface Water Mosquito Breeding Sites with Larvae, by Type of Site, Mississauga, 2003
- 29** **Figure 11**
Proportion of Potential Surface Water Mosquito Breeding Sites with Larvae, by Type of Site, Brampton, 2003



- 29 Figure 12**
Proportion of Potential Surface Water Mosquito Breeding Sites with Larvae, by Type of Site, Caledon, 2003
- 30 Figure 13**
Types of Sites Found to Contain Mosquito Larvae, Region of Peel, 2003
- 31 Figure 14**
Proportion of Catch Basins with Larvae, by Type of Catch Basin and Larval Density, Catch Basin Study, Region of Peel, 2003
- 33 Figure 15**
Numbers of *Culex pipiens* and *Culex restuans* Larvae by Week of Collection, Region of Peel, 2003
- 44 Figure 16**
Number of Confirmed and Probable Human WNV Infections by Forward Sortation Area, Region of Peel, 2003
- 45 Figure 17**
Confirmed & Probable Human WNV Cases by Date of Onset of Symptoms, Region of Peel, 2003
- 46 Figure 18**
Temporal Analysis of Dead Crow Sightings, WNV-Positive Mosquito Batches and Onset of Symptoms of Confirmed and Probable Human Cases, Mississauga, 2003



LIST OF APPENDICES

Appendix A

West Nile Virus Week Codes for 2003

Appendix B

Dead Bird Surveillance for West Nile Virus by Health Unit, Ontario, 2003

Appendix C

Location of Common Mosquito Traps, Region of Peel, 2002 and 2003

Appendix D

Adult Mosquito Surveillance for West Nile Virus by Health Unit, Ontario, 2003

Appendix E

Mosquito Activity Among WNV-Positive Species, Region of Peel, 2003

Appendix F

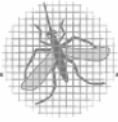
Human Case Surveillance for West Nile Virus by Health Unit, Ontario, 2003

Appendix G

Horse Surveillance for West Nile Virus by Health Unit, Ontario, 2003

Appendix H

Definition of Terms



WEST NILE VIRUS IN THE REGION OF PEEL 2003



EXECUTIVE SUMMARY

Introduction

West Nile Virus (WNV) is a mosquito-borne “flavivirus”. Transmission of this disease in North America was first recognized in 1999. It is a human, horse and bird neuropathogen that can result in encephalitis, meningitis and even death.

Surveillance information from birds and mosquitoes provides an early warning of risk to human health and helps to guide control and education interventions. In the Region of Peel, WNV was first detected in birds and mosquitoes in 2001, with cases of locally acquired human illness occurring for the first time in 2002.

In 2003, Peel Health conducted surveillance activities in the Region involving dead birds, adult mosquitoes, larval mosquitoes and human cases. A larval mosquito reduction program was also introduced, along with environmental monitoring of pesticide efficacy and effects.

This report is the second report in which WNV surveillance data have been compiled and published by Peel Health. It describes findings from the WNV surveillance activities conducted in Peel Region in 2003 involving dead birds, adult mosquitoes, larval mosquitoes and human cases. Comparisons between findings from the 2002 and 2003 WNV seasons are provided, where appropriate. In addition, activities relating to the larval mosquito control program are also described. Analyses of these data sources informed an evaluation of Peel Health’s 2003 West Nile Virus surveillance and control initiatives, as well as the West Nile Virus Prevention Plan 2004.

Dead Bird Surveillance

In total, 150 dead crow sightings were reported to Peel Health in 2003, of which 58 were tested and 12 (21%) found to be positive for WNV. This was about one-tenth the number of sightings in 2002 (1,436).

Peel’s first WNV-positive bird in 2003 was found in Caledon on July 4th. There was no dramatic increase in dead crow sightings in 2003 as was the case in 2002.

Adult Mosquito Surveillance

Thirty-nine species of mosquitoes were identified in the Region of Peel in 2003; however, as in 2002, only a small number were likely important in the transmission of WNV to humans. In 2003, four species of mosquitoes were found to be positive for WNV. Mosquitoes from the genus *Culex* were the most important, accounting for an



estimated 13% of the mosquitoes tested and 96% of the WNV-positive batches. *Culex* mosquitoes also exhibited the highest WNV infection rates in Peel. In general, minimum infection rates showed that infection rates were down and that there were far fewer bridge vector mosquito species infected in 2003 compared to 2002.

Culex pipiens/restuans were once again key “amplification” mosquitoes, because they prefer to feed on birds, the main reservoir of WNV, and are more common in urban and suburban settings. As in 2002, very few *Culex* mosquitoes were trapped in the Caledon area compared to Mississauga or Brampton. No WNV-positive batches of mosquitoes were found in Caledon in 2003.

While other species might contribute to human WNV transmission, control of *Culex* mosquitoes is one of the most important strategies to reduce the risk of WNV transmission to humans. An analysis of *Culex* mosquitoes collected in 2002 compared to 2003 showed lower proportions in 2003, possibly as a result of the WNV Prevention Plan efforts, although other factors such as weather and a decreased number of WNV-susceptible birds may have also played a role.

Larval Mosquito Surveillance

Larval surveillance provides crucial information for mosquito control interventions. Potential breeding sites were identified on the basis of complaints from Peel residents, by referencing historical breeding site data collected from 2002 and by conducting field surveys for suitable habitats. In 2003, over 2,100 sites were surveyed for standing water in Peel: 77% were in Mississauga, 15% in Brampton and 8% in Caledon. The presence of mosquito larvae was identified in 28% of the potential breeding sites from which samples were taken, while “vector” larvae were identified in 17%. Ditches and culverts were some of the more numerous breeding sites and often contained mosquito larvae.

Between May and October 2003, a total of 19 different species or groups of mosquito larvae were identified from 3,942 specimens collected at breeding sites. Over 80% of those collected belonged to two *Culex* species: *Culex restuans* accounted for 42% and *Culex pipiens* accounted for 41% of all mosquito larvae that were collected and identified.

Larval Mosquito Control and Environmental Monitoring

Based on findings from larval surveillance activities in 2002, a larval mosquito reduction program involving the inspection and larviciding of 75,516 roadside catch basins across Peel Region was undertaken in 2003. An additional 372 catch basins located at Regional Long-Term Care facilities, parks or in private backyards were also treated.



Over the course of the 2003 mosquito season, a total of 221,342 treatments using the larvicide Methoprene were made in roadside, backyard or other types of catch basins. Methoprene was effective in reducing the emergence of viable adult mosquitoes, with an overall efficacy rate of 74% in Peel and an efficacy of up to 96% during the first 21 days after application, according to a study in Halton conducted by the Ministry of the Environment (MOE).

A total of 128 open surface water sites were identified for monitoring and treatment; those with moderate to high larval densities as per MOE guidelines were treated with Bti. A total of 131 Bti treatments were administered at 68 sites, with a resulting efficacy of 100%.

Treatments of 162 environmentally sensitive catch basins located within 30 meters of bodies of water were conducted using a device called a Larvasonic[®], producing efficacy rates of between 20% and 67%.

A collaborative study done by the MOE and a number of Ontario health departments showed that Methoprene had no impacts on surface water quality, including drinking water.

Human Case Surveillance

Human illness due to WNV acquired in Peel occurred for the first time in 2002, with 112 residents having laboratory evidence of WNV (55 suspect cases, 20 probable cases and 37 confirmed cases, including two deaths).

As of December 2, 2003, there were 10 residents of Peel who had laboratory evidence of WNV infection stemming from the 2003 season, nine of whom were classified as having West Nile Fever and one having a diagnosis of West Nile Neurological Manifestations. There were no deaths due to WNV in 2003. All of the 10 cases were residents of Mississauga. As in 2002, most cases occurred in the southern areas of Mississauga.

In 2003, half of the WNV confirmed cases in Peel were aged 40 to 59 years. Similarly, in 2002, contrary to initial expectations, about half of the confirmed and probable cases of WNV occurred among the 50 to 69 year age groups as opposed to being limited to older adults or the infirmed.

As in 2002, the most frequently reported symptoms among the confirmed cases in 2003 were fever, headaches and fatigue. Other common symptoms included muscle pain, confusion or forgetfulness and sensitivity to light.

Identification of WNV in humans underscores the importance of active, hospital-based human surveillance programs starting in July through to September, as well as the need



to consider WNV as a possible diagnosis when clinicians encounter patients with encephalitis, meningitis, acute flaccid paralysis or non-specific fevers occurring throughout this time period.

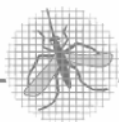
Conclusion

In Peel in 2003, the first indication of WNV activity was a WNV-infected dead bird found in Caledon on July 4th. The first human illness from WNV had an onset of symptoms on August 13th, approximately three weeks following the collection of the first WNV-positive batch of adult mosquitoes on July 24th.

Results from the 2003 mosquito season indicate that WNV activity, including cases of illness in people due to WNV, was substantially reduced compared to 2002.

Detailed analysis of information on Peel mosquitoes shows that *Culex* mosquitoes play a key role in local transmission of WNV as reported for other similar areas in the North American literature. In Peel, in 2003, *Culex* mosquitoes continued to be numerous and were the predominant species having positive WNV testing results. Compared to 2002, the number of *Culex* mosquitoes was substantially decreased, possibly as a result of the larviciding program, although other factors such as weather and a decreased number of WNV-susceptible birds may have also played a role. The larviciding program had no impacts on surface water quality.

Analysis of the Region of Peel's complete surveillance results shows that the monitoring of this information has served as an "early warning system" for human illness from WNV. It is appropriate that the Peel WNV Prevention Plan continue to focus control efforts on *Culex* mosquitoes.



INTRODUCTION

West Nile Virus (WNV) is a mosquito-borne “flavivirus”. Transmission of this disease in North America was first recognized in 1999. It is a human, horse and bird neuropathogen¹ that can result in encephalitis, meningitis and even death.

“West Nile” Virus is so named because it was first isolated and identified in an infected person from the West Nile Province of Uganda in 1937.² There have since been reported outbreaks of WNV in Africa, Asia, the Middle East and Europe. There was no known transmission of WNV in the Western Hemisphere until reports of humans with the mosquito-acquired infection occurred in New York City in 1999.

There are several theories as to how the virus arrived in North America. One theory suggests that the virus arrived in an infected migratory or imported bird; another suggests that mosquitoes infected with the virus were accidentally transported to North America with other cargo.³

WNV was detected for the first time in Canada in 2001 in birds and mosquitoes from Ontario, including those from Peel. In 2002, Canadian health authorities documented WNV activity in five provinces: Nova Scotia, Quebec, Ontario, Manitoba and Saskatchewan.³ By the end of 2002, there were 319 confirmed and 86 probable human cases of WNV in Ontario, with an additional 21 confirmed human cases across the rest of Canada.⁴ Cases of locally acquired human illness occurred for the first time in the Region of Peel in 2002.

In 2003, the disease spread westward across Canada, causing 1,335 probable and confirmed cases, nearly all of which occurred in Manitoba (141), Saskatchewan (792) and Alberta (272).⁵ Ontario had 89 confirmed cases of WNV in 2003, British Columbia and the Yukon Territory combined for 21 human cases and only 20 cases occurred in all of Quebec and the eastern provinces.⁵ However, cases reported in Nova Scotia, New Brunswick, British Columbia and the Yukon were likely related to travel outside of that province or territory.

The WNV Transmission Cycle

Evidence suggests that WNV can remain in an area over the winter months in infected birds, adult mosquitoes⁶ or in unhatched mosquito eggs.⁷ A relatively small number of infected mosquitoes and/or birds would therefore be present within the region in early spring. This is when the virus begins to amplify. As certain types of female mosquitoes (*Culex pipiens* and *restuans*) feed on birds to get their blood meal in order to breed, the



virus is transmitted back and forth between the “vector” (the mosquito) and the reservoir “host” population (the bird), causing an increasing number of both birds and mosquitoes to become infected.

Towards mid- to late summer, certain other mosquito species, such as *Aedes vexans* and *Coquillettidia perturbans*, that feed on both birds and mammals become important in the transmission of WNV to people. By this time, there has been significant “amplification” of the virus among the bird population. These “bridge vector” mosquitoes that have fed on a WNV-infected bird become infected with WNV themselves. When they subsequently bite a person, they can infect them with WNV as well. Hence, the period of greatest risk to humans and other mammals is in late summer or early fall when the level of WNV in birds and mosquitoes is at its highest.²

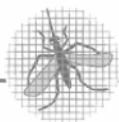
The WNV Prevention Plan 2003

In 2003, to ensure a coordinated approach in preventing mosquito-borne disease outbreaks in the Region of Peel, Peel Health worked closely with local municipalities and conservation authorities, the Ontario Ministry of Health and Long-Term Care (MOHLTC), the Ontario Ministry of the Environment (MOE), Health Canada and neighbouring public health departments.⁶

Peel Health’s approach to WNV control emphasizes disease prevention and protection of the environment. The goal of the 2003 WNV Prevention Plan was to minimize impact of WNV through region-wide surveillance that directed integrated pest management-based mosquito control activities at a level commensurate with the risk of human illness. This meant an emphasis on public education, source reduction and larviciding.⁶

Peel Health enhanced surveillance and education activities (for the public and health care providers) in 2003. Also new for 2003 was a region-wide effort to reduce mosquito breeding through source reduction and larviciding in urban and suburban areas of Peel. Source reduction and larviciding focused on *Culex pipiens* and *Culex restuans* mosquitoes, the main vectors of WNV and the most common mosquito species in Peel.

This report is the second report in which WNV surveillance data have been compiled and published by Peel Health. It describes findings from the WNV surveillance activities conducted in Peel Region in 2003 involving dead birds, adult mosquitoes, larval mosquitoes and human cases. Comparisons between findings from the 2002 and 2003 WNV seasons are provided, where appropriate. In addition, activities relating to the larval mosquito control program are also described. Analyses of these data sources informed an evaluation of Peel Health’s 2003 West Nile Virus surveillance and control initiatives, as well as the West Nile Virus Prevention Plan 2004.



DEAD BIRD SURVEILLANCE

Introduction

Over 130 native species of birds in North America are known to have been infected by WNV.^{8,9,10} In Canada, the birds found to be most susceptible to WNV include crows, ravens, jays, and magpies. American crows (*Corvus brachyrhynchos*) are the most sensitive indicator of WNV activity in Peel. After infection with WNV, nearly all crows die due to inflammation of the brain and other organs.¹⁰

The wild bird WNV surveillance program operated by the Canadian Cooperative Wildlife Health Centre (CCWHC) has been in place since May 2000.² The program tests only members of the crow family (crows, ravens, jays and magpies). In 2000, 2,288 birds were examined from across Canada and none were found to have the WNV present. In 2001, 3,911 birds were tested and 128 (3%) were found to have the virus. In 2002, 3,478 birds were examined; 563 (16%) were found to be WNV-infected. In 2003, 11,323 birds were tested; 1,633 (14%) were found to be positive for WNV.¹¹

Surveillance programs for dead birds entail finding birds that have recently died during the mosquito season, collecting their carcasses and testing them for the presence of the virus.² Factors such as the density of the human population, the types of birds and the size of the remaining bird population in a given area will affect the number of reported dead bird sightings. The purpose of dead bird surveillance is to establish whether or not WNV is present in an area,¹² which can serve as an early warning of risk to human health and aid in the decision-making on WNV control measures.

Methods

In the spring, summer and fall of 2003, members of the public were asked to contact the Peel Health Department if they found dead crows, taking note of the location and condition of the bird. Only crows (and ravens in Northern Ontario) were used for dead bird surveillance of WNV in Ontario. Animal control services in Brampton, Caledon and Mississauga collected the dead crows, which were sent to the CCWHC laboratory in Guelph, Ontario for testing.

Information on the locations of the dead crows was collected from callers and/or by obtaining actual latitude and longitude measures using hand-held global positioning system (GPS) devices, which were accurate to within plus or minus three to five metres. The information, including date collected and test results, was entered into a geographic information system. Analyses were conducted by week of collection. The numbers



used throughout this report to describe the weeks of the year in 2003 can be found in Appendix A.

The CCWHC conducted a rapid test of birds for WNV using a VecTest[®]. The first four WNV-positive birds from a given health unit found to be positive using this test underwent further confirmatory testing by the CCWHC. After the first four birds in a single Ontario health unit were confirmed positive, all those subsequently determined to be positive using the preliminary test were deemed “presumed confirmed” without any further formal testing. Results of bird testing were then reported back to the appropriate public health agencies.¹²

Dead birds were collected from April to October, 2003. Once it was established that WNV activity was present in crows in Peel, testing was discontinued for a period of time through the summer. Testing of dead crows resumed in the fall to observe the seasonal extent of WNV infection in birds. As of September 14, Peel Health resumed submitting a maximum of four dead crows per week to the CCWHC for WNV testing. Dead crow sightings continued to be reported throughout the fall; the last dead crow to be picked up and sent for testing was found on October 22, 2003, after which no further dead crows were reported.

Results

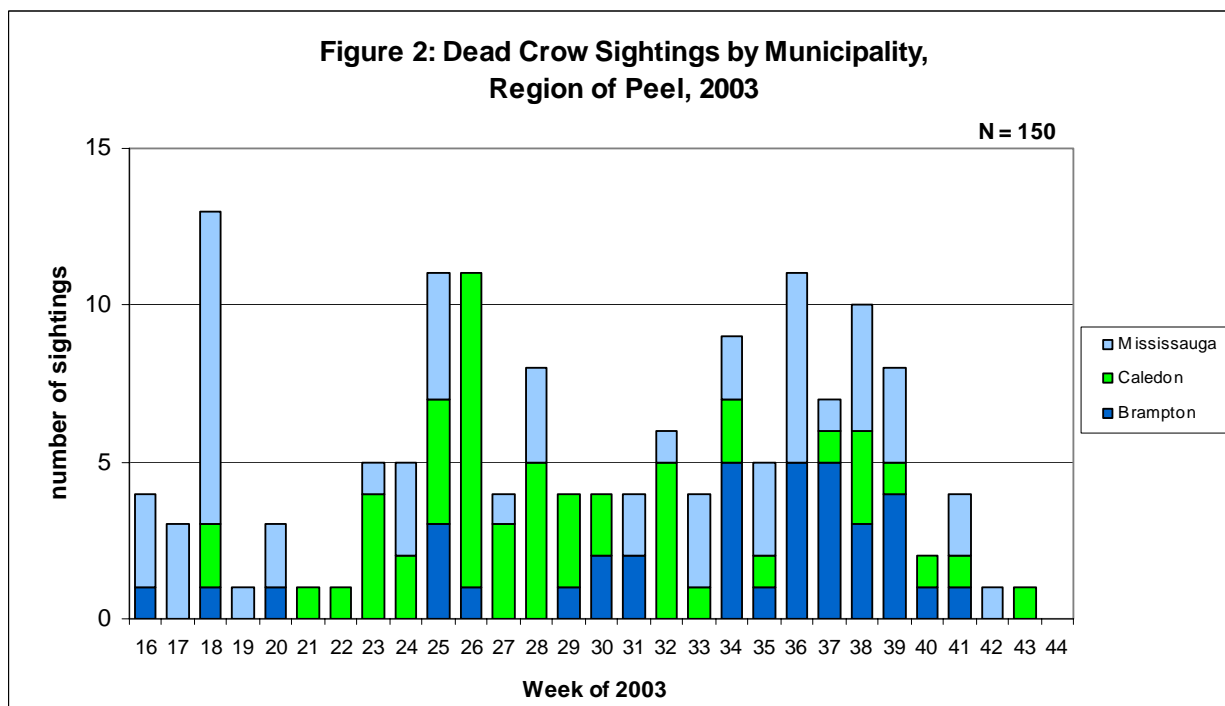
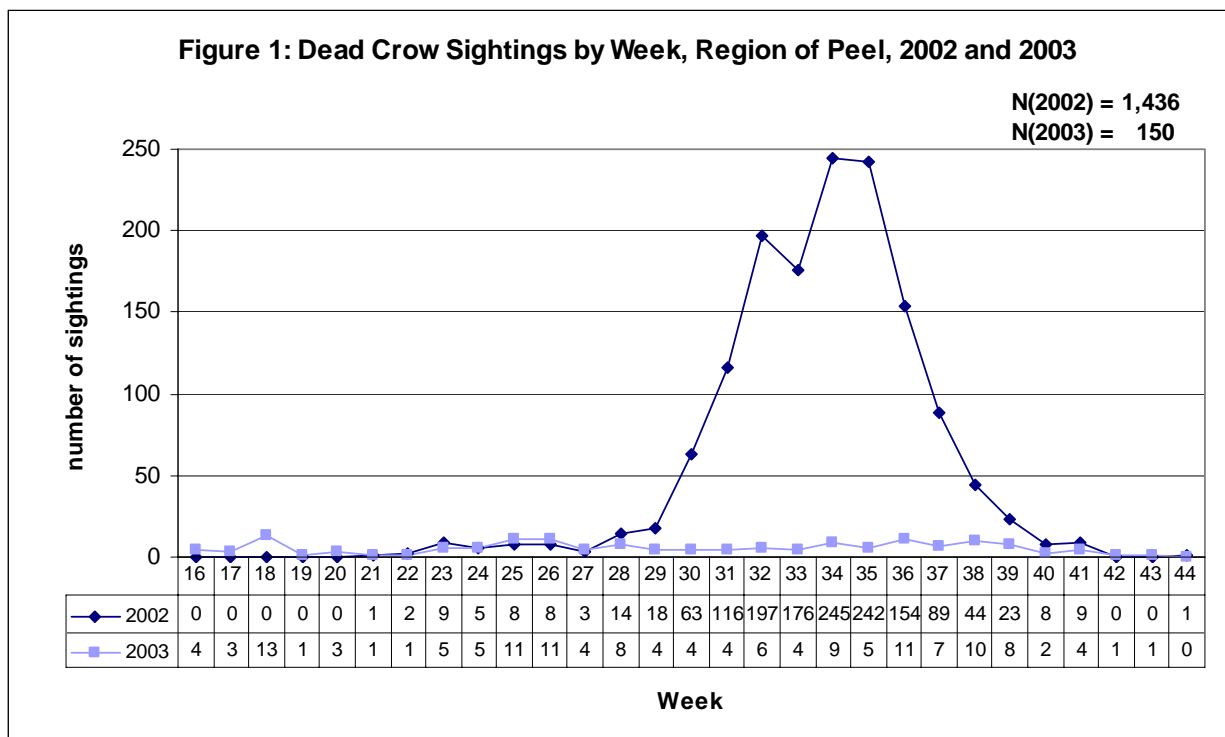
The first WNV-infected dead crow of 2003 in Ontario was found in York Region on April 15, 2003. As of November 21, 2003, at least one positive dead bird had been found in every health unit area across Ontario with the exception of the Porcupine region of northern Ontario.¹³ A total of 1,484 dead crows were tested for the presence of WNV in Ontario, of which 242 (16%) were confirmed to be positive or “presumed confirmed”.^{11,12}

In total, 150 dead crow sightings were reported to Peel Health in 2003, of which 58 were tested and 12 (21%) found to be positive for WNV. This was about one-tenth the number of sightings in 2002 (1,436), of which 71 dead crows were tested and 20 (28%) found to have WNV. The decrease in sightings was not likely due to underreporting, since Peel Health received over 2,500 telephone calls from Peel residents for dead birds other than crows. Peel’s first confirmed positive dead crow was found in Caledon on July 4, 2003, followed by two positive dead crows in south Mississauga on August 2 and August 7. Peel’s fourth positive dead crow was found in Brampton on August 18. The last WNV-positive dead bird in Peel was found on October 6 (Week 41) in south Mississauga.

In 2002, a sharp increase in the number of dead crow sightings began in the third week of July (Week 30) and peaked during the last two weeks of August (Weeks 34 and 35) with nearly 250 sightings in each of these two weeks. Contrary to the findings from 2002, there were no large increases or peaks seen in the numbers of dead crow



sightings over the course of the 2003 mosquito season, as shown in Figure 1.





In 2003, the greatest number of sightings occurred early on in the season (Week 18), when a total of 13 dead crow sightings were reported, mostly in south Mississauga (Figure 2). This may have been due to a reason other than WNV infection, such as deaths of recently hatched or young birds as they tried to leave their nests. In Caledon, a small increase in dead crow sightings occurring during Weeks 23 through 26 preceded the finding of Peel's first WNV-positive dead crow on July 4th (Week 27).

Most dead crow sightings in Caledon were found to occur during June and July (Weeks 23 to 30), whereas in Brampton, most dead crow sightings took place from mid-August to mid-October (Weeks 34 to 41). In Mississauga, there were two periods of time when the majority of dead crows were sighted: mid-April to mid-May (Weeks 16 to 20), and from the end of July through to the end of September (Weeks 31 to 39).

Locations of dead crow sightings by Forward Sortation Area (FSA – the first three-digits of the postal code) are shown in Figure 3. In 2003, over one-third (36%) of dead crow sightings in Peel occurred in Caledon, despite Caledon only having five per cent of Peel's human population. While in 2002 it was found that more sightings occurred in more populated areas, this was not the case in 2003.

The number of sightings in 2003 in Brampton and Mississauga was likely affected by the large die-off of crows in 2002 as a result of WNV infection. Thus numbers and proportions of sightings in these two municipalities were much lower than in the previous year. This is supported by local observations of low crow numbers in Mississauga and Brampton. A recent study in east-central Illinois estimated that 82% of the crow population died during 2002, largely as a result of WNV.¹⁴ Because of the low crow numbers in Peel, a peak in sightings could not have happened in 2003.

Densities of dead crows reported per square kilometre were mapped by FSA and are depicted in Figure 4. Over the course of the 2003 mosquito season, the highest densities of dead crows occurred in central Brampton (L6V and L6W) and in south Mississauga (L5H, L5B and L4Y). This is roughly the same pattern as found in 2002, except on a much smaller scale. Whereas crow densities ranged upwards to 10 crows per square kilometre in 2002, the highest density of dead crows in 2003 was one crow per square kilometre.

Of the 58 dead crows found in Peel and submitted for testing in 2003, 12 (21%) were WNV-positive – five in Mississauga, five in Brampton and two in Caledon (Figure 3). The largest numbers of WNV-positive dead crows were found in postal code area L6V in Brampton (three), followed by postal code area L5G in south Mississauga (two). In 2002, the largest number of WNV-positive crows found in one postal code area was observed in FSA L5J of Mississauga, where four positive birds were found.



A comparison of numbers of WNV-positive crows found in various Ontario Health Units in 2003 is shown in Appendix B. Only Toronto to the east of Peel and Halton Region to the west had higher numbers of birds found to be WNV-positive (17 and 15, respectively) than Peel (12).

Summary

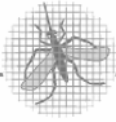
Surveillance programs for dead birds attempt to establish the presence of WNV in the bird population, which can serve as an early warning of risk to human health.

In total, 150 dead crow sightings were reported to Peel Health in 2003, of which 58 were tested and 12 (21%) found to be positive for WNV. This was about one-tenth the number of sightings in 2002 (1,436). Members of the public reported nearly 250 dead crow sightings per week in each of the last two weeks of August in 2002; however, the highest number of sightings in a one-week period in 2003 was just 13, occurring at the end of April and beginning of May (Week 18).

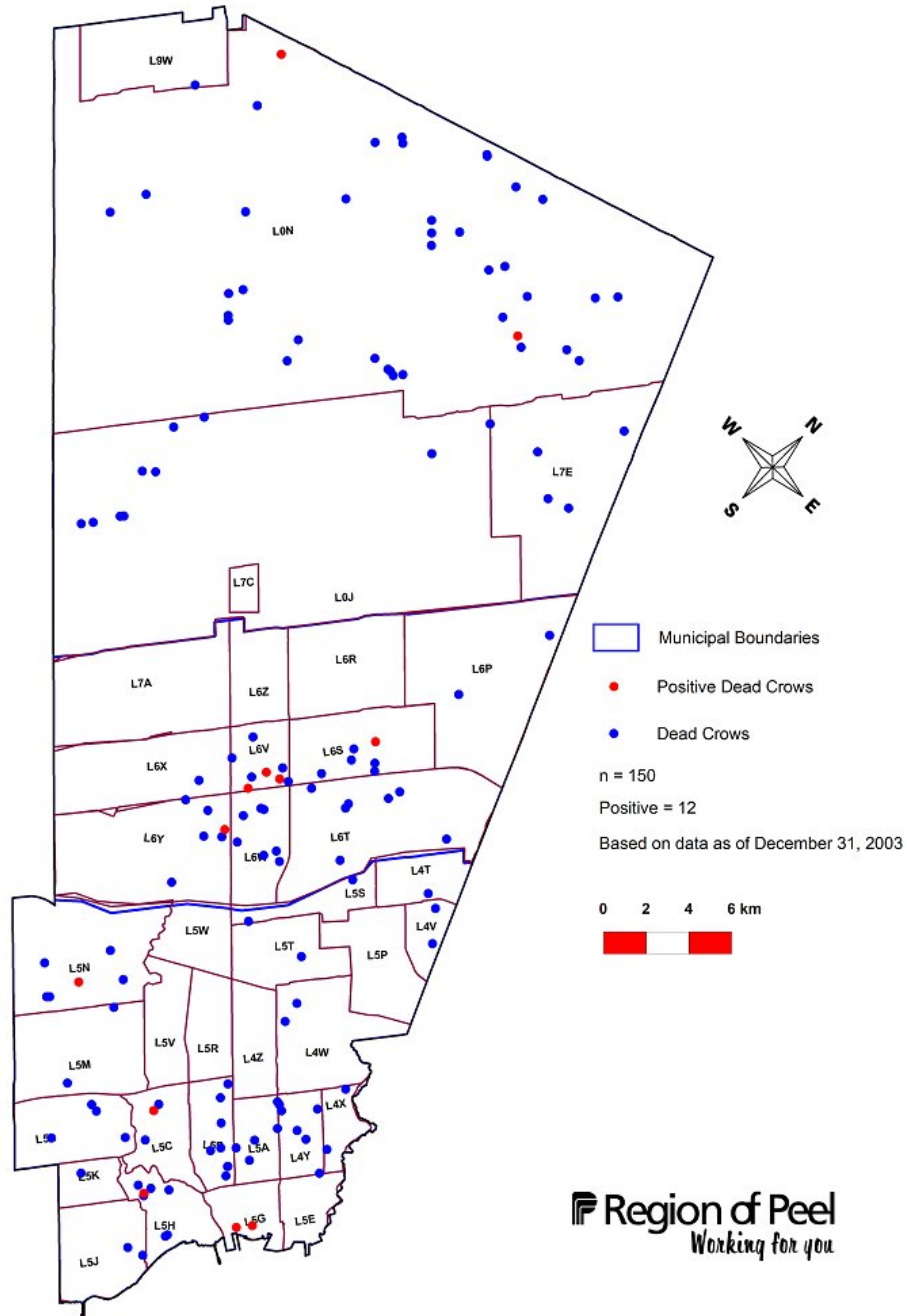
Die-offs of crows in the 2002 mosquito season meant that bird surveillance activities were attenuated in the municipalities of Brampton and Mississauga in 2003. Nevertheless, the testing of dead crow specimens by the CCWHC established that WNV was still present in flocks of birds in Peel.

Peel's first WNV-positive bird in 2003 was found in Caledon on July 4th. There was no dramatic increase in dead crow sightings in 2003 as was the case in 2002.

Research has shown that the presence of dead birds found to be positive for WNV precedes an increased risk for human illness by a period of two to six weeks.¹⁵ A more detailed temporal analysis comparing the timing of dead bird sightings, positive mosquitoes and human cases in one municipality of Peel will be shown in a later section of this report.



**Figure 3 : Locations of Dead Crow Sightings,
Region of Peel, 2003**



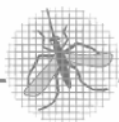
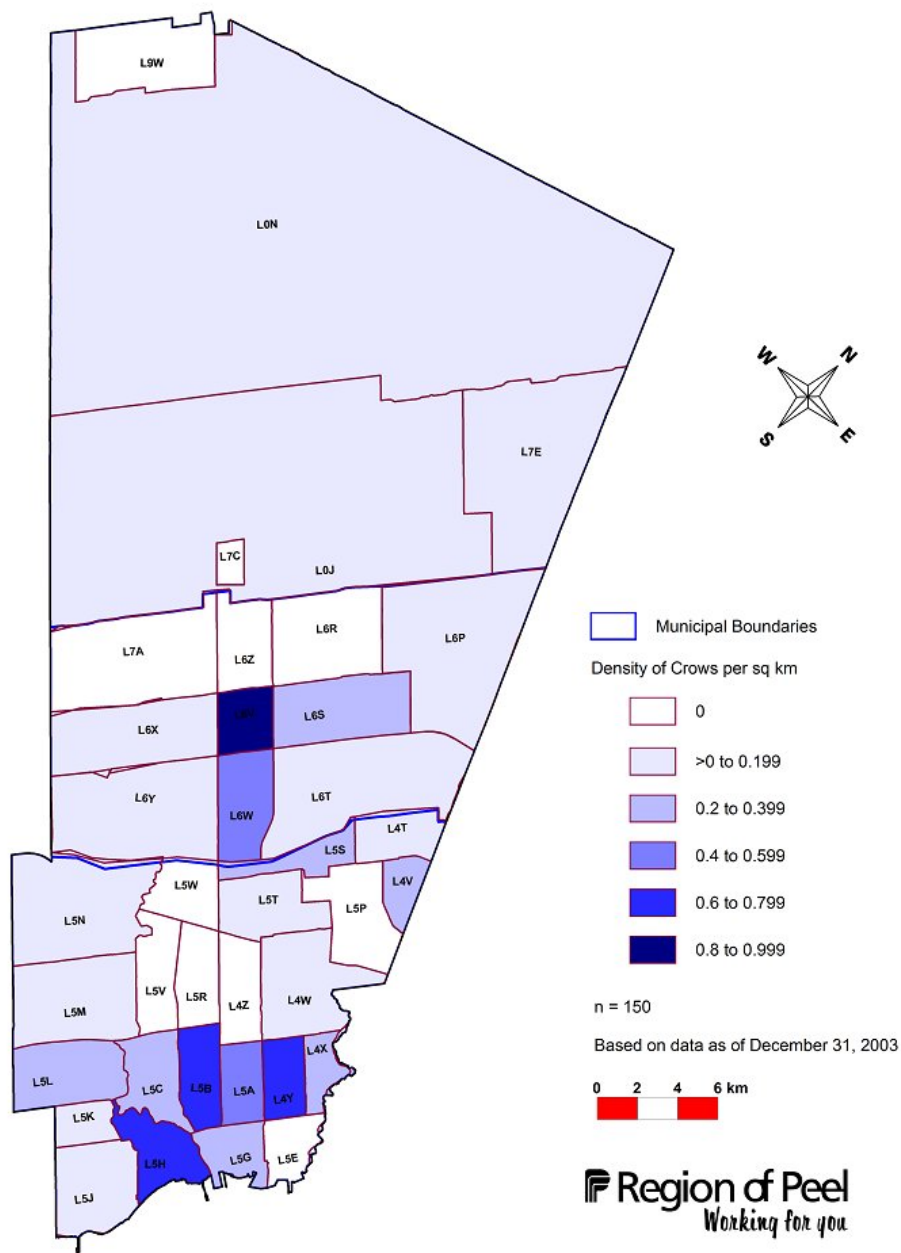
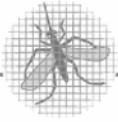


Figure 4 : Density of Dead Crows Reported by Forward Sortation Area, Region of Peel, 2003





WEST NILE VIRUS IN THE REGION OF PEEL 2003



ADULT MOSQUITO SURVEILLANCE

Introduction

The West Nile Virus survives by circulating between bird and mosquito populations. A female mosquito can acquire the infection by obtaining a blood meal from a WNV-infected bird. After a two-to-three week incubation period, it can then pass the infection by injecting its saliva into another host (bird, horse, human or other animal) when it takes another blood meal.⁶ Once in the new host, the virus can multiply, causing illness and possibly death. The virus can also survive over winter in adult female mosquitoes or eggs. When these mosquitoes take a blood meal or the eggs hatch in early spring, a new cycle of WNV transmission can begin.⁶

There are 74 known species of mosquitoes in Canada,³ 60 of these have been identified in Ontario.¹⁶ As of 2003, at least 10 species had been found to be infected by WNV in this country,³ whereas there were 49 WNV-positive species found in the United States.¹⁷ Ten WNV-positive species have now been identified in Ontario.¹⁸

Species responsible for amplifying the virus between the mosquito population and the bird population in Ontario are thought to include *Culex pipiens* and *Culex restuans*. “Bridge vector” mosquitoes, which bite both birds and other mammals including humans, are highly dependant on local conditions, and include *Coquillettidia perturbans* and *Aedes vexans*. Other species of bridge vector mosquitoes (*Culex salinarius*, *Ochlerotatus triseriatus* and *Ochlerotatus trivittatus*) may be important in the transmission of WNV to humans in Peel because of their aggressive biting of people.

The purposes of mosquito surveillance programs are: to monitor mosquito populations associated with WNV; to determine the level of WNV activity among these species; and to use this information to make decisions regarding the risk of transmission to humans and the need to implement mosquito control plans.

Methods

In 2003, Center for Disease Control (CDC) miniature light traps were exclusively used to capture adult female mosquitoes, whereas in 2002, a combination of light and gravid traps was used. Light traps use carbon dioxide and light to attract host-seeking adult female mosquitoes looking for a blood meal, whereas gravid traps use nutrient-rich stagnant water to attract female mosquitoes searching for a suitable site in which to lay their eggs.¹⁹

Eighteen traps were deployed in 25 fixed and five temporary locations across the Region of Peel from May 21 to October 23, 2003. Adult mosquito traps were located as



shown in Figure 5. There were 15 sites in Mississauga, nine in Brampton and six in Caledon.

Adult mosquitoes were usually collected once per week at a trap site, refrigerated and transported alive via courier to the Department of Biological Sciences at Brock University in St. Catharine's, Ontario. There, the trap contents were frozen until such time as they could be examined. At that point, the contents were evenly spread out on a dry ice platform in order to keep them frozen. Large insects (moths, caddis flies, etc.) were removed and then a section of the sample was chosen at random. Without the use of a microscope, female mosquitoes were individually removed by the sorter until a count of 100 was reached. The entire sample of mosquitoes was then counted and separated into males (which feed on nectar and do not take blood meals) and remaining females, which were classified as "extras". The 100 females were separated into species, recounted and then "pooled" or batched by species, date of collection and location for testing. Batches typically numbered ≤ 50 adult female mosquitoes.²⁰

When species could not be distinguished, they were either classified as a group (e.g. *Culex pipiens/restuans*) or to the level of genus (e.g. *Culex spp.*). Some mosquitoes ended up being classified as "unidentifiable females" because the specimens were either unusable due to the natural aging process, or were damaged during collection, shipping or storage, making them difficult to identify.¹⁹

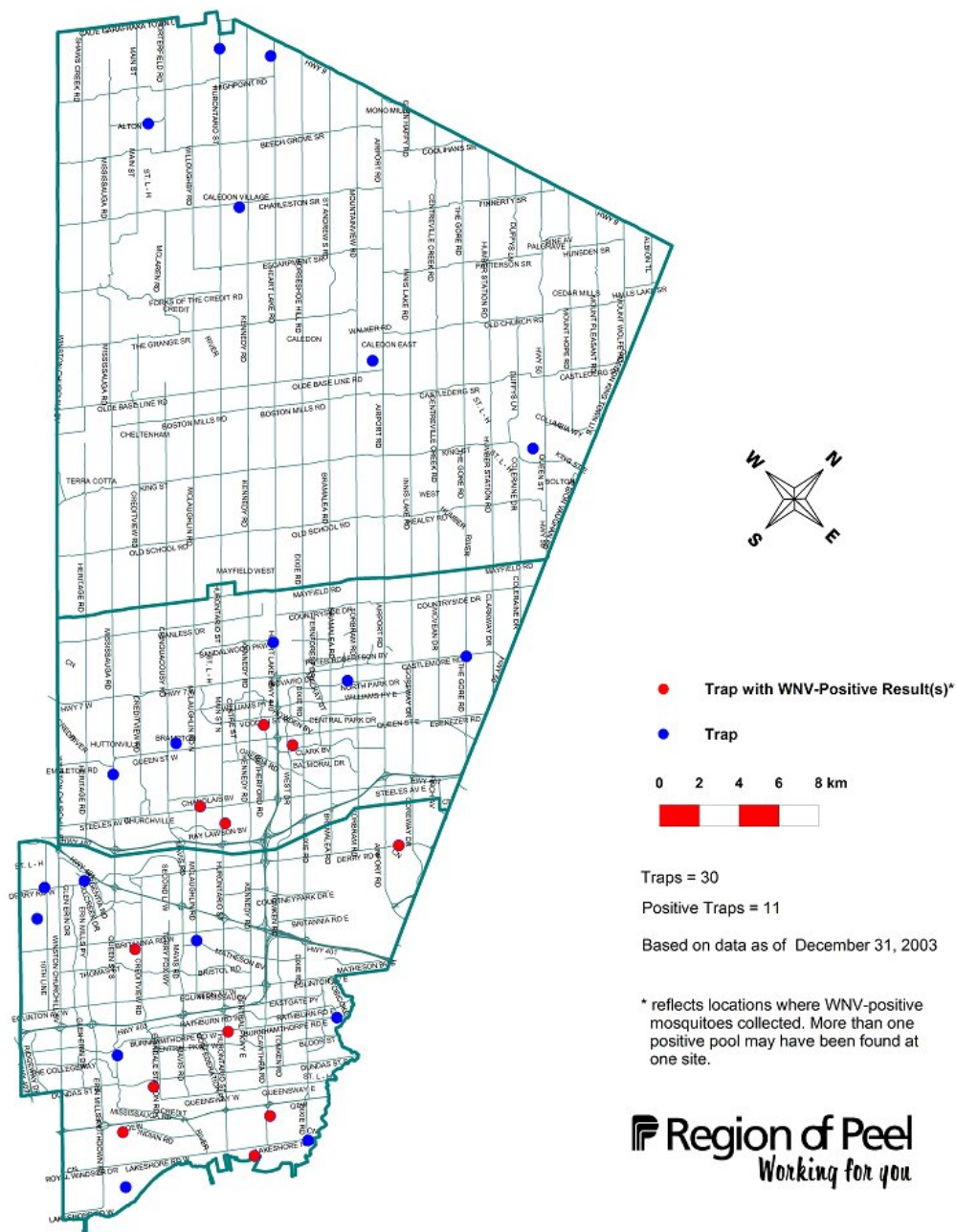
Counts of sampled female mosquitoes by species, unidentifiable females, males, extras and total mosquitoes, along with their corresponding date collected and site identification number were entered into an Excel spreadsheet by staff at Brock University; this file was then distributed to the public health units that had submitted specimens. Testing for WNV was done by Brock University and positive batch test results were sent to health units in a second Excel file.

Upon notification of laboratory evidence of either dead birds, WNV-positive mosquito batches or human cases in a given area in Peel, light traps were relocated to that area (called a "hot spot") to test for the presence of WNV and better monitor the risk of human infection in that area. Towards the end of the mosquito season, two of the traps in Mississauga were set twice per week.

The above procedures were somewhat different than those used in the preceding year. For example in 2002, more than just two traps were set out twice per week at the same site, for longer periods of time, resulting in a higher number of trapping events. In addition, Brock University identified all female mosquitoes by species in 2002, rather than taking a portion of the mosquitoes and sampling them as was done in 2003. All viral testing of female mosquitoes was conducted at Brock University in 2003, whereas in 2002, some of the testing was done at Health Canada's National Microbiology Laboratory in Winnipeg, Manitoba.



Figure 5: Location of Mosquito Traps and Traps with WNV-Positive Results, Region of Peel, 2003





Estimates of the total number of mosquitoes for a particular species were derived using the actual number of adult female mosquitoes that had been separated into species as a proportion of the total number of mosquitoes (excluding males). In the tables and charts of this section of the report, certain analyses are based on actual numbers while others are based on estimated numbers of mosquitoes, and are notated accordingly.

Comparison of 2002 and 2003 Mosquito Trap Data

An analysis comparing traps which were operational in both 2002 and 2003 was conducted to try to ascertain whether or not using larvicide to reduce numbers of *Culex* mosquitoes was effective (*Culex* species included: *Culex pipiens*, *Culex restuans*, *Culex pipiens/restuans* and *Culex spp.*). The analysis was conducted using data pertaining to light traps set at 13 sites over a period of 19 weeks for both years (Weeks 23 to 41). This included six sites in Brampton, five in Mississauga and two in Caledon (Appendix C).

The data were examined to account for the fact that mosquito populations could vary from year to year independent of reduction efforts. The hypothesis was that because *Culex* mosquitoes were targeted for reduction, their abundance relative to other mosquito species should decrease. This effect should be observed regardless of whether conditions in 2003 produced more or less mosquitoes than in 2002. Because *Culex pipiens* mosquitoes prefer catch basins much more than *Culex restuans*, the former species should be reduced preferentially. In addition, an examination was done to see if the numbers of *Culex* mosquitoes were reduced in 2003 compared to 2002.

Because a particular trap may have been used more than once per week in one year and not in the other, average numbers of *Culex* for the season and numbers of *Culex* per trap event were calculated as means of comparison between the two years. Note that for the 2003 data, numbers and proportions are based on estimates for these species.

Results

In Peel, approximately 43,500 mosquitoes were trapped over the course of the 2003 season, of which 15,300 were actually tested for the presence of WNV. This compares to approximately 41,700 mosquitoes trapped in 2002, of which 24,269 adult female mosquitoes were tested for WNV.

Estimates of the number of adult female mosquitoes by species were produced by Peel Health and are depicted by municipality in Table 1. In 2003, there were 39 species or groups of mosquitoes collected and submitted for testing, compared to 41 in 2002. However, the mosquito species that were collected and reported differ between the two years.



WEST NILE VIRUS IN THE REGION OF PEEL 2003

Table 1: Estimated Number of Female Adult Mosquitoes Collected by Species and Municipality, Region of Peel, 2003

Species Name	Brampton	Caledon	Mississauga	Peel
<i>Coquillettidia perturbans</i> *	591	1404	11731	13725
<i>Aedes vexans</i>	3261	206	3792	7259
<i>Ochlerotatus canadensis</i>	2103	4979	137	7219
<i>Culex pipiens/restuans</i>	1475	114	1744	3333
<i>Ochlerotatus stimulans</i>	1839	802	226	2867
<i>Aedes/Ochlerotatus spp.**</i>	1029	808	536	2373
<i>Culex restuans</i>	273	18	625	915
<i>Culex spp.</i>	213	24	447	684
<i>Ochlerotatus trivittatus</i>	294	21	231	546
<i>Anopheles punctipennis</i>	162	30	287	479
<i>Ochlerotatus triseriatus</i>	60	32	384	476
<i>Culex pipiens</i>	245	3	91	339
<i>Ochlerotatus excrucians</i>	109	115	15	239
<i>Aedes vexans/cantator</i>	62	8	131	200
<i>Aedes cinereus</i>	143	19	26	188
<i>Ochlerotatus triseriatus/hendersonii</i>	8	0	69	77
<i>Anopheles quadrimaculatus</i>	43	6	8	57
<i>Ochlerotatus dorsalis</i>	40	1	4	45
<i>Culex territans</i>	0	0	43	43
<i>Anopheles spp.</i>	21	1	7	29
<i>Ochlerotatus aurifer</i>	21	0	0	21
<i>Aedes vexans nipponi</i>	3	0	17	20
<i>Anopheles earlei</i>	11	0	2	13
<i>Culex salinarius</i>	10	0	2	12
<i>Culiseta morsitans</i>	4	6	1	11
<i>Ochlerotatus fitchii</i>	4	0	5	9
<i>Ochlerotatus provocans</i>	4	3	1	8
<i>Culiseta inornata</i>	3	0	2	5
<i>Ochlerotatus cantator</i>	1	0	3	4
<i>Anopheles perplexans</i>	0	0	4	4
<i>Ochlerotatus sollicitans</i>	0	0	1	1
<i>Anopheles walkeri</i>	0	0	1	1
<i>Culiseta melanura</i>	0	0	1	1
<i>Culiseta minnesotae</i>	1	0	0	1
<i>Ochlerotatus euedes</i>	0	0	1	1
<i>Ochlerotatus hexodontus</i>	1	0	0	1
<i>Ochlerotatus japonicus</i>	0	0	1	1
<i>Ochlerotatus mercurator</i>	0	0	1	1
<i>Uranotaenia sapphirina</i>	0	0	1	1
Unknown	0	0	0	0
Total Mosquitoes[†]	12,033	8,599	20,580	41,212

* includes one mosquito classified as *Cq. perturbans* (*pale legs*) (not a species type).

** includes 76 mosquitoes classified as *Oc. black-legged* and 587 mosquitoes classified as *Oc. broad-banded* (not a species type).

† includes adult female mosquitoes, "Unidentifiable Females" and "Extras", but excludes "Males" that were counted.

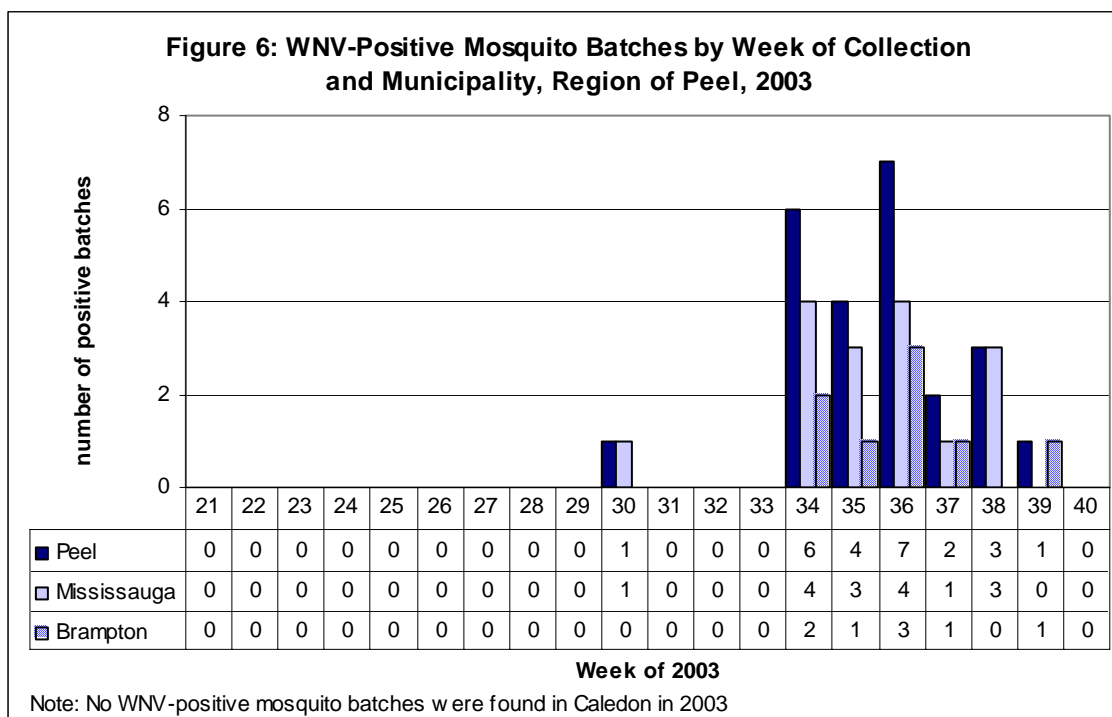


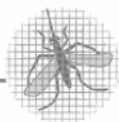
In 2003, the first notification of a WNV-positive batch of mosquitoes identified in Ontario was one collected in Haldimand-Norfolk on July 8, and was the first of 135 positive batches in Ontario (Appendix D).²¹ As of December 2, 2003, 24 positive mosquito batches from the 2003 season had been identified in the Region of Peel, with the first occurring on July 24th. This compares with 128 positive batches identified in Peel in 2002, with the first occurring on June 20th.

Sixty-six per cent (16) of the positive batches identified in 2003 were from Mississauga and 33% (8) were from Brampton (Table 2). As in 2002, no positive batches were identified in Caledon. Locations of WNV-positive mosquitoes found in Peel are shown in Figure 5.

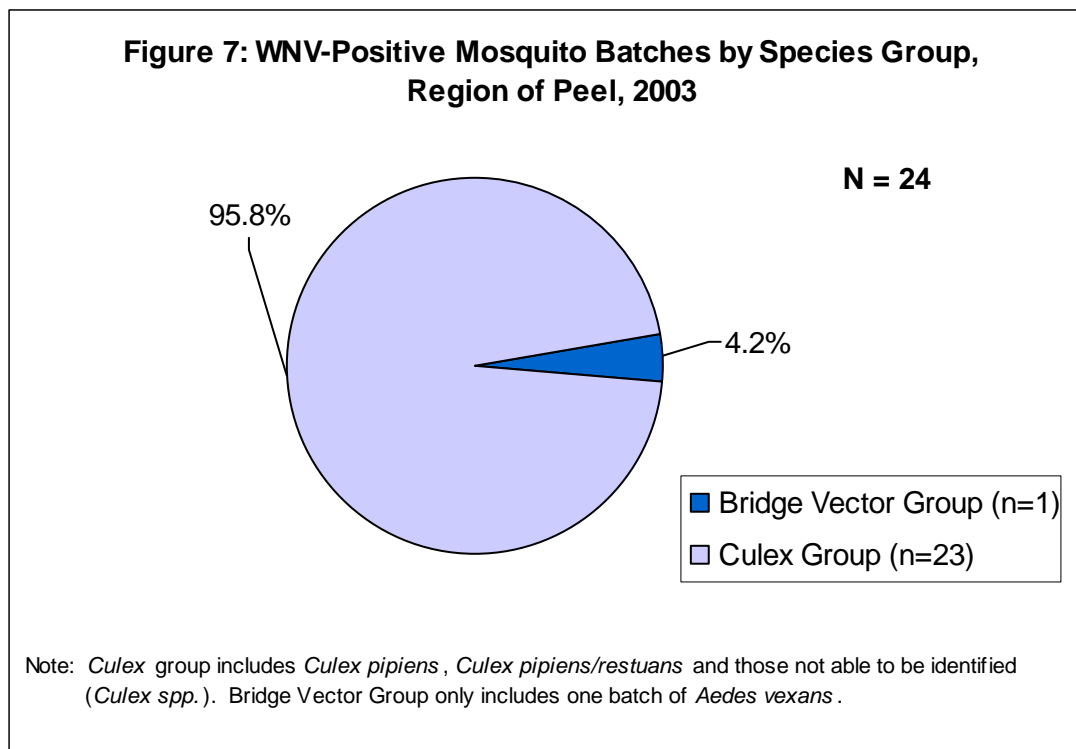
A comparison of the number of positive batches and their dates of collection by Health Unit in Ontario can be found in Appendix D. In 2003, only Toronto had a higher number of positive batches identified (56) than Peel (24).²¹

A temporal analysis of WNV-positive mosquito batches by week of collection was conducted by municipality and is shown in Figure 6. Overall, 71% (17/24) of the positive batches in Peel were collected during weeks 34 to 36 (August 17th to September 6th). There were no large peaks seen in the numbers of positive batches collected in any one week as was the case in 2002 (23 in Mississauga in week 34, August 18-24).





Only four species of mosquito were found to be WNV-positive in Peel in 2003 (Figure 7 and Table 2), compared to 11 positive species identified in 2002. *Culex* mosquitoes were once again found to be the most important. While it is estimated that they only accounted for 13% of the mosquitoes that were collected, they represented 96% (23/24) of the WNV-positive mosquito samples. However as in 2002, WNV was not isolated in all species within the *Culex* genus.



Meanwhile, it is estimated that the bridge vector species *Aedes vexans* represented 18% of mosquitoes collected, although they were found to represent only 4% (1/24) of the WNV-positive batches. None of the batches of *Coquillettidia perturbans* was found to be WNV-positive in 2003. The relatively low number of infected bridge vector mosquito species in 2003 versus 2002 may help to explain the lower number of WNV human cases identified in Peel in 2003.

Appendix E consists of three charts showing levels of mosquito activity (number of mosquitoes trapped) by week for eight of the groups or species of mosquitoes for which WNV-positive results were found in 2003. Note that these data are based on estimates, the scales in the charts are different and that decreases in numbers collected during Weeks 27 and 32 are likely a function of fewer traps having been set at those times.



Culex restuans activity peaked slightly earlier during Weeks 24 and 25 in 2003 compared to during Week 28 in 2002, but there were similar numbers of mosquitoes collected at these peak times. *Culex spp.* and *Culex pipiens/restuans* also peaked slightly earlier during Week 25 in 2003 compared to during Week 28 in 2002, and several generations were apparent. However, the last peak during Weeks 33 and 34 contained about half the number of mosquitoes collected compared to 2002. *Culex pipiens* activity peaked around Week 35 as was the case in 2002; however, overall estimated numbers were also lower by half in 2003 compared to 2002.

Aedes vexans mosquitoes had only one peak of activity in 2003 at Week 35, with an estimated 200 mosquitoes collected, compared to multiple peaks of activity for this species in 2002 of over 500 mosquitoes each. Peaks of activity for *Coquillettidia perturbans* mosquitoes occurred in Weeks 28, 31 and 35 in 2003 and in Weeks 28, 33 and 35 in 2002. Estimated numbers for this species are as high or higher in 2003 compared to 2002. The species *Anopheles punctipennis*, *Ochlerotatus triseriatus* and *Ochlerotatus trivittatus* also experienced similar activity patterns and volumes in both years.

The minimum infection rate (MIR) is an indicator of the prevalence of WNV, transmission intensity and thus risk of disease to humans.¹⁹ MIRs of WNV in certain species, expressed as the number infected per 1,000 specimens tested, are shown in Table 2 by municipality and overall. Higher MIRs are usually indicative of greater WNV activity among a given species, but can become unreliable if based on small numbers.¹⁹

Table 2: Minimum Infection Rates by Mosquito Species and Municipality, Region of Peel, 2003

Municipality	Species	Actual Number Tested	Positive Batches	MIR*
Mississauga	<i>Culex spp.</i>	338	1	2.96 †
	<i>Culex pipiens</i>	84	1	11.90 †
	<i>Culex pipiens/restuans</i>	1574	14	8.89
Brampton	<i>Aedes vexans</i>	1498	1	0.67
	<i>Culex pipiens/restuans</i>	1175	7	5.96
Caledon	(none)**	---	0	---
Peel	<i>Aedes vexans</i>	3967	1	0.25
	<i>Culex spp.</i>	527	1	1.90 †
	<i>Culex pipiens</i>	200	1	5.00 †
	<i>Culex pipiens/restuans</i>	2835	21	7.41
All Species Total		15300	24	

* The Minimum Infection Rate (MIR) is calculated as the number of positive batches of infected mosquitoes of a given species divided by the total number of mosquitoes of a given species that were tested for the presence of the virus, expressed per 1,000.

** 19 different species from Caledon were tested (231 batches; 2,130 specimens), but none were WNV-positive.

† MIRs based on numbers < 1000 are more likely to be unstable than those based on numbers ≥ 1000 (bolded).



Overall, the highest MIR based on a sample of 1,000 or more mosquitoes in Peel was observed among *Culex pipiens/restuans* (7.4 per 1,000). The only other MIR based on at least 1,000 mosquitoes was that for *Aedes vexans*, but the rate was fairly low (0.25 per 1,000) (Table 2). While higher MIRs were calculated for other mosquito species, they were based on samples of less than 1,000 mosquitoes and are more likely to be unstable. These include *Culex pipiens* (5.0 per 1,000) and *Culex spp.* (1.9 per 1,000).

Results by species are somewhat similar to those found in 2002, when *Culex spp.*, *Culex pipiens* and *Culex pipiens/restuans* had the highest MIRs among those species with at least 1,000 tested mosquitoes (18.1, 13.1 and 9.5, respectively). *Aedes vexans* had an overall MIR of 2.5 in 2002.

Note that the MIRs from 2003 are much lower, suggesting a lower prevalence of WNV in the mosquito population and thus a lower risk of disease to humans than was the case in 2002. This bears out in the surveillance of human case data, as will be demonstrated in a later section of this report. Interestingly, *Culex pipiens/restuans* MIRs are only slightly decreased compared to 2002 (7.4 in 2003 versus 9.5 in 2002).

Table 3 shows the exact dates when the first notification of positive viral test results was made, by species and location during 2002 and 2003. In 2003, the first positive batch (*Culex pipiens/restuans*) was collected in the second last week of July in north Mississauga. Two other *Culex* batches were collected in south Mississauga towards the end of August. The positive batch of *Aedes vexans* mosquitoes was collected in Brampton at this time as well (Week 35).

Table 3: First Notification of Positive WNV Test Results by Species, Location and Dates Collected, Region of Peel, 2002 and 2003

Mosquito Species	Location 2003	Date Collected 2003	Week 2003	Date Collected 2002	Week 2002
<i>Culex pipiens/restuans</i>	Mississauga N	July 24, 2003	30	July 4, 2002	27
<i>Culex spp.</i>	Mississauga S	August 21, 2003	34	June 25, 2002	26
<i>Culex pipiens</i>	Mississauga S	August 26, 2003	35	July 30, 2002	28
<i>Aedes vexans</i>	Brampton	August 26, 2003	35	August 8, 2002	32

As this table indicates, dates of collection of positive batches occurred later in the mosquito season during 2003 than in 2002, providing less time for WNV to amplify to levels that would put people at risk.

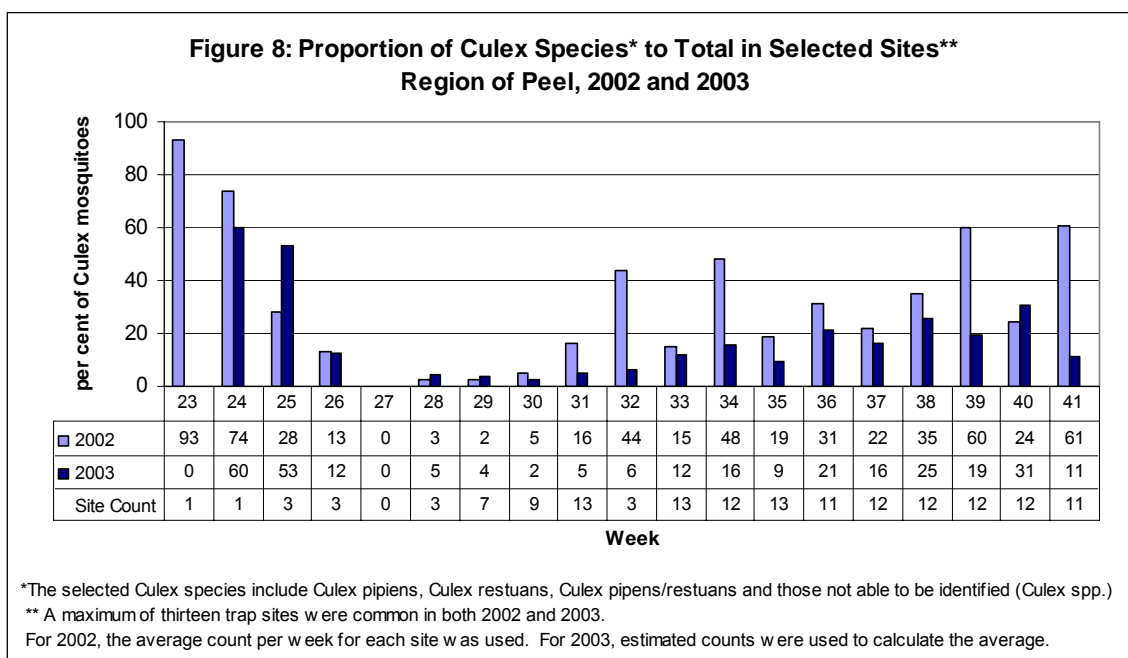


Comparison of 2002 and 2003 Mosquito Trap Data

An analysis comparing traps which were operational in both 2002 and 2003 was conducted to try to ascertain whether or not using larvicide to reduce numbers of *Culex* mosquitoes was effective. *Culex* species included *Culex pipiens*, *Culex restuans*, *Culex pipiens/restuans* and *Culex spp.*

Results of the analysis of relative abundance of *Culex* mosquitoes are shown in Figure 8 and Table 4. As a proportion of total mosquitoes, *Culex* mosquitoes were lower in 2003 than 2002 in 14 out of 18 weeks (the exceptions were Weeks 25, 28, 29 and 40). Summed over the year, the proportion of *Culex* decreased from 25% in 2002 to 9% in 2003. All individual *Culex* species decreased in both proportion and rank in 2003.

These results are consistent with the prediction of the larvicide program preferentially reducing *Culex pipiens* over *Culex restuans*. *Culex pipiens* were ranked fifth in 2002 and comprised 6% of mosquitoes trapped at those sites; in 2003, their rank dropped to eleventh and they comprised 0.7% of collected mosquitoes. *Culex restuans*, which ranked eighth with 2.5% of total mosquitoes in 2002, retained their rank of eighth but only accounted for 1% of total mosquitoes in 2003. Most interesting is that *Culex pipiens* became less abundant than *Culex restuans* in 2003 when it had been the more commonly identified species in 2002. The other *Culex* species also decreased in relative abundance from 2002 to 2003. *Culex spp.* went from fourth to tenth most common and *Culex pipiens/restuans* from third to fourth most common.





Differences in the numbers of *Culex pipiens* and *Culex spp.* need to be interpreted with caution as so few of these species were identified in 2003.

Table 4: Comparison of the Top 12 Mosquito Species Collected from Common Trap Sites and Time Periods, Region of Peel, 2002 and 2003

Rank 2003	Species (Estimated)	Average Estimate Number 2003*	Per Cent	Rank 2002	Species (Actual)	Average Actual Number 2002**	Per Cent
1	<i>Coquillettidia perturbans</i>	11991	57.9	1	<i>Coquillettidia perturbans</i>	4148	38.4
2	<i>Aedes vexans</i>	3657	17.7	2	<i>Aedes vexans</i>	2366	21.9
3	<i>Ochlerotatus canadensis</i>	1422	6.9	3	<i>Culex pipiens/restuans</i>	1186	11.0
4	<i>Culex pipiens/restuans</i>	1286	6.2	4	<i>Culex spp.</i>	616	5.7
5	<i>Aedes/Ochlerotatus spp.</i>	570	2.8	5	<i>Culex pipiens</i>	615	5.7
6	<i>Ochlerotatus trivittatus</i>	320	1.5	6	<i>Aedes vexans/cantator</i>	449	4.2
7	<i>Ochlerotatus stimulans</i>	237	1.1	7	<i>Aedes/Ochlerotatus spp.</i>	320	3.0
8	<i>Culex restuans</i>	216	1.0	8	<i>Culex restuans</i>	267	2.5
9	<i>Anopheles punctipennis</i>	195	0.9	9	<i>Ochlerotatus excrucians</i>	177	1.6
10	<i>Culex spp.</i>	169	0.8	10	<i>Ochlerotatus trivittatus</i>	175	1.6
11	<i>Culex pipiens</i>	147	0.7	11	<i>Ochlerotatus canadensis</i>	120	1.1
12	<i>Aedes vexans/cantator</i>	98	0.5	12	<i>Ochlerotatus triseriatus</i>	93	0.9

* 2003 data are based on average, estimated numbers collected per trap event at 13 common trap sites.

** 2002 data are based on average, actual numbers collected per trap event at the same trap sites.

The data in Table 4 show that, as a group, average *Culex* numbers decreased by 32 %, from 2,684 in 2002 to 1,818 in 2003. Looking at this another way, the numbers of *Culex* caught per trap event, shown in Table 5, decreased by 18% from 22 *Culex* mosquitoes per trap per night in 2002 to 18 in 2003. This decrease in *Culex* numbers may appear small, however it occurred in the context of large increases in the numbers of seven of the 10 non-*Culex* mosquito species listed in Table 4. It is quite possible that without intervention, the number of *Culex* mosquitoes could have increased in 2003 rather than remained the same or decreased. If this happened, then the reduction of *Culex* mosquitoes when compared to 2002 would appear to be less than what actually took place.



Table 5: Proportion of Culex Group Mosquitoes Collected per Trap Event at Common Sites Region of Peel, 2002 and 2003

Year	Number* of Culex Group Mosquitoes	Number of Trap Events	Average Number of Culex per Trap Event
2002	3419	158	21.6
2003	1818	103	17.7
% Change			-18.4

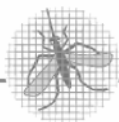
* 2003 data are based on estimated numbers collected per trap event at 13 common trap sites; 2002 data are based on actual numbers collected per trap event at the same trap sites.

It is impossible to prove conclusively with the information at hand that the larval mosquito reduction program was responsible for the decline of *Culex* mosquitoes observed in 2003. Differences in temperature and rainfall could have produced a similar effect. The monitoring procedure itself is influenced by weather so that a trap may catch fewer mosquitoes if weather conditions are unfavourable.

Differences in trap locations cannot account for any observed changes, as this comparison only examined data from traps in the same location in both years. However, adult mosquito traps were not placed randomly across the Region, but rather were placed somewhat systematically at sites expected to yield larger numbers of mosquitoes in general, while maintaining the security and reliability of the traps (i.e. traps were placed in locations where tampering and vandalism could be avoided).

These results are also based on observational data, rather than having had “*a priori*” hypotheses and other rigid controls in place. Therefore, it is difficult to draw strong inferences about causality when using this information.

Nevertheless, all of the results are consistent with the larviciding program having had an effect on its intended target. *Culex* mosquitoes were specifically affected, while most other mosquito species actually increased in number. In addition, *Culex* numbers were lower as result of a consistent decrease over the course of the entire season, not just because of a few unusual weeks. One would anticipate that changes in mosquito populations due to weather conditions would not affect *Culex* mosquitoes so specifically, but that similar changes in many other species of mosquitoes would be seen as well.

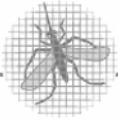


Summary

Thirty-nine species of mosquitoes were identified in the Region of Peel in 2003; however, as in 2002, only a small number were likely important in the transmission of WNV from mosquitoes to humans. Four species of mosquitoes were found to be positive for WNV. Mosquitoes from the genus *Culex* were the most important, accounting for an estimated 13% of the mosquitoes tested and 96% of the WNV-positive batches. *Culex* mosquitoes also exhibited the highest WNV infection rates in Peel, based on analyses of Minimum Infection Rates (MIRs). In general, MIRs showed that infection rates were down and that there were far fewer bridge vector mosquito species infected in 2003 compared to 2002.

Culex pipiens/restuans were once again key “amplification” mosquitoes, because they prefer to feed on birds, the main reservoir of WNV, and are more common in urban and suburban settings.⁶ As in 2002, very few *Culex* mosquitoes were trapped in the Caledon area compared to Mississauga or Brampton. No WNV-positive batches of mosquitoes were found in Caledon in 2003.

While other species might contribute to human WNV transmission, control of *Culex* mosquitoes is one of the most important strategies to reduce the risk of WNV transmission to humans.²² An analysis of the proportions of *Culex* mosquitoes collected in 2002 and 2003 showed lower proportions of these mosquitoes in 2003, possibly due to larval mosquito reduction measures.



WEST NILE VIRUS IN THE REGION OF PEEL 2003



LARVAL MOSQUITO SURVEILLANCE

Introduction

A mosquito's life cycle includes four stages, three of which often take place in water.⁶ Many mosquito species lay their eggs in or near water, where the eggs hatch into larvae and grow into pupae. The pupae become adults, which are able to take flight. In preparation for breeding, females then seek a blood meal from mammal, avian or amphibian sources, depending on their feeding preferences.

Larval surveillance data are integral in planning and implementing an effective mosquito reduction program. Measures can be directed at those habitats likely to support the breeding of mosquito larvae important to WNV transmission within areas populated by humans, including standing water sources, whether natural or man-made.

Surveys of road-side catch basins, ditches, culverts, field pools and other potential mosquito breeding sites conducted in 2001 and 2002 confirmed the presence of mosquito larvae in Peel. In 2001, 77% (20 of 26) of catch basins examined were found to contain mosquito larvae, while in 2002, the presence of mosquito larvae was identified in 42% (118 of 278) of the potential mosquito breeding sites from which samples were taken.

Surveillance of potential breeding sites on publicly-owned lands was enhanced in 2003 in order to determine the presence, volume and type of larvae in surface water at over 2100 sites across the Region of Peel.

Methods

Standing Water Surveillance

Peel Health seasonal field staff surveyed a wide range of aquatic habitats for the presence of mosquitoes in the larval stage from mid-May to late October. Staff identified breeding sites by referencing historical breeding site data collected from 2002, conducting field surveys and by investigating standing water complaints received from Peel residents. In areas where positive dead crows, positive adult mosquito batches or human cases were identified, concentrated breeding site field surveys were conducted.

The larval sampling procedure involved collection of larvae in a standard aquatic dipper. A standardized larval sampling method was used to quantify larvae density and the breeding sites were ranked as nil, low, medium or high density. This information was entered into a handheld computer in the field. Other data captured were the type and dimensions of the breeding site and the date of the inspection. The exact latitude and



longitude of the potential breeding site was recorded using a Global Positioning System (GPS) unit.

Catch Basin Study

A study was conducted in late August, 2003 by Peel Health to explore the presence and density of larvae in catch basins in industrial areas and along main roads. This would assist with determining the extent to which larvae were present in these types of catch basins, and the need for future larval control measures. Catch basins situated in residential areas have abundant vegetation and are therefore likely to contain mosquito larvae. This was confirmed by studies conducted in previous years.

A convenience sample of catch basins in industrial areas and on main streets was identified, with 20 catch basins randomly selected from each group for inclusion in the study. Samples were collected from catch basins on selected main streets between August 22 and August 25th, 2003 and in industrial areas on August 27th, 2003.

Larval Mosquito Identification

Larval surveillance also involved the identification of larvae found at the breeding sites. Larvae were collected and sent to an in-house mosquito laboratory for species identification by Peel Health staff. When species could not be distinguished, they were classified as a group (e.g. *Aedes/Ochlerotatus spp.*). These data were used to determine mosquito species distribution, abundance and seasonal occurrence and assisted in guiding larval control measures.

A computer-based geographic information system (GIS) was used to maintain all the larval surveillance information. Maps identified the location of all potential breeding sites in the Region of Peel. The breeding site software program was used to compile and extract the laboratory and field surveillance data. This information was used to determine the type of habitats that supported mosquito populations and the abundance of vector species present in an area.

Results

Standing Water Surveillance

In 2003, over 2,100 potential mosquito breeding sites were surveyed for standing water (Figure 9). Of these, 77% (1,627) were in Mississauga, 15% (304) were in Brampton and 8% (172) were in Caledon. The distribution of these sites was highly influenced by standing water complaints from Peel residents.

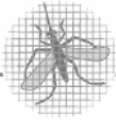
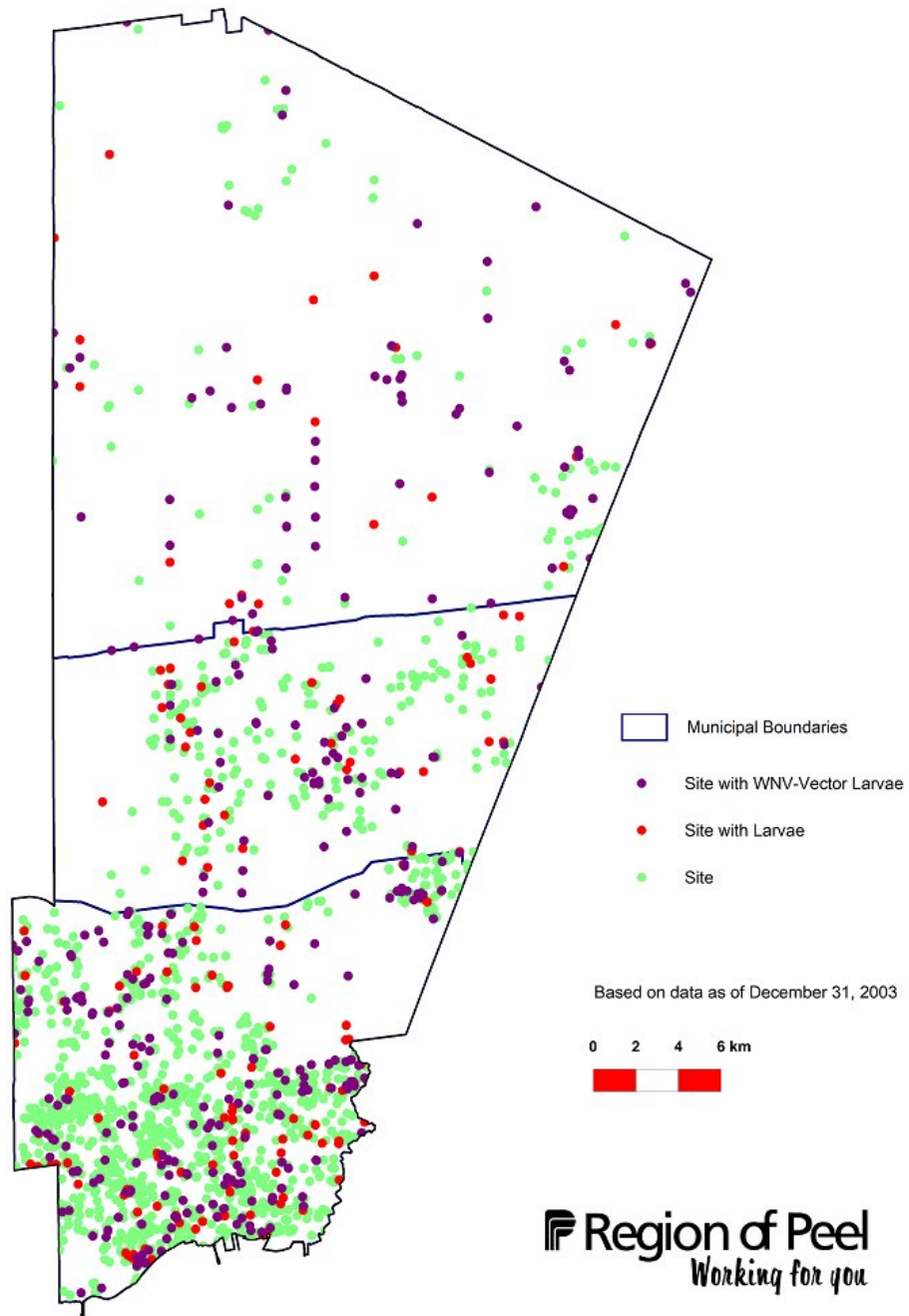


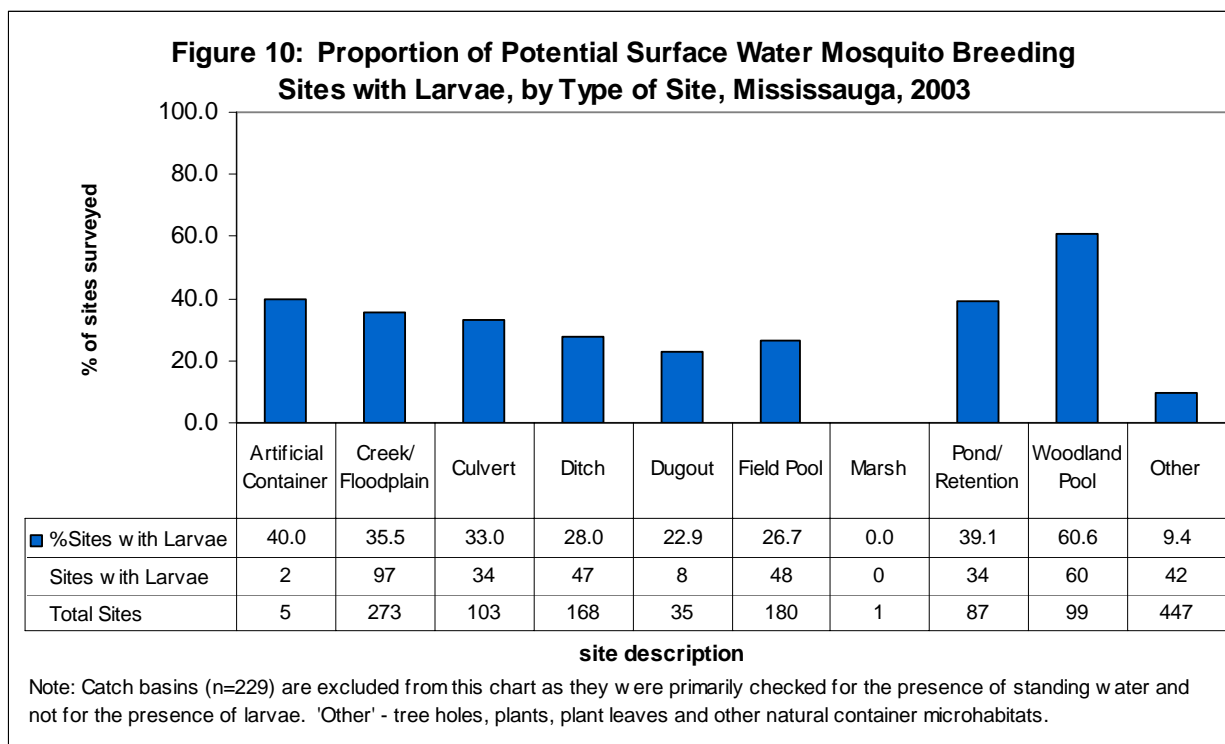
Figure 9: Locations of Mosquito Breeding Sites, Sites with Larvae and Vector Larvae, Region of Peel, 2003





The presence of mosquito larvae was identified in 28% (586 of 2103) of the breeding sites from which samples were taken. However, “vector” larvae (larvae of a species found to have tested positive for WNV) were identified in 17% (362 of 2103) of Peel sites surveyed.

Results by municipality and type of site are shown in Figures 10 through 12. In Mississauga, 25% (402 of 1,627) of sites sampled contained mosquito larvae, but only 14% (234 of 1,627) contained vector larvae. In Brampton, 29% of sites surveyed (89 of 304) were found to have larvae and 17% (53 of 304) contained vector larvae. In Caledon, 55% of sites (95 of 172) contained larvae, while 44% of these (75 of 172) were found to have vector larvae.



Among sites that were surveyed in 2003, man-made structures such as ditches and culverts tended to have higher proportions of larvae present than naturally-occurring sites such as lakes, marshes, rivers and woodland pools. In Caledon in 2003, 56% of man-made structures and 52% of natural sites were found to have larvae. In Mississauga, 31% of artificial sites contained larvae, compared to 28% of natural sites. In Brampton, the reverse occurred, with 36% of natural sites having been found to contain larvae, compared to 31% of man-made structures.

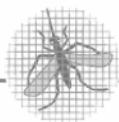
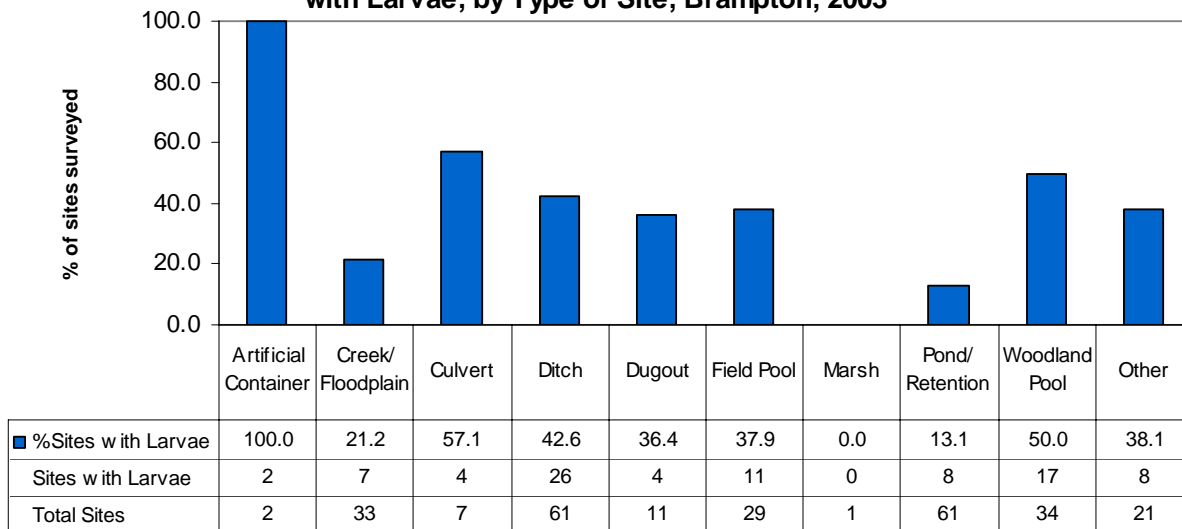


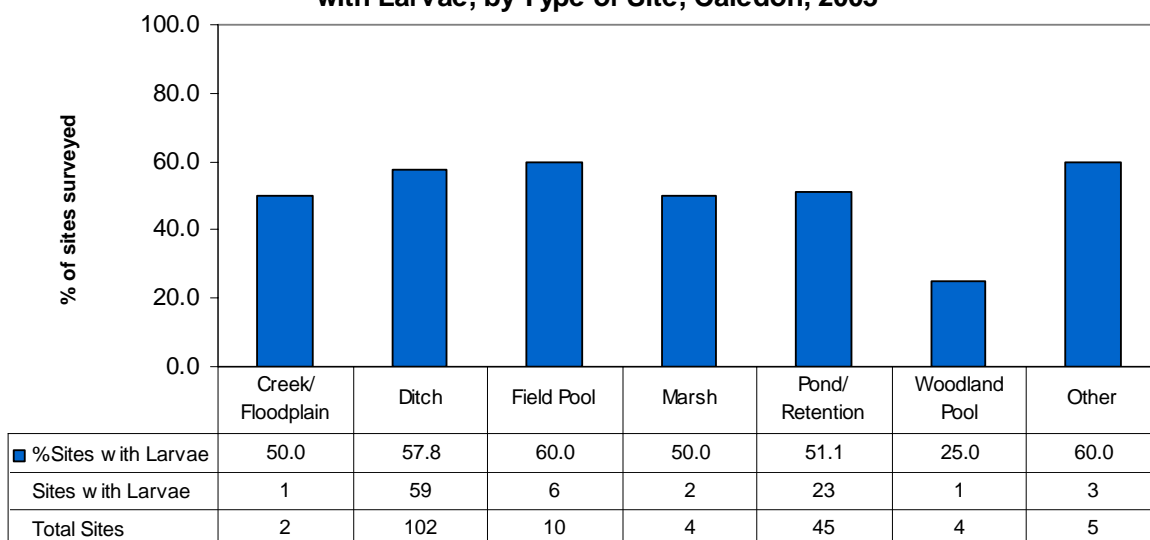
Figure 11: Proportion of Potential Surface Water Mosquito Breeding Sites with Larvae, by Type of Site, Brampton, 2003



site description

Note: Catch basins (n=44) are excluded from this chart as they were primarily checked for the presence of standing water and not for the presence of larvae. 'Other' - tree holes, plants, plant leaves and other natural container microhabitats.

Figure 12: Proportion of Potential Surface Water Mosquito Breeding Sites with Larvae, by Type of Site, Caledon, 2003

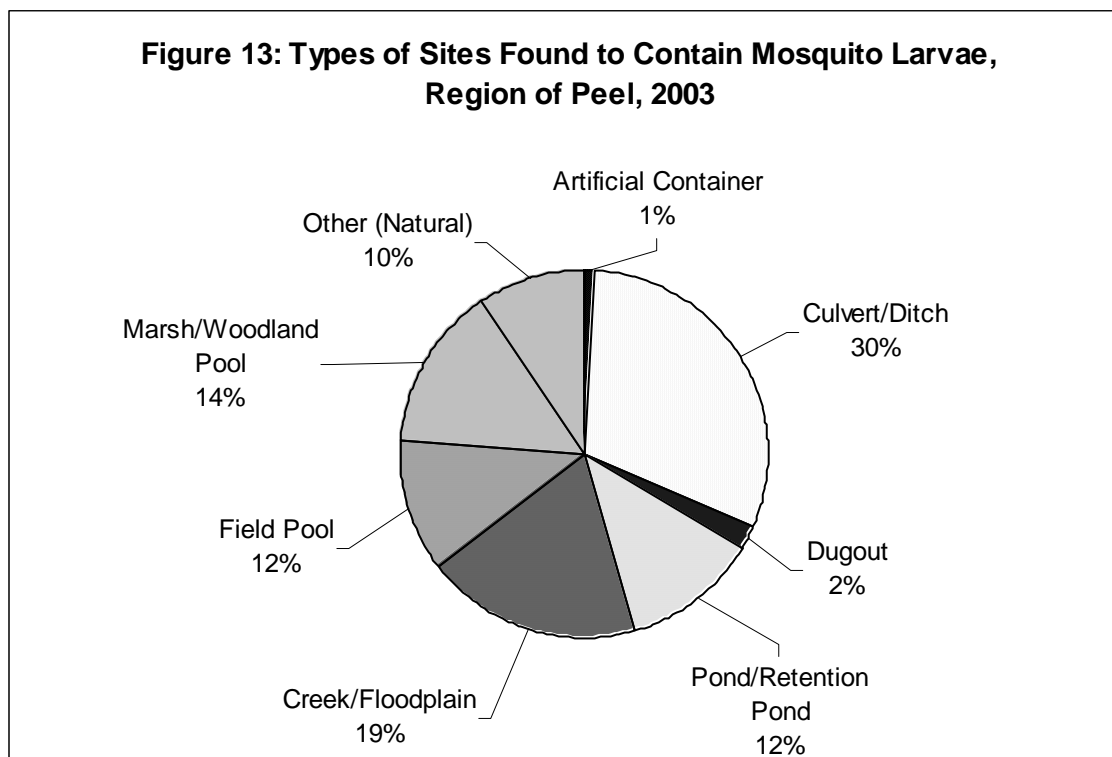


site description

Note: There were no catch basins surveyed in Caledon. 'Other' - tree holes, plants, plant leaves and other natural container microhabitats.



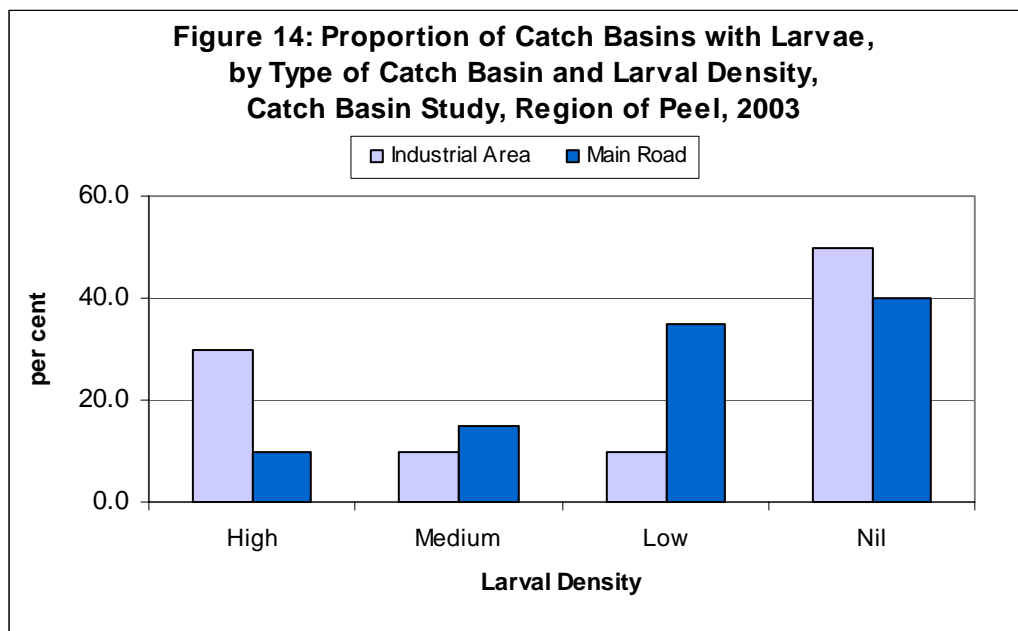
Among the sites in Peel containing larvae, ditches and culverts were the most frequent types of sites in which larvae were found (Figure 13).



Note that the larval surveillance data for 2003 are somewhat limited and need to be interpreted with caution. For example, the data do not show relative amounts of larvae or their persistence over time. A site with a few larvae on one occasion cannot be distinguished from a site with many larvae throughout the season.

Catch Basin Study

An investigation of catch basins in industrial areas and on main streets was undertaken, where a total of 20 catch basins were randomly selected from each group to explore the presence and density of larvae. Larvae were observed in 50% of the industrial-area catch basins compared to 60% of those on main roads (Figure 14). Higher densities of larvae were observed in catch basins of the industrial areas (30%) than for main roads (10%). Similarly, lower densities of larvae were observed in catch basins around main roads (35%) than in industrial areas (10%).



Larval Mosquito Identification

The identification of larval species found at breeding sites took place at an in-house mosquito laboratory. While counts of larvae were dependent on the number and frequency of dips taken, the collected specimens were completely random and would likely be generalizable across the Region.

Table 6 shows the results of the larvae identification process for the period May to October, 2003. Nineteen different species or groups of mosquito larvae were identified from the 3,942 specimens collected. Over 80% of those collected were of two *Culex* species: *Culex restuans* accounted for 42% and *Culex pipiens* accounted for 41% of all larvae collected and able to be identified.

An analysis of these two species by date of collection was conducted to determine when the density of these larvae were at their highest, and whether any differences were seen over the course of the mosquito season (Figure 15). One would expect to find that the abundance of mosquito larvae might increase with increasing generations of adult female mosquitoes.

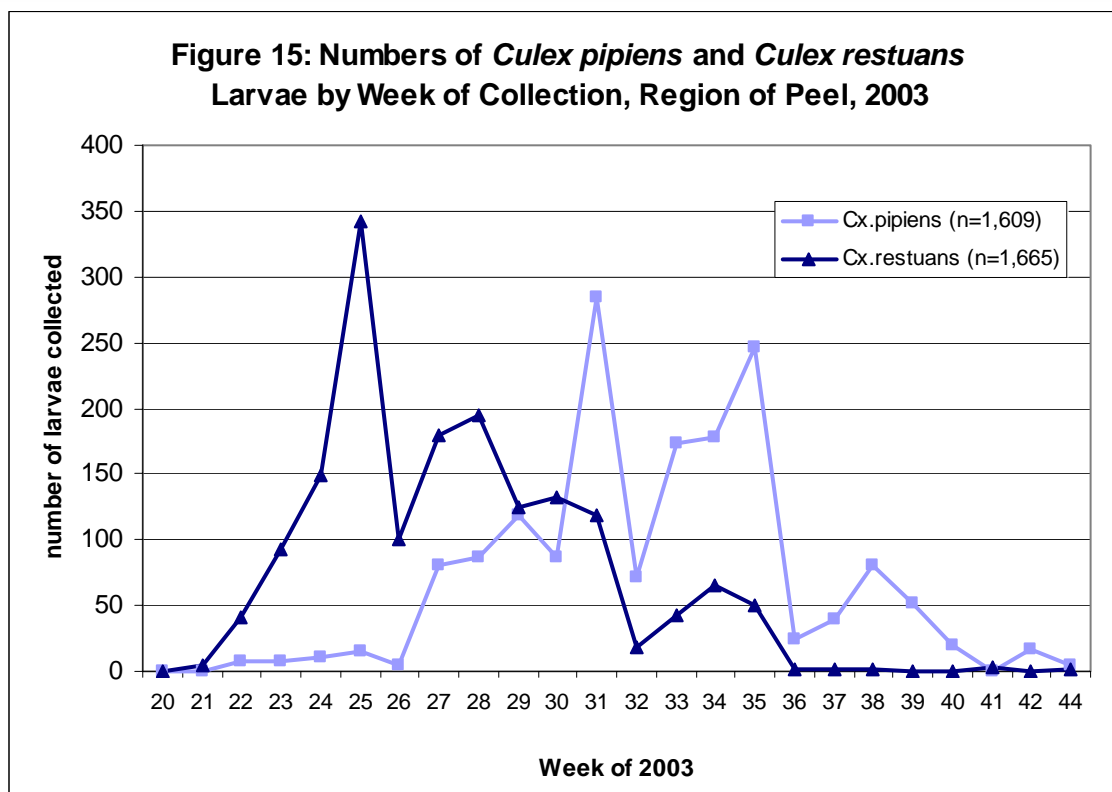
As expected, *Culex restuans* larvae appeared earlier in the mosquito season, and peaked around Week 25 (June 15 to June 21), whereas *Culex pipiens* larvae did not reach their highest numbers until Week 31 (July 27 to August 2). While several peaks can be observed for both species, as the season progressed, there was attenuation in the height of the peaks, possibly meaning that fewer of these species were collected.



After Week 35 (August 24 to 30), the numbers of larvae collected dropped dramatically, likely as a result of the loss of seasonal field staff who had done the majority of sample collections over the summer months.

Table 6: Mosquito Larvae Identification, Region of Peel, 2003

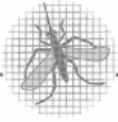
Mosquito Species/Group	Number	Per cent
<i>Culex restuans</i>	1665	42.2
<i>Culex pipiens</i>	1609	40.8
<i>Aedes vexans</i>	198	5.0
<i>Culex territans</i>	185	4.7
<i>Ochlerotatus dorsalis</i>	170	4.3
<i>Anopheles punctipennis</i>	65	1.6
<i>Aedes/Ochlerotatus spp.</i>	12	0.3
<i>Aedes cinereus</i>	9	0.2
<i>Ochlerotatus canadensis</i>	9	0.2
<i>Anopheles quadrimaculatus</i>	4	0.1
<i>Culiseta inornata</i>	3	0.1
<i>Ochlerotatus excrucians</i>	3	0.1
<i>Ochlerotatus triseriatus</i>	3	0.1
<i>Anopheles earlei</i>	2	0.1
<i>Ochlerotatus fitchii</i>	1	0.0
<i>Ochlerotatus hendersoni</i>	1	0.0
<i>Ochlerotatus stimulans</i>	1	0.0
<i>Ochlerotatus trivittatus</i>	1	0.0
<i>Ochlerotatus euedes</i>	1	0.0
Total	3942	100.0



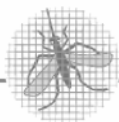
Summary

Larval surveillance provides crucial information for mosquito reduction interventions. Potential breeding sites were identified on the basis of complaints from Peel residents, by referencing historical breeding site data collected from 2002 and by conducting field surveys for suitable habitats. In 2003, over 2,100 sites were surveyed for standing water in Peel: 77% were in Mississauga, 15% in Brampton and 8% in Caledon. The presence of mosquito larvae was identified in 28% of the potential breeding sites from which samples were taken, while “vector” larvae were identified in 17%. Ditches and culverts were some of the more numerous breeding sites and often contained mosquito larvae.

Between May and October 2003, a total of 19 different species or groups of mosquito larvae were identified from 3,942 specimens collected at breeding sites. Over 80% of those collected belonged to two *Culex* species: *Culex restuans* accounted for 42% and *Culex pipiens* accounted for 41% of all mosquito larvae that were collected and identified.



WEST NILE VIRUS IN THE REGION OF PEEL 2003



LARVAL MOSQUITO CONTROL AND ENVIRONMENTAL MONITORING

Introduction

Larval surveillance programs are intended to identify the presence, type and abundance of vector larvae in a defined geographic area. Information obtained from such programs aids in making decisions as to whether or not WNV control measures are necessary. In 2002, data collected in the Region of Peel verified the presence of vector larvae in standing surface water found in catch basins and other man-made structures, as well as in natural habitats.

Using larval surveillance data from 2002, a larval mosquito reduction program involving the inspection and larviciding of over 75,000 roadside catch basins across Peel Region was undertaken in 2003. Catch basins are designed to collect rain and storm water from city streets, diverting it into receiving bodies such as streams, creeks, rivers and lakes. One method of controlling mosquito breeding in these catch basins is by the application of the larvicide Methoprene.

Methoprene is a chemical substance that mimics the mosquito's juvenile growth hormone²³ and prevents the emergence of adult mosquitoes from the pupal stage.²⁴ Standing water in the breeding site is treated with Methoprene pellets that dissolve in the water and allow the larvae to develop into pupae; however, the artificially higher hormonal level in the water causes the mosquitoes to stay as pupae and eventually die or to develop into adult mosquitoes which are unable to reproduce.²³

In addition to roadside catch basins, plans were also made to larvicide other mosquito breeding sites located on federal, provincial, municipal and private lands. Decisions to larvicide these other sites were based on the results of larval surveillance activities and in response to standing water complaints. If these sites were considered to be in sensitive areas or significant wetlands, the larvicide Bti (*Bacillus thuringiensis* variation *israelensis*) was to be used. The use of this larvicide may be ordered by the local Medical Officer of Health if risk assessments identify an abundance of WNV-vector mosquito larvae in standing water which is in close proximity to inhabited areas.²⁵

Bti is a bacterium found to naturally occur in soils. It targets only mosquito and blackfly larvae.²⁶ Bti works by producing a microscopic protein crystal that, when ingested by feeding larvae, gets converted to a toxin. The toxin destroys the walls of the insect's stomach and within hours, the insect stops feeding, dying within days.²⁶

Measures of the effectiveness of Methoprene, including the lack of adult mosquito emergence and amounts of residual Methoprene, were obtained from samples of standing water taken from 33 catch basins in Peel. In addition, monitoring of the storm water outflow downstream from a sample of four catch basins was undertaken to



measure any impacts on the environment and its aquatic life from the use of Methoprene.

Methods

Larval Mosquito Control

The 2003 larval mosquito reduction program involved obtaining the correct permits from the Ministry of the Environment for the purchase of pesticides to perform water exterminations in either municipal roadside catch basins or standing surface water found in ditches, storm water retention ponds, lakes and woodland or field pools.

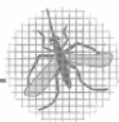
Pestalto Environmental Products Inc. was contracted by the Region of Peel to provide these larval mosquito control services. The contract involved locating catch basins and standing water sites, measuring mosquito larval populations prior to the application of larvicide, larviciding the site, collecting samples post-treatment and determining larvicide efficacy.

Locations of catch basins and standing surface water sites were either provided to Pestalto by Peel Health staff from historical breeding site data, through field surveys, by investigating standing water complaints received from Peel residents, or they were found in the course of conducting the treatment program.

The condition of each catch basin was assessed to determine if it was environmentally sensitive, dry, had flowing water, or was a likely mosquito breeding site. Treatments of catch basins located within 30 metres of environmentally sensitive areas (e.g. bodies of water including creeks, rivers, marshes or ponds) were conducted using a special ultrasound-emitting device called a Larvasonic[®]. If the catch basin was not near an environmentally sensitive area and its condition suitable for treatment, Methoprene in the form of Altosid[®] pellets was deposited into the standing water in the catch basin at a rate of approximately 0.7 grams per application. Catch basins were generally treated three times over the course of the mosquito season.²⁷

Environmental Monitoring

Environmental monitoring of a sample of roadside catch basins was conducted by Peel Health in conjunction with staff from Pestalto Environmental Products Inc. and Peel Public Works.²³ Thirty-three catch basins (20 in Mississauga, 10 in Brampton and 3 in Caledon) were randomly selected to test for the presence and effectiveness of Methoprene, with the interval between larvicide application and sample collection varying between two and 44 days. The sampling and testing was done by Region of Peel staff. Samples were taken a minimum of three times each following the application. Selected catch basins in Mississauga were sampled a total of five times.



Peel Health also worked with staff from the Credit Valley Conservation Authority and the Ontario Ministry of the Environment (MOE) on a study to determine the environmental impact of Methoprene in receiving waters and the impact the larvicide might have on aquatic species. Four sites were selected in Peel: three in Mississauga (Credit River, Mullet Creek and Sheridan Creek) and one in Brampton (Etobicoke Creek). Each site was visited one day before the application of Methoprene, then on day plus three, plus seven, plus 14, plus 28, plus 56, and plus 112. Water and invertebrate samples were taken immediately upstream of a catch basin, at the outflow, immediately downstream of the outflow and well downstream of the outflow. The samples were taken to the MOE laboratory for analysis.

The MOE also tested drinking water from 29 water treatment plants across the province, including the Lakeview and Lorne Park plants in Peel Region.

Results

Larval Mosquito Control

Four permits to purchase pesticide for the purpose of water extermination of mosquito larvae were obtained for use in the Region of Peel and received by Pestalto. Peel Health notified the public about the application of larvicide treatments as per MOE requirements.

In 2003, there were a total of 75,516 roadside municipal catch basins in Brampton, Mississauga and Caledon (Table 7). Methoprene, in the form of Altosid[®] pellets, was applied to 71,664 catch basins (95%) in the first round of applications conducted between May 26 and June 11, 2003. The second application took place from June 23 to July 16, and included 73,556 catch basins (97%). The third treatment was applied to all 75,516 catch basins from July 21 to August 14. Larvicide applications were not made to catch basins which were deemed to be environmentally sensitive, found to be dry or had flowing water.

In addition, 372 catch basins not located on municipal streets were identified as needing to be treated. A total of 327 catch basins in residential backyards received 522 treatments with Altosid[®] pellets from June 10 to August 14, 2003. Thirty treatments were applied at 15 catch basins located at the three Regional Long-Term Care facilities and 54 treatments were made in 30 catch basins located in 10 parks during July and up to August 14 (Table 7). Over the course of the 2003 mosquito season, a total of 221,342 larvicide treatments were made in roadside, backyard or other types of catch basins using a quantity of 155 kilograms of pesticide.



Table 7: Number of Catch Basin Treatments Using Altosid® Pellets, Region of Peel, 2003

Type of Catch Basin (number)	Number of Catch Basin Treatments	Quantity Used (grams)
Municipal Roadside (n=75,516)		
1st Treatment	71,664	50,165
2nd Treatment	73,556	51,489
3rd Treatment	75,516	52,861
Backyard (n=327)		
1st + 2nd Treatments	522	365
Long Term Care Facilities (n=15)		
1st + 2nd Treatments	30	21
Parks (n=30)	54	38
Total	221,342	154.94 Kg

Source: Pestalto Environmental Products Inc., February 2004

Site surveys of standing surface water by Peel Health staff resulted in the identification of 128 open surface water sites for monitoring and treatment. Those with moderate to high larval densities as per MOE guidelines were treated with Bti in the form of Aquabac 200G. Mississauga had 57 sites of which 23 were treated one or more times; Brampton had 30 sites of which 23 received applications one or more times; and Caledon had 41 sites of which 22 received treatments. Pestalto administered a total of 131 Bti treatments at these 68 sites using approximately 18 kilograms of larvicide, with a resulting efficacy of 100% based on samples taken 48 to 72 hours after the treatment was applied.²⁷

Considering that 362 surface water sites were identified as having vector larvae only 19% (68/362) of sites that required treatment received it. This was due in part to a lengthy process which involved larval identification, then assessment for remediation and then treatment referral. As well, a proportion of these sites were found to contain amounts of larvae too low to be considered for treatment.

Treatments of catch basins located within 30 metres of environmentally sensitive areas (e.g. bodies of water including creeks, rivers, marshes or ponds) were conducted using a special ultrasound-emitting device called a Larvasonic®, rather than using pesticides. A total of 162 sensitive catch basins were treated in this way.

The Larvasonic® generator provided variable results, with proportions of mosquito larvae being killed ranging from low levels of mortality to 100%. An examination of the effectiveness of the Larvasonic® undertaken at 15 sites in Peel Region resulted in efficacy rates of between 20 and 67%. Pestalto plans to review the performance of this device for use in the 2004 mosquito season to determine reasons for this variability.²⁷



Environmental Monitoring

A random sample of 33 catch basins across Peel was monitored to determine residual levels of Methoprene and its efficacy. The minimum detection limit of Methoprene in water samples analyzed at the Region of Peel Public Works laboratory was 0.47 micrograms per litre ($\mu\text{g/L}$). Sixty-nine per cent of the samples had levels below 0.47 $\mu\text{g/L}$ and 16% of the samples had non-detectable levels of Methoprene.

The overall efficacy rate for 10 samples of pupae and adult mosquitoes collected by Peel Health from 7 catch basins on two different occasions was 74%. This means that Methoprene was generally effective in reducing adult emergence of viable mosquitoes. However, efficacy rates for individual catch basins ranged between 0% and 100% (although the zero per cent was based on a sample of one pupae and one adult that emerged).²³

Caution must be taken when interpreting these results due to small sample sizes and limitations encountered during the course of the study. Some of these limitations included the lack of a recognized protocol, changes in testing methodology over the course of the year, variations in levels of organic matter and water within the catch basins, incomplete recording of treatment dates or conditions of catch basins, and other factors such as human activities or weather conditions that may have affected the efficacy of the larvicide.²³

Three other Ontario studies have found similar results with slightly higher estimates of efficacy. Two were conducted by Pestalto and one by the MOE.

In the first study, Pestalto collected larvae and pupae from catch basins in Peel Region as well as other jurisdictions having contracts with their company. In this study, 68 of 474 pupae emerged into adults, resulting in an efficacy rate of approximately 86%.²⁷

These results are similar to findings of a second Pestalto study of post-treatment Methoprene efficacy, in which 233 samples were drawn from 88 catch basins in southern Ontario.²⁴ The overall efficacy rate was determined to be 81%; however, efficacy rates again ranged from 0% to 100%. The report found that the efficacy of Methoprene is variable and makes numerous recommendations to improve the planning, delivery and monitoring aspects of a larval control program.

The MOE conducted a study of Methoprene efficacy in Halton Region.²⁸ They found that, up to 21 days after application of the larvicide, 96% of pupae failed to emerge from treated catch basins. When corrected for natural factors (e.g. pupae that would not have normally emerged), the efficacy was found to be at least 87%. From 21 to 30 days, the efficacy was found to decline to 43%. As a result, the MOE will be changing



their recommendations for Methoprene pellet use such that applications will be recommended every 21 days, instead of 28 days as was the case in 2003.

Published results from the collaborative study on Methoprene levels in drinking water and downstream from catch basins were not yet available from the MOE at the time of production of this report. However, a presentation made in December 2003 by the MOE reported that among all receiving water samples taken downstream from catch basins, not one contained detectable levels of Methoprene. A single sample taken from Sheridan Creek in Mississauga upstream of a catch basin outfall did contain detectable Methoprene; however, the level of Methoprene found was lower than that of the water quality standard.²⁹ No Methoprene was detected in any of the drinking water samples. Results of studies on the impact of Methoprene on aquatic organisms have yet to be released.

Summary

Based on findings from larval surveillance activities in 2002, a larval mosquito reduction program involving the inspection and larviciding of 75,516 roadside catch basins across Peel Region was undertaken in 2003. An additional 372 catch basins located at Regional Long-Term Care facilities, parks or in private backyards were also treated.

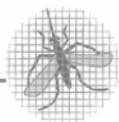
Over the course of the 2003 mosquito season, a total of 221,342 treatments using the larvicide Methoprene were made in roadside, backyard or other types of catch basins. Methoprene was effective in reducing the emergence of viable adult mosquitoes, with an overall efficacy rate of 74% and up to 96% at 21 days post-treatment.

A total of 128 open surface water sites were identified for monitoring and treatment; those with moderate to high larval densities as per MOE guidelines were treated with Bti. A total of 131 Bti treatments were administered at 68 sites, with a resulting efficacy of 100%. This represented only 19% of sites potentially requiring treatment.

Treatments of 162 environmentally sensitive catch basins located within 30 metres of bodies of water, including creeks, rivers, marshes or ponds, were conducted using a device called a Larvasonic[®], producing efficacy rates of between 20% and 67%.

A collaborative study done by the MOE and a number of Ontario health departments showed that Methoprene had no impacts on surface water quality, including drinking water.

Results of studies that examined levels and effects of Methoprene in receiving water collected downstream from catch basins at four sites in Peel Region will be published by the Ministry of the Environment. Preliminary results show that Methoprene was not detectable in drinking water or downstream from catch basin outfalls.



HUMAN CASE SURVEILLANCE

Introduction

The purpose of human case surveillance is to quickly detect human illness due to the West Nile Virus. Human illness due to WNV acquired in Peel occurred for the first time in 2002, when there were 112 residents with laboratory evidence of WNV (55 suspect cases, 20 probable cases and 37 confirmed cases, including two deaths). Most of these cases occurred in August and September. Many cases required hospitalization and intensive care.

While most human WNV infections are without symptoms, about one in five people (20%) develop a less severe illness (West Nile fever).³⁰ The incubation period is estimated to be three to 14 days, with symptoms lasting approximately three to six days. This form of WNV infection is described as a sudden onset of fever that is often accompanied by malaise, headache, nausea, vomiting, anorexia, eye pain, myalgia, and less commonly, rash and/or swollen lymph nodes.³⁰

Approximately one case in 150 will develop severe neurological disease, with encephalitis being reported more often than meningitis. Additional symptoms among those with severe disease include muscle weakness and a change in mental status. Other symptoms include seizures, optic nerve involvement, cranial nerve abnormalities, paralysis and ataxia (difficulty coordinating movement or body functions).³⁰

As there is no cure for WNV, treatment is supportive in nature, and involves hospitalization, administering intravenous fluids, providing respiratory support and preventing secondary infections for patients with severe disease.³⁰

The 2002 WNV epidemic in North America included the first documented cases of person-to-person WNV transmission through organ transplantation,³¹ blood and blood product transfusion³¹ and breastfeeding,³² as well as a case of intrauterine infection (the mother passing the infection to her unborn child).³³ A poliomyelitis-like syndrome was first recognized among some West Nile patients with onset of acute flaccid paralysis (AFP) during the early stages of infection in the United States.³⁴ Parkinsonism and Rhabdomyolysis³⁵ were also occasionally seen.

Modifiable risk factors for WNV include known travel in an area previously identified as having WNV activity, acquiring the infection through occupational exposure,¹ or having received blood, blood products or organ transplants from an infected donor. Since July 1, 2003, Canadian Blood Services have screened all donations of blood for WNV.³⁶



Methods

In 2003, human case definitions in Canada became more complex than in 2002, classifying human WNV illness according to the severity of symptoms and the level of clinical and laboratory evidence.³⁵ The three main categories of infection from lowest to highest severity were: WNV Asymptomatic Infection, WNV Fever and WNV Neurological Manifestations. The first category was sub-classified into “probable” or “confirmed”. The latter two categories were divided into four levels: “suspect”, “possible”, “probable” or “confirmed”.

Any individuals with symptoms suspected of being related to WNV infection were to be investigated and reported to the Ontario Ministry of Health and Long-Term Care (MOHLTC). This differed from 2002, when only those cases with encephalitis or laboratory confirmation were to be reported.

Peel Health updated local physicians about the importance of immediately reporting all suspected cases of viral encephalitis and viral meningitis, and submitting appropriate laboratory samples to determine if the cause was a mosquito-borne virus. Public Health Inspectors and the Communicable Disease Infection Control Specialist collaborated with Infection Control Practitioners from the three area hospitals regarding case definitions as defined by the MOHLTC and the process of reporting suspect, probable and confirmed cases.

Physicians and Infection Control Practitioners identified patients with suspected WNV infection causing viral encephalitis, viral meningitis or other illnesses consistent with WNV infection based on their clinical symptoms and patient histories. Preliminary blood tests were ordered which tested for antibodies to WNV, but may also detect other flaviviruses.

The main test used for front-line testing was the ELISA test (Enzyme-Linked Immunosorbent Assay). The HI test (Haemagglutination Inhibition) was also used in some cases. Confirmatory testing to ensure the virus was in fact WNV was done using the PRNT test (Plaque-Reduction Neutralization Test).

After the first five cases within a given Health Unit were confirmed by PRNT, all cases for that health unit that met the “probable” laboratory criteria were classified as “confirmed” cases. In 2003, all testing was conducted at the Ontario Central Public Health Laboratory in Toronto, rather than at Health Canada’s National Microbiology Laboratory in Winnipeg as in the previous year. This allowed for a very fast turn-around time for test results, often within 48 hours.

Once suspected cases were identified, they were immediately reported to public health officials for notification and follow-up. Peel Health staff investigated all possible,



probable and confirmed cases among residents in Peel. Standardized medical information including demographics, symptoms, risk factors (such as travel history or having received blood products), and test results were entered into an Access database. This was later linked to the person's address information in a geographic information system so that the incidence of the disease could be mapped by postal code area.

Results

As of December 2, 2003, there were 10 residents of Peel who had laboratory evidence of WNV infection stemming from the 2003 season, nine of whom were confirmed as having West Nile Fever (WNF) and one having a diagnosis of West Nile Neurological Manifestations (WNNM). There were no deaths due to WNV in 2003. Each of the 10 cases reported onset of symptoms having occurred in August or September. An additional 56 residents were assessed but either they had had a previous infection (49) or it was determined that they did not meet the case definition (7).

With the caveat that case definitions and laboratory testing methods differed between 2002 and 2003, these results are still much lower than the 112 residents with laboratory evidence of WNV identified in 2002, 37 of whom were "confirmed" and 20 were classified as "probable" cases. Onset of symptoms for the cases in 2002 also occurred predominantly in August or September of that year.

In 2003, all of the confirmed human cases of WNV disease in Peel were residents of Mississauga. There were no confirmed or probable cases among residents of Brampton or Caledon.

Numbers of WNV-confirmed and probable cases were mapped by Forward Sortation Area (FSA – the first three-digits of the postal code) and are depicted in Figure 16. As in 2002, more cases occurred in the southern parts of Mississauga. Postal code area L5G had two cases in 2003, and also posted the highest rate of WNV infection in humans in 2002 (35.1 cases per 100,000 population). The only other area with more than one human case was postal code area L5N in north-west Mississauga, with two cases.

The median age of confirmed human cases was 51.2 years (range 25 to 82 years), compared to 60.3 years (range: seven to 82 years) in 2002. As in 2002, there were slightly more females (6) than males (4) among the confirmed cases in Peel. Half of these cases (50%) were aged 40 to 59 years. In 2002, contrary to initial expectations, about half of the confirmed and probable cases of WNV occurred among the 50 to 69 year age groups as opposed to being limited to older adults or the infirmed.

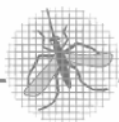
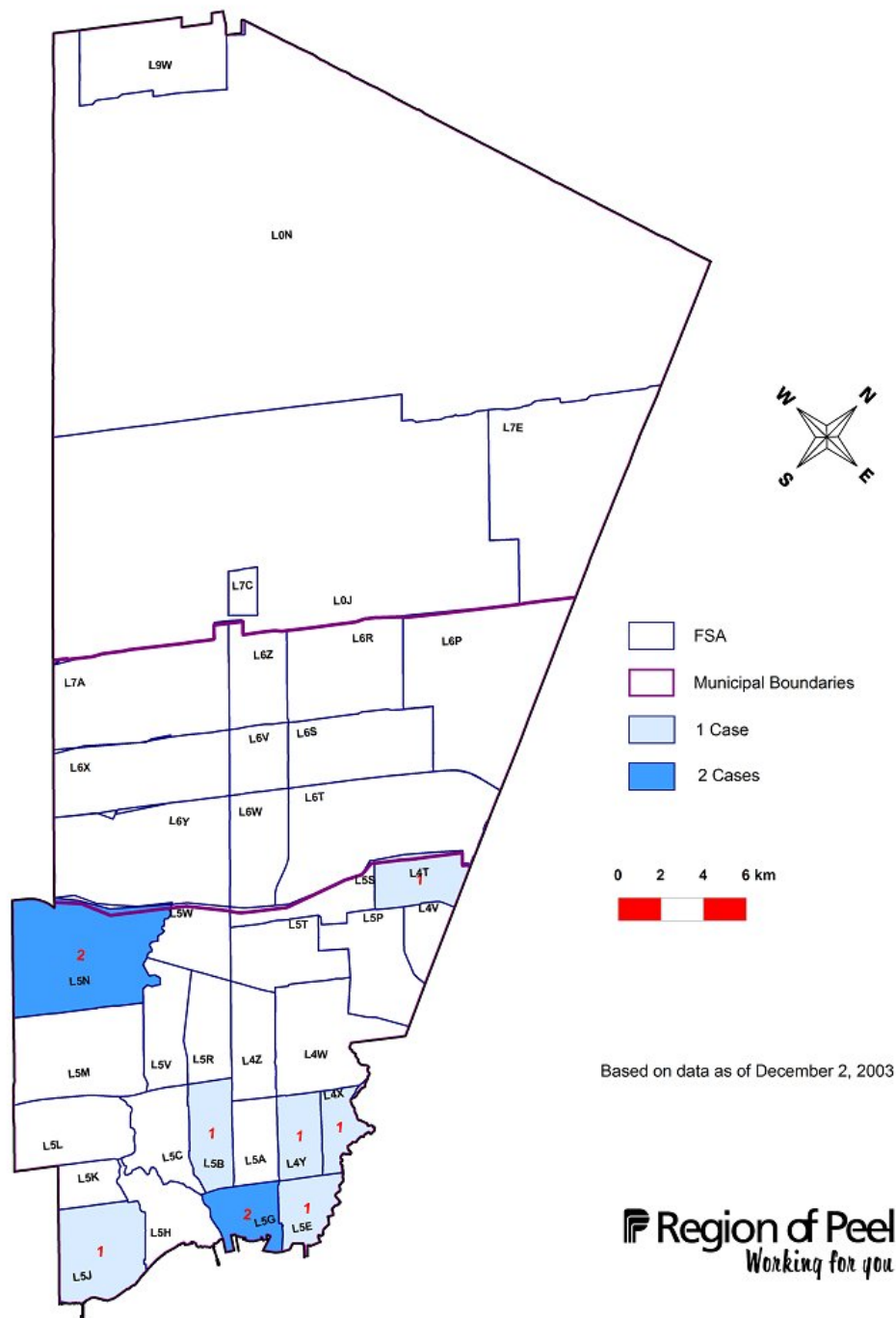
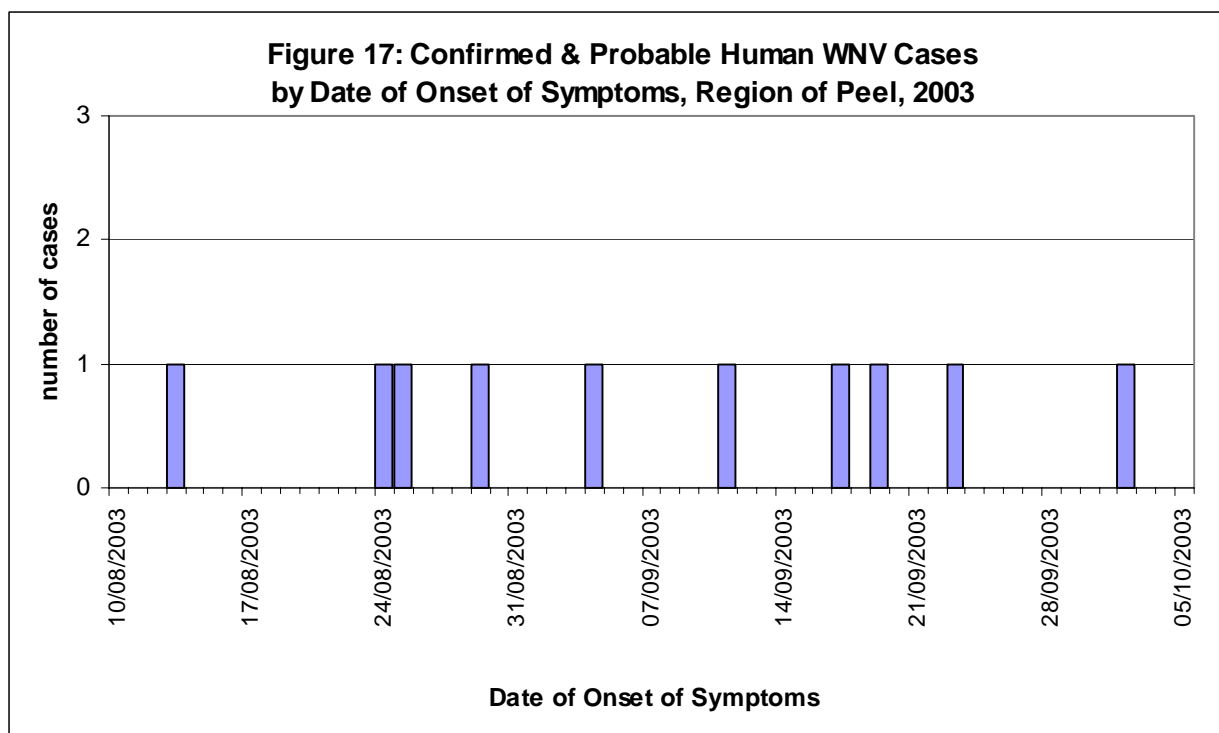


Figure 16: Number of Confirmed and Probable Human WNV Infections by Forward Sortation Area, Region of Peel, 2003





The first confirmed human case reported to Peel Health, a 51 year-old female from north Mississauga, had onset of symptoms on August 24, 2003; however, a later case had even earlier onset of symptoms, reported to have started on August 13. The latest date of onset of symptoms in a Peel human case was on October 2, 2003 (Figure 17).



Confirmed or probable WNV cases were asked if they had traveled or spent time outdoors in the three weeks prior to the onset of their symptoms. Only one person stated that they had traveled (to a cottage within Ontario); this individual was the only case to recall being bitten by a mosquito in the three weeks prior to the onset of symptoms. Two cases reported having spent time outdoors during the day, and one reported walking outdoors at dusk. No WNV cases in Peel had been recipients of blood products.

Symptoms of those with confirmed WNV infection are listed in Table 8. As in 2002, the most frequently reported symptoms were fever, headaches and fatigue. Other common symptoms included muscle pain, confusion or forgetfulness and sensitivity to light.

Four (40%) of the WNV human cases required hospitalization for their symptoms; all recovered and were released. Two stayed in hospital for 9 days, another for 16 days and the fourth for a total of 39 days, giving an average length of stay of 18.3 days.



Table 8: Confirmed and Probable Human WNV Cases by Reported Symptoms*, Region of Peel, 2003

Symptom	Confirmed & Probable	
	number	percent
Fever	8	80.0
Headache	8	80.0
Fatigue	8	80.0
Muscle pain	5	50.0
Confusion or forgetfulness	5	50.0
Eyes sensitive to light	5	50.0
Visual distortion	4	40.0
Muscle weakness	2	20.0
Rash	3	30.0
Enlarged glands	3	30.0
Stiff neck	3	30.0
Parkinsonism	2	20.0
Change in mental status	2	20.0
Vomiting	2	20.0
Nausea	2	20.0
Encephalitis	1	10.0
Chills	1	10.0
Joint Pain	1	10.0
Total	10	100.0

* More than one symptom is possible. Numbers do not sum to total.

In 2002, Halton Region to the west of Peel had 56 confirmed and three probable WNV cases for a total of 59, most of which occurred in the southern municipalities of Oakville and Burlington.³⁸ In 2003, Halton had no WNV cases reported in any of their area municipalities.³⁹

Meanwhile in Toronto to the east, there were 127 confirmed and 41 probable cases of WNV among their residents in 2002, but only 44 cases in 2003.³⁹ In all of Ontario in 2002, there were 307 confirmed cases of WNV, with an additional 83 probable cases; this number dropped to 89 confirmed cases in 2003 (Appendix F).

In 2003, the disease spread westward across Canada, causing a total of 1,220 confirmed and 115 probable human cases of WNV in Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia and the Yukon Territory; however, cases reported in Nova Scotia, New Brunswick, British Columbia and the Yukon were likely related to travel outside of that province or territory.⁵ The vast majority of these cases occurred in Manitoba (141), Saskatchewan (792) and Alberta (272).⁵ Ontario had 89 confirmed cases of WNV in 2003, British Columbia and the Yukon Territory combined for 21 human cases and only 20 cases occurred in all of



Quebec and the eastern provinces.⁵ This is similar to the western predominance of WNV in the United States in 2003.¹⁷

Summary

Human illness due to WNV acquired in Peel occurred for the first time in 2002, with 112 residents having laboratory evidence of WNV (55 suspect cases, 20 probable cases and 37 confirmed cases, including two deaths).

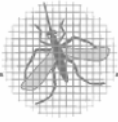
As of December 2, 2003, there were 10 residents of Peel who had laboratory evidence of WNV infection stemming from the 2003 season, nine of whom were confirmed as having West Nile Fever and one having a diagnosis of West Nile Neurological Manifestations. There were no deaths due to WNV in 2003. All of the 10 cases were residents of Mississauga. There were no confirmed or probable cases among residents of Brampton or Caledon. As in 2002, most cases occurred in the southern areas of Mississauga.

In 2003, half of the WNV confirmed cases in Peel were aged 40 to 59 years. This was similar to findings in 2002, where contrary to initial expectations, approximately half of the confirmed and probable cases of WNV occurred among the 50 to 69 year age groups as opposed to being limited to older adults or the infirmed.

As in 2002, the most frequently reported symptoms among the confirmed cases in 2003 were fever, headaches and fatigue. Other common symptoms included muscle pain, confusion or forgetfulness and sensitivity to light.

Identification of WNV in humans underscores the importance of active, hospital-based human surveillance programs starting in July through to September, as well as the need to consider WNV as a possible diagnosis when clinicians encounter patients with encephalitis, meningitis, AFP or non-specific fevers occurring throughout this time period.^{6,22}

Presently, there is no vaccine available for use in humans.¹⁰ A human vaccine against WNV is under development, with commercial availability some years away.



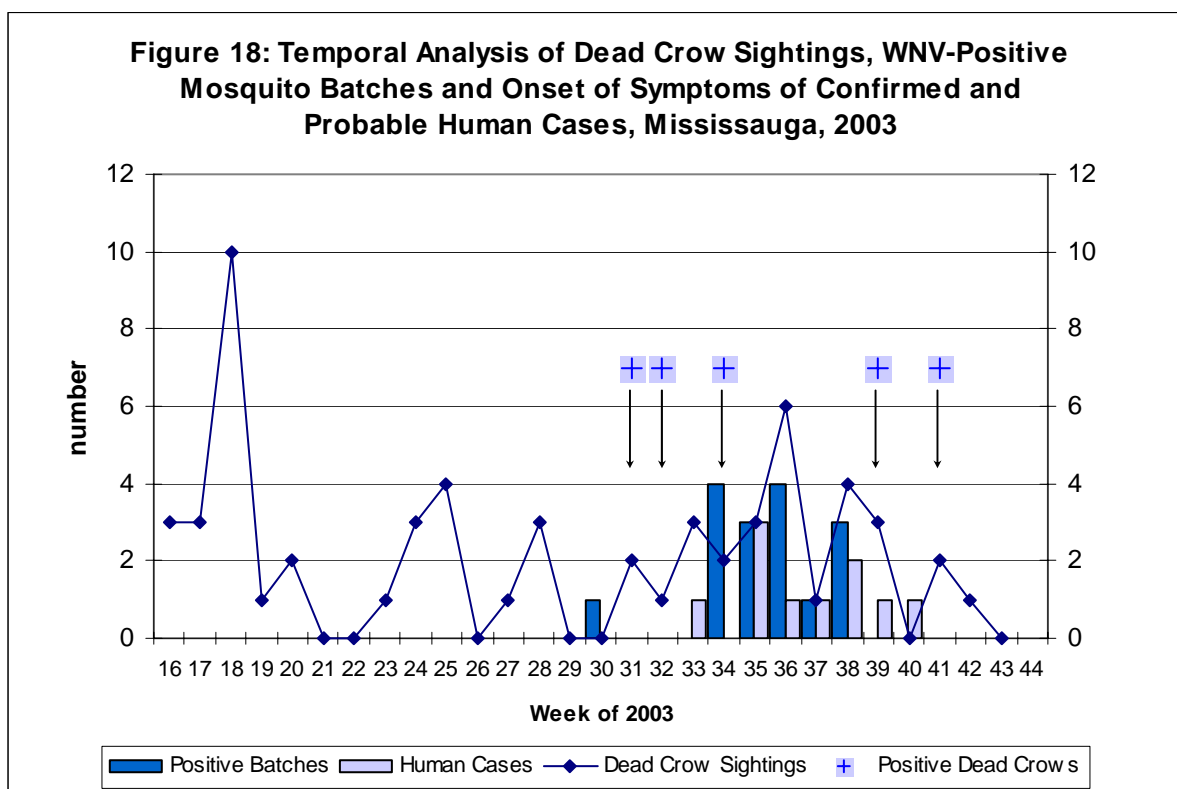
WEST NILE VIRUS IN THE REGION OF PEEL 2003



Comparison of the Timing of Dead Crow Sightings, Positive Mosquito Batches and Human Cases in Mississauga

It has been suggested that one of the key surveillance factors which serves as a predictor of potential human infection is the reporting of dead birds of the crow family.^{15,38} A U.S. study using data from 2001 and 2002 found that areas where a WNV-infected bird had been found early in the season were several times more likely to also report a human case than were areas that did not find infected birds early in the season.⁴⁰

Figure 18 shows dead crow sightings, crows positive for WNV, positive mosquito batches and onset of human WNV confirmed and probable cases by week in Mississauga. Dead crow sightings began to occur during week 16, the first WNV-positive mosquito batch was collected during Week 30, the first WNV-positive crow was collected in Week 31 and the first human case of WNV occurred during Week 33. The initial peak in dead crow sightings preceded the 'peak' of positive mosquito batches by approximately 16 weeks, but as suggested earlier, this increase may have been due to reasons other than WNV.





Cases of human illness are not always reported to Peel Health according to their date of onset of symptoms. The first report of a confirmed human case in Peel had a symptom onset date during Week 35. The second case to be reported had an earlier onset date during Week 33, which was three weeks after the first positive mosquito batch occurred in Mississauga. After a slow start to the WNV surveillance season, the first reports of human cases were preceded by an increase in the number of positive mosquito batches, with four occurring during Week 34, and two dead crow sightings reported in the same week.

The period of sustained and high rates of WNV infection in mosquitoes also coincided with human illness from WNV. The first WNV positive mosquito batch seemed to precede the first human cases by about three weeks, showing the value of this monitoring system.

There was no clear increase in dead crow sightings during this period of WNV infection in mosquitoes and humans. Given the impacts of WNV on the crow population, a large increase in dead crow sightings as observed in 2002 may not reoccur as the crow population has been substantially reduced. This means that the testing of crows for WNV throughout the season may be more important than before as an indicator of WNV activity in a given area.



OTHER ANIMAL SURVEILLANCE

Wild birds are the predominant host animal for WNV; however, the virus can also infect amphibians, domestic poultry, domestic mammals (especially horses), and apes and monkeys.¹⁰

A vaccine manufactured in the United States has been available in Canada since September 2001 to protect horses from disease caused by WNV. Initially allowed for use under an “emergency use permit system”, the vaccine was licensed and registered for use in Canada as of February 2003.⁴¹ Numbers of infected horses would be expected to decline in the future with increased use of this vaccine.

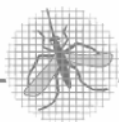
As part of the provincial West Nile Virus surveillance, led by the MOHLTC, the Ontario Ministry of Agriculture and Food works with the Canadian Food Inspection Agency (CFIA), Health Canada and private laboratories in the collection and presentation of Ontario equine case data.⁴²

In Canada, a total of 445 positive results were reported to the CFIA in 2003, as per the Immediately Notifiable Disease Regulations.⁴³ Many of the positive results reported to the CFIA are positive results to IgG detection only, with or without neurological clinical signs. In some cases, the information available to the CFIA does not mention whether the horses had clinical signs or not or if the animal had been vaccinated or not against WNV. They are reported and counted as “presumptive positives” on the Health Canada website, but some of these positive IgG results could probably be explained by vaccination or by a previous exposure.

The data must be interpreted with caution, since the total number of animals reported with at least one positive test does not necessarily represent the total number of “cases” of WNV.⁴³ In addition, as veterinarians feel more confident in their ability to diagnose WNV on clinical grounds, some horse owners may be reluctant to pay for WNV tests done on an already sick animal.

The first equine case of WNV in Peel occurred in the Inglewood area of Caledon on July 17, 2003.⁴² This is the first horse to have ever tested positive or presumptive positive for West Nile Virus in the Region. There were no other reports of WNV infection in animals such as horses, dogs or cats in the Region of Peel in 2003.

WNV activity was also reported among horses in other Ontario health units in 2003, including one confirmed positive horse in each of Durham, Eastern Ontario, Halton, Perth, and Windsor (Appendix G). In addition, there was one probable and one confirmed equine case of WNV in Windsor, and two confirmed cases in Niagara.⁴⁴ Peterborough County-City Health Unit also had one equine case that was either presumptive or confirmed positive for WNV.⁴³ As of January 12, 2004 in total there were



WEST NILE VIRUS IN THE REGION OF PEEL 2003

41 presumptive or confirmed positive horses in Ontario health units for the 2003 season, 31 for which the health unit was unknown.⁴³ This compares to 101 confirmed and six probable equine cases in 18 different health units in 2002.⁴⁵



CONCLUSION

WNV management programs are designed to reduce human risk of contracting the disease by limiting the amplification of the virus within the *Culex* mosquito population. This should limit the number of infected birds and thus the number of bridge vector mosquitoes that might become infected and pass the disease on to people.²⁷

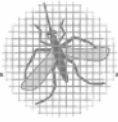
In Peel in 2003, the first indication of WNV activity was a WNV-infected dead bird found in Caledon on July 4th. The first human illness from WNV had an onset of symptoms on August 13th, approximately three weeks following the collection of the first WNV-positive batch of adult mosquitoes on July 24th.

Results from the 2003 mosquito season indicate that WNV activity, including cases of illness in people due to WNV, was substantially reduced compared to 2002. This may have been a function of several components to the WNV Prevention Plan:

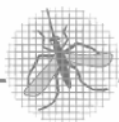
- the aggressive mosquito larvae reduction campaigns – treatments of catch basins and standing water likely resulted in lower numbers of adult *Culex* mosquitoes emerging from these types of breeding sites;
- improved public awareness of personal protective practices, including the use of insect repellent, long-sleeved clothing or avoidance of outdoor activities at times when mosquitoes are most active;
- the reduction of standing water in artificial containers located on private property, especially tires, planters, bird baths, children's wading pools and other areas where stagnant water can collect.

However, other natural factors may also have been at play, including temperature, rainfall levels, or a smaller host population in which WNV could amplify as a result of the decimation of the crow population and immunity in other birds in parts of Peel Region during the 2002 mosquito season. All of these variables may have had a role in reducing the amount of contact between infected mosquitoes and humans in 2003.

Analysis of the Region of Peel's complete surveillance results shows that the monitoring of this information has served as an "early warning system" for human illness from WNV. Detailed analysis of information on Peel mosquitoes shows that *Culex* mosquitoes play a key role in local transmission of WNV as reported for other similar areas in the North American literature. In Peel, in 2003, *Culex* mosquitoes continued to be numerous and were the predominant species having positive WNV testing results. Compared to 2002, the number of *Culex* mosquitoes was substantially decreased, possibly as a result of the larviciding program, although other factors such as weather and a decreased number of WNV-susceptible birds may have also played a role. It is appropriate that the Peel WNV Prevention Plan continue to focus control efforts on *Culex* mosquitoes.



WEST NILE VIRUS IN THE REGION OF PEEL 2003



LIMITATIONS

Data sources used in this report and limitations of the data are described below. When comparing results between years, results should be interpreted with caution where changes in methodologies have occurred.

REGION OF PEEL WNV SURVEILLANCE DATABASES

Bird Surveillance Database

Dead crow sightings are most likely to occur in areas that are populated by Peel residents. Consequently, more dead crow sightings would be expected to occur in urban areas of the region compared to rural areas. Thus fewer sightings in rural areas do not necessarily equate with lower risks of WNV infection to humans.

Dead crows were collected from April to October 2003. Only dead crows were tested for the presence of the WNV. Once it was established that WNV activity was present in crows in Peel, testing was discontinued for a period of time through the summer. Only a maximum of four dead crows per week were submitted to the CCWHC for WNV testing.

It is difficult to determine whether or not dead crow sightings were increased during the period of WNV infection in mosquitoes and humans during 2003. Given the impacts of WNV on the crow population, a large increase in dead crow sightings as observed in 2002 may not reoccur as the crow population has been substantially reduced. This means that the testing of crows for WNV throughout the season is more important than before as an indicator of WNV activity in a given area.

When comparing data between 2002 and 2003, results should be interpreted with caution where changes in methodologies have occurred.

Adult Mosquito Surveillance Database

In 2002, Brock University identified the number and species of all female mosquitoes collected. However, in 2003, 100 female mosquitoes were randomly chosen, separated into species, and then recounted. Peel Health estimated the number of mosquitoes by species by applying the proportions of female mosquitoes for each species in the sample of 100, to the total number of female mosquitoes collected, to give a “best estimate”. This was not ideal, as the process of sampling mosquitoes in 2003 resulted in fewer “stable” minimum infection rates (MIRs) that could be calculated based on 1,000 or more mosquitoes.



It was not possible to prove conclusively with the information at hand that the larval mosquito reduction program was responsible for the decline of *Culex* mosquitoes observed in 2003. Differences in temperature and rainfall could have produced a similar effect. The monitoring procedure itself was influenced by weather so that a trap may have caught fewer mosquitoes if weather conditions were unfavourable.

In addition, adult mosquito traps were not placed randomly across the Region, but rather were placed somewhat systematically at sites expected to yield larger numbers of mosquitoes in general, while maintaining the security and reliability of the traps (i.e. traps were placed in locations where tampering and vandalism could be avoided).

These results were also based on observational data, rather than having had “*a priori*” hypotheses and other rigid controls in place. Therefore, it was difficult to draw strong inferences about causality when using this information.

When comparing data between 2002 and 2003, results should be interpreted with caution where changes in methodologies occurred.

Larval Mosquito Surveillance Database

The larval surveillance data for 2003 were somewhat limited and need to be interpreted with caution. For example, the data do not show relative amounts of larvae or their persistence over time. A site with a few larvae on one occasion cannot be distinguished from a site with many larvae throughout the season.

Information on locations of standing water sites was collected from field staff by obtaining actual latitude and longitude measures using hand-held GPS devices. Hand-held GPS devices are accurate to three to five meters. In some instances, a standing water site that was on the border of the region may have been recorded by the GPS device as ‘outside of region’.

Other details addressing the conditions of the standing water sites were not well documented in the database.

When comparing data between 2002 and 2003, results should be interpreted with caution where changes in methodologies have occurred.



Human Case Surveillance Database

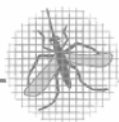
When comparing results between years, results should be interpreted with caution since the case definitions and laboratory testing methods changed between the 2002 and 2003 WNV seasons.

LARVAL MOSQUITO CONTROL AND ENVIRONMENTAL MONITORING

Caution must be taken when interpreting results of the Methoprene efficacy and residual study due to small sample sizes and limitations encountered during the course of the study. Some of these limitations include the lack of a recognized protocol, changes in testing methodology over the course of the year, variations in levels of organic matter and water within the catch basins, incomplete recording of treatment dates or conditions of catch basins in some studies, and other factors such as human activities or weather conditions that may have affected the efficacy of the larvicide.²³

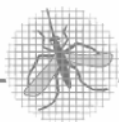


WEST NILE VIRUS IN THE REGION OF PEEL 2003

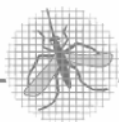


REFERENCES

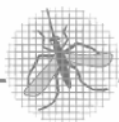
1. Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report. *Laboratory-Acquired West Nile Virus Infections – United States, 2002*. December 20, 2002;51 (50):1133-1135. [cited 2004 Feb 4]:[1 screen]. Available from URL: <http://www.cdc.gov/mmwr/pdf/wk/mm5150.pdf>
2. Leighton F. *West Nile Virus in Canada 2003*. [cited 2004 Feb 4]:[1 screen]. Available from URL: <http://wildlife.usask.ca/bookhtml/arbovirus/arbown.htm>
3. Health Canada. *West Nile Virus: General Information*. 2003 June 13. [cited 2004 Feb 5]:[1 screen]. Available from URL: <http://www.hc-sc.gc.ca/english/westnile/general.html>
4. Health Canada. *West Nile Virus Canada. Results of 2002 Surveillance Program, Human Test Results by Health Unit/Region*. 2003 November 19. [cited 2004 Feb 26]:[1 screen]. Available from URL: http://www.hc-sc.gc.ca/pphb-dgsp/wnv-vwn/pdf_sr-rs/2003/situation_report_111903_hm.pdf
5. Health Canada. *West Nile Virus Canada. Human Surveillance: Results of 2003 Program, Human Test Results by Province*. 2004 January 12. [cited 2004 Feb 26]:[1 screen]. Available from URL: http://www.hc-sc.gc.ca/pphb-dgsp/wnv-vwn/pdf_sr-rs/2004/surveillance_table_011204_hm.pdf
6. Region of Peel. *Region of Peel West Nile Virus Prevention & Control Plan 2003*. February 2003.
7. Weiss R. *Ecological Impact of West Nile Virus*. The Washington Post. 2002 December 28. [cited 2004 Mar 1]:[1 screen]. Available from URL: <http://environmentalrisk.cornell.edu/WNV/WNV-LArchive/1-3-03.html>
8. Centers for Disease Control and Prevention, Division of Vector-Borne Infectious Diseases. *West Nile Virus – Vertebrate Ecology*. 2003 July 2. [cited 2004 Feb 5]:[1 screen]. Available from URL: <http://www.cdc.gov/ncidod/dvbid/westnile/birdspecies.htm>
9. US Geological Survey, National Wildlife Health Center. *Species Found Positive for WNV in Surveillance Efforts*. 2003 April 9. [cited 2004 Feb 5]:[1 screen]. Available from URL: http://www.nwhc.usgs.gov/research/west_nile/wnvaffected.html
10. Canadian Cooperative Wildlife Health Centre. *What is West Nile Virus?* [cited 2004 Feb 5]:[1 screen]. Available from URL: http://wildlife1.usask.ca/ccwhc2003/west_nile_virus/about_wnv.php?&width=1024&height=768
11. Health Canada. *West Nile Virus Canada. Dead Bird Surveillance Results of 2003 Program, Dead Bird Test Results by Province. Update as of: 12 January 2004*. [cited 2004 Feb 4]:[1 screen]. Available from URL: http://www.hc-sc.gc.ca/pphb-dgsp/wnv-vwn/pdf_sr-rs/2004/surveillance_table_011204_db.pdf



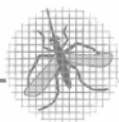
12. Ontario Ministry of Health and Long-Term Care. *Public Information: West Nile Virus 2003 - Birds*. 2003 December. [cited 2004 Feb 4]:[1 screen]. Available from URL: http://www.health.gov.on.ca/english/providers/program/pubhealth/westnile/wnv_03/wnv_birds.html
13. Health Canada. *Dead Birds Submitted for West Nile Virus Diagnosis by Health Region, Canada as of November 21, 2003*. [cited 2004 Feb 5]: [2 screens]. Available from URL: http://www.hc-sc.gc.ca/pphb-dgspsp/wnv-vwn/mon_maps_e.html
14. Yaremych S, Warner R, Mankin P, et al. *West Nile Virus and High Death Rate in American Crows*. *Emerging Infectious Diseases*. 2004 April;10 (4) [Ahead of print]. [cited 2004 Mar 9]: [1 screen]. Available from URL: <http://www.cdc.gov/ncidod/EID/vol10no4/03-0499.htm>
15. Canadian Cooperative Wildlife Health Centre. *West Nile Virus Surveillance Program 2003: Looking For West Nile Virus in Dead Corvids*. [cited 2004 Feb 5]:[1 screen]. Available from URL: http://wildlife1.usask.ca/ccwhc2003/west_nile_virus/wnv_home.php?&width=1024&height=768
16. Ontario Ministry of Health and Long-Term Care. *West Nile Virus Control Plan, Appendix III: Mosquitoes of Southern Ontario*. 2003 May 27. [cited 2004 Feb 10]:[1 screen]. Available from URL: http://www.health.gov.on.ca/english/public/pub/ministry_reports/wnv_plan_2003/app_3.pdf
17. Centers for Disease Control and Prevention, Division of Vector-Borne Infectious Diseases. *Summary of West Nile Virus Activity in the United States, 2003*. Presented at the Fifth National Conference on West Nile Virus in the United States, Denver, Colorado, February 3-5, 2004. [cited 2004 Mar 11]:[1 screen]. Available from URL: http://www.cdc.gov/ncidod/dvbid/westnile/conf/pdf/Hayes_1_04.pdf
18. Hunter F, Bidochka M. *Adult Mosquito Surveillance 2003*. Presented at the End of Season West Nile Virus Workshop, Delta Chelsea Hotel, Toronto, Ontario, December 3, 2003.
19. Nasci R, White D, Stirling H et al. *West Nile Virus Isolates from Mosquitoes in New York and New Jersey, 1999*. *Emerging Infectious Diseases* [serial online: 2001 July-August]. [cited 2004 Feb 10]:[1 screen]. Available from URL: <http://www.cdc.gov/ncidod/eid/vol7no4/nasci.htm>
20. Hunter F. Department of Biological Services, Brock University: personal communication, August 7, 2003.



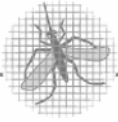
21. Ontario Ministry of Health and Long-Term Care. *Public Information: West Nile Virus 2003-Mosquitoes*. 2003 December. [cited 2004 Feb 4]:[1 screen]. Available from URL: http://www.health.gov.on.ca/english/providers/program/pubhealth/westnile/wnv_03/wnv_mosquitoes.html
22. Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report. *Provisional Surveillance Summary of the West Nile Virus Epidemic – United States, January-November 2002*. December 20, 2002:51 (50):1129-1133. [cited 2004 Feb 4]:[1 screen]. Available from URL: <http://www.cdc.gov/mmwr/pdf/wk/mm5150.pdf>
23. Region of Peel. *Region of Peel Methoprene Efficacy Study 2003*. (Unpublished report). February 2004.
24. Pestalto Environmental Products Inc. *Methoprene Efficacy Trials – Southern Ontario Results – (First Draft)*. October 2003.
25. Ontario Ministry of Natural Resources. *MNR Fact Sheet: Sensitive Areas and Species Protocol*. Presented at the End of Season West Nile Virus Workshop, Delta Chelsea Hotel, Toronto, Ontario, December 3, 2003.
26. Federation of BC Naturalists. *West Nile Virus, Healthy Wetlands and Natural Predators*. 2003 May. [cited 2004 Mar 1]:[1 screen]. Available from URL: <http://www.naturalists.bc.ca/news/documents/West%20Nile%20Virus%20-%20FBCN%20Brief.htm>
27. Pestalto Environmental Products Inc. *Mosquito Abatement Program for Vector Reduction of West Nile Virus: Final Report for the Regional Municipality of Peel Public Health Department*. November 2003.
28. Baker S, Hayton A, Ontario Ministry of the Environment. *West Nile Virus Environmental Monitoring Program – Catch Basin Efficacy Study*. Presented at the End of Season West Nile Virus Workshop, Delta Chelsea Hotel, Toronto, Ontario, December 3, 2003.
29. Ontario Ministry of the Environment. *2003 West Nile Virus Summary of Monitoring and Surveillance Program*. Presented at the End of Season West Nile Virus Workshop, Delta Chelsea Hotel, Toronto, Ontario, December 3, 2003.
30. Centers for Disease Control and Prevention. *West Nile Virus (WNV) Infection – Information for Clinicians*. 2002 August 20. [cited 2004 Feb 18]:[1 screen]. Available from URL: http://www.cdc.gov/ncidod/dvbid/westnile/resources/fact_sheet_clinician_082102_0802.pdf



31. Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report. *Update: investigations of West Nile Virus infections in recipients of organ transplantation and blood transfusion – Michigan, 2002*. October 4, 2002:51 (39):879. [cited 2004 Feb 18]:[1 screen]. Available from URL: <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5139a2.htm>
32. Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report. *Possible West Nile Virus Transmission to an Infant through Breastfeeding – Michigan, 2002*. October 4, 2002:51 (39):877-878. [cited 2004 Feb 18]:[1 screen]. Available from URL: <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5139a1.htm>
33. Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report. *Intrauterine West Nile Virus Infection – New York, 2002*. December 20, 2002:51 (50):1135-1136. [cited 2004 Feb 4]:[1 screen]. Available from URL: <http://www.cdc.gov/mmwr/pdf/wk/mm5150.pdf>
34. Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report. *Acute Flaccid Paralysis Syndrome Associated with West Nile Virus Infection – Mississippi and Louisiana, July – August 2002*. September 20, 2002:51 (37):825-828. [cited 2003 Apr 30]:[5 screens]. Available from URL: <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5137a1.htm>
35. Sejvar J. *Emerging clinical syndromes of West Nile Virus Infection*. Presentation at the Fourth National Conference on West Nile Virus in the United States, New Orleans, Louisiana, February 9-11, 2003. Available from URL: http://www.cdc.gov/ncidod/dvbid/westnile/conf/pdf/Sejvar_4th03.pdf
36. Canadian Blood Services. *West Nile Virus (WNV): Update*. 2004 February [cited 2004 Feb 26]:[1 screen]. Available from URL: http://www.bloodservices.ca/centreapps/internet/uw_v502_mainengine.nsf/web/87E5F16FC7398A4385256C53004D32DC?OpenDocument
37. Ontario Ministry of Health and Long-Term Care. *West Nile Virus Control Plan, Appendix VI: Surveillance for West Nile virus (WNV) Illness*. May 27, 2003. [cited 2004 Feb 10]:[1 screen]. Available from URL: http://www.health.gov.on.ca/english/public/pub/ministry_reports/wnv_plan_2003/app_6.pdf
38. Halton Region Health Department. *West Nile Virus Vector Control Program*. February 2003. Available at URL: http://www.region.halton.on.ca/health/programs/infectionctrl/Infectioncontrol_PDFs/WNV/MO-09-03_WNV.pdf
39. Ontario Ministry of Health and Long-Term Care. *Public Information: West Nile Virus 2003 - Humans*. 2003 November. [cited 2004 Feb 2]:[1 screen]. Available from URL: http://www.health.gov.on.ca/english/providers/program/pubhealth/westnile/wnv_03/wnv_humans.html



40. Guptill S, Julian K, Campbell G, Price S, Marfin A. *Early-Season Avian Deaths from West Nile Virus as Warnings of Human Infection*. *Emerging Infectious Diseases*. 2003 April;9 (4):483-484. 2003 April [cited 2004 Feb 18]: [1 screen]. Available from URL: <http://www.cdc.gov/ncidod/EID/vol9no4/pdfs/02-0421.pdf>
41. Hutchings D. Senior Veterinary Biologics Evaluator, Canadian Food Inspection Agency: personal communication, June 23, 2003.
42. Ontario Ministry of Agriculture and Food. *West Nile Virus Equine Surveillance 2003*. 2003 August 7. [cited 2004 Feb 18]:[1 screen]. Available from URL: http://www.gov.on.ca/OMAFRA/english/livestock/horses/facts/wnv_surveillance.htm
43. Health Canada. *West Nile Virus Canada. Horse Surveillance: Results of 2003 Program, Horse Test Results by Health Unit/Health Region/First Nations Community*. 2004 January 12. [cited 2004 Feb 26]:[1 screen]. Available from URL: http://www.hc-sc.gc.ca/pphb-dgsp/wnv-vwn/pdf_sr-rs/2004/surveillance_table_011204_hr.pdf
44. Ontario Ministry of Health and Long-Term Care. *Public Information: West Nile Virus 2003 - Horses*. 2003 November 13. [cited 2004 Feb 4]:[1 screen]. Available from URL: http://www.health.gov.on.ca/english/providers/program/pubhealth/westnile/wnv_03/wnv_horses.html
45. Ontario Ministry of Health and Long-Term Care. *Public Information: West Nile Virus: 2002 Archive - Horses*. 2003 October 22. [cited 2004 Feb 18]:[1 screen]. Available from URL: http://www.health.gov.on.ca/english/providers/program/pubhealth/westnile/wnv_02/wnv_horses.html
46. Sykes, J.B. (editor). *The Concise Oxford Dictionary of Current English*. 6th ed. Oxford University Press, Walton Street, Oxford; 1976.
47. Petersen L, Marfin A. *West Nile Virus: A Primer for the Clinician*. *Annals of Internal Medicine*. 2002 August 6:137 (3): E173-E179. [cited 2004 Feb 18]: [1 screen]. Available from URL: <http://www.annals.org/cgi/reprint/137/3/173.pdf>
48. Ontario Ministry of Health and Long-Term Care. *West Nile Virus Control Plan, Appendix VII: Ontario Regulation 199/03, Health Protection and Promotion Act*. 2003 May 27. [cited 2004 Feb 10]:[1 screen]. Available from URL: http://www.health.gov.on.ca/english/public/pub/ministry_reports/wnv_plan_2003/app_7.pdf
49. Beatty H. Manager, Environmental Health Division, Region of Peel Health Department: personal communication, March 1, 2004.



WEST NILE VIRUS IN THE REGION OF PEEL 2003



APPENDICES

Appendix A

WEST NILE VIRUS WEEK CODES FOR 2003

*** Week includes dates from
Sunday to Saturday**

Week Number	Dates Included
16	April 13 – April 19
17	April 20 – April 26
18	April 27 – May 3
19	May 4 – May 10
20	May 10 – May 17
21	May 18 – May 24
22	May 25 – May 31
23	June 1 – June 7
24	June 8 – June 14
25	June 15 – June 21
26	June 22 – June 28
27	June 29 – July 5
28	July 6 – July 12
29	July 13 – July 19
30	July 20 – July 26
31	July 27 – August 2
32	August 3 – August 9
33	August 10 – August 16
34	August 17 – August 23
35	August 24 – August 30
36	August 31 – September 6
37	September 8 – September 13
38	September 14 – September 20
39	September 21 – September 27
40	September 28 - October 4
41	October 5 – October 11
42	October 12 – October 18
43	October 19 – October 25
44	October 26 – November 1



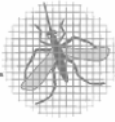
Appendix B
Dead Bird Surveillance for West Nile Virus by Health Unit, Ontario, 2003

Region	First Positive Bird Found	Latest Positive Bird Found	Total (Confirmed/Presumed Confirmed)
Algoma	July 12, 2003	September 3, 2003	4
Brant	July 17, 2003	September 2, 2003	6
Chatham–Kent	August 12, 2003	October 22, 2003	7
Durham	June 3, 2003	August 14, 2003	6
Eastern Ontario	July 29, 2003	August 26, 2003	4
Elgin – St. Thomas	August 12, 2003	September 5, 2003	4
Grey Bruce	July 8, 2003	September 11, 2003	4
Haldimand–Norfolk	May 30, 2003	August 27, 2003	9
Haliburton–Kawartha	July 21, 2003	August 20, 2003	5
Halton Region	July 19, 2003	September 23, 2003	15
Hamilton	May 13, 2003	August 20, 2003	7
Hastings	July 16, 2003	August 11, 2003	6
Huron	July 5, 2003	August 26, 2003	2
Kingston–Frontenac	August 7, 2003	August 25, 2003	4
Lambton	August 12, 2003	August 16, 2003	7
Leeds–Grenville	July 14, 2003	September 4, 2003	4
Middlesex–London	July 2, 2003	September 2, 2003	4
Muskoka–Parry Sound	July 16, 2003	August 19, 2003	8
Niagara	August 5, 2003	August 20, 2003	6
North Bay	July 15, 2003	July 29, 2003	3
Northwestern	July 25, 2003	September 12, 2003	11
Ottawa	May 21, 2003	August 17, 2003	10
Oxford County	May 23, 2003	August 18, 2003	5
Peel Region	July 4, 2003	September 27, 2003	12
Perth District	July 18, 2003	August 19, 2003	5
Peterborough	June 27, 2003	August 25, 2003	6
Renfrew	July 10, 2003	August 10, 2003	6
Simcoe County	June 12, 2003	July 29, 2003	11
Sudbury	August 13, 2003	August 27, 2003	4
Thunder Bay	July 20, 2003	July 29, 2003	2
Timiskaming	June 7, 2003	August 31, 2003	3
Toronto	July 16, 2003	October 22, 2003	17
Waterloo	July 23, 2003	September 9, 2003	5
Wellington–Dufferin	June 24, 2003	September 29, 2003	10
Windsor–Essex	August 7, 2003	September 18, 2003	11
York Region	April 15, 2003	September 25, 2003	9
Ontario Total			242

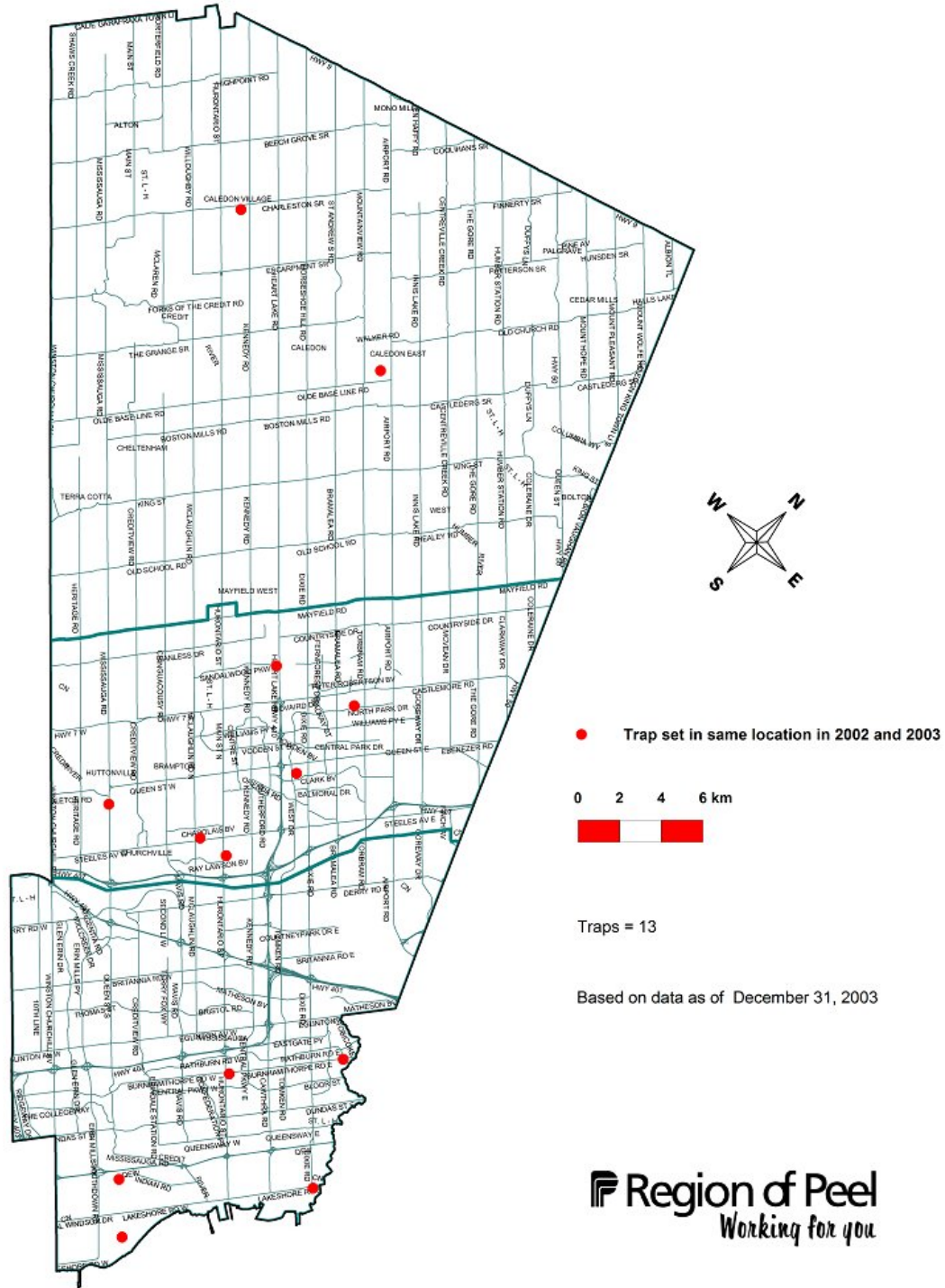
Data as of December 16, 2003.

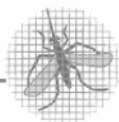
Source: Ontario Ministry of Health and Long-Term Care. Available from URL:

http://www.health.gov.on.ca/english/providers/program/pubhealth/westnile/wnv_03/wnv_birds.html



Appendix C: Location of Common Mosquito Traps Region of Peel, 2002 and 2003





Appendix D

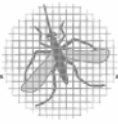
Adult Mosquito Surveillance for West Nile Virus by Health Unit, Ontario, 2003

Region	First Positive Batch Found	Last Positive Batch Found	Total Positive Batches
Brant	August 26, 2003	August 26, 2003	1
Durham	August 8, 2003	August 14, 2003	2
Haldimand - Norfolk	July 8, 2003	July 8, 2003	1
Haliburton - Kawartha	August 12, 2003	August 25, 2003	2
Halton	July 24, 2003	September 10, 2003	19
Hamilton	September 3, 2003	September 16, 2003	2
Middlesex - London	August 13, 2003	August 20, 2003	2
Niagara *	September 3, 2003	September 4, 2003	8
Ottawa	August 12, 2003	August 29, 2003	3
Oxford	August 13, 2003	August 13, 2003	1
Peel	July 24, 2003	September 23, 2003	24
Porcupine	August 26, 2003	August 26, 2003	1
Toronto	August 12, 2003	October 21, 2003	56
Waterloo	August 29, 2003	August 29, 2003	1
Wellington - Dufferin	August 12, 2003	August 12, 2003	1
Windsor	August 19, 2003	September 16, 2003	5
York Region	July 30, 2003	September 18, 2003	6
ONTARIO TOTAL			135

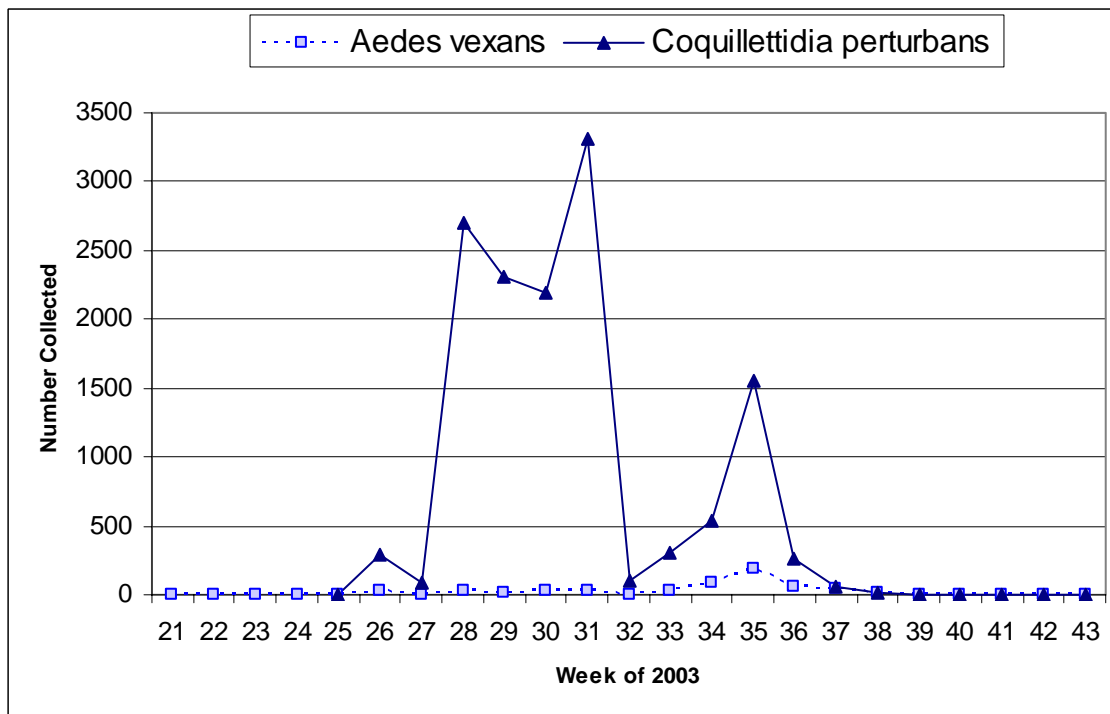
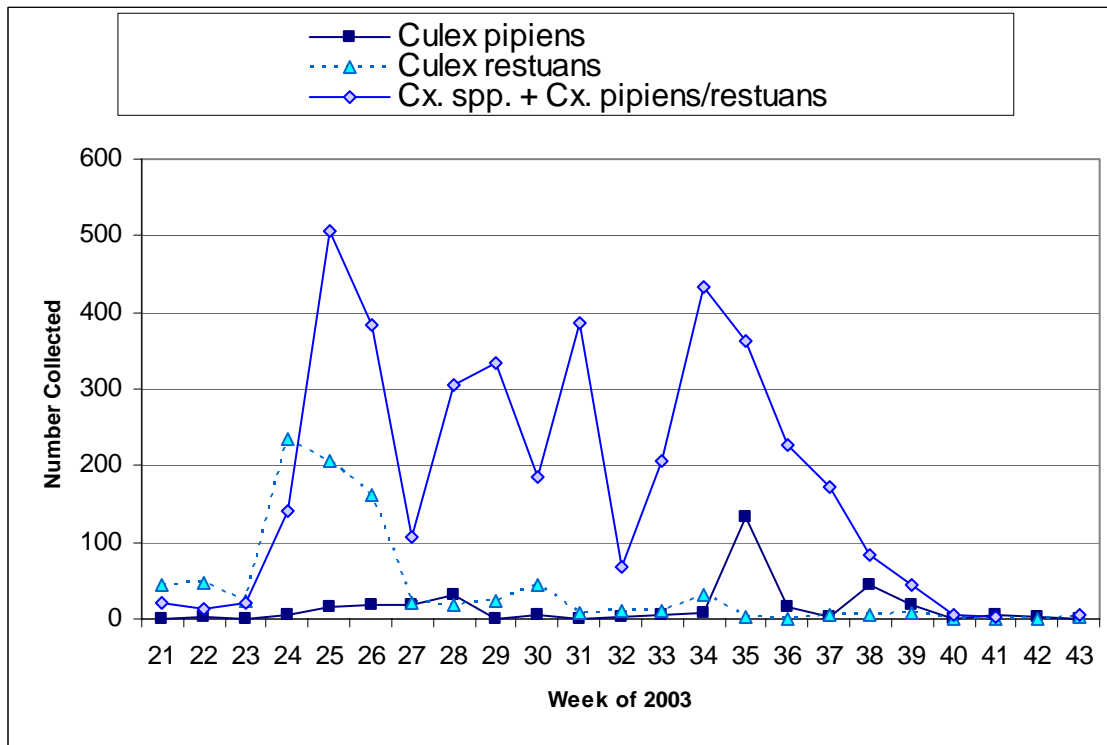
Data as of December 2, 2003.

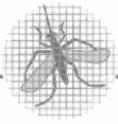
Source: Ontario Ministry of Health and Long-Term Care. Available from URL:

http://www.health.gov.on.ca/english/providers/program/pubhealth/westnile/wnv_03/wnv_mosquitoes.html

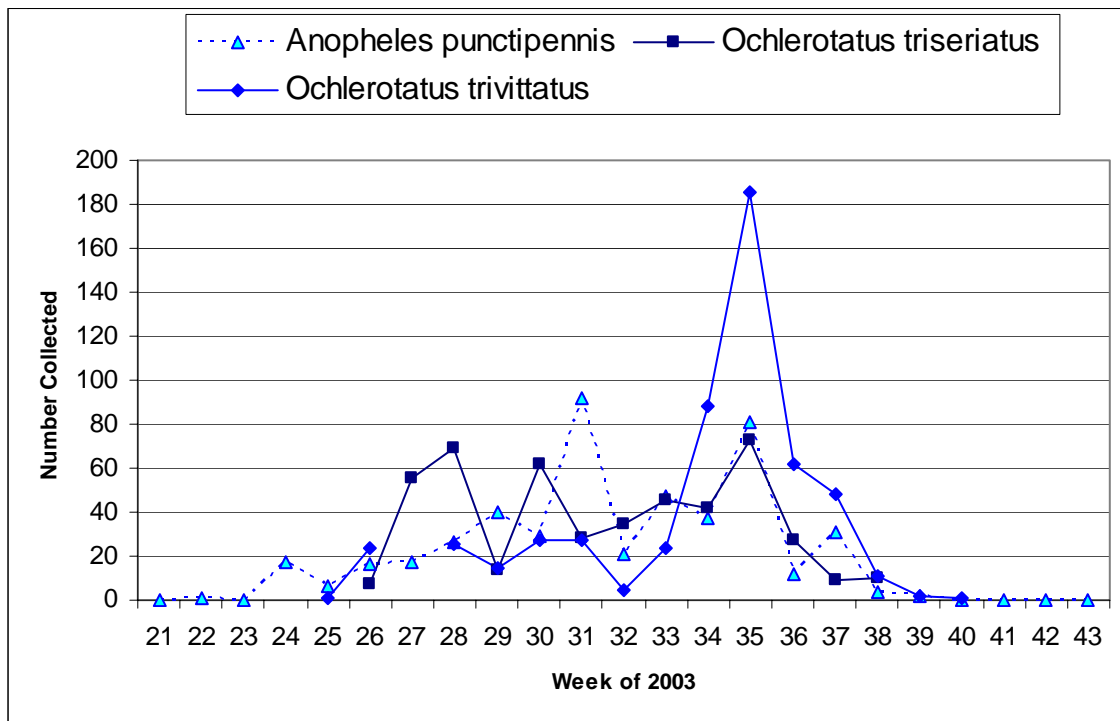


Appendix E Mosquito Activity among WNV-Positive Species, Region of Peel, 2003





WEST NILE VIRUS IN THE REGION OF PEEL 2003





Appendix F

Human Case Surveillance for West Nile Virus by Health Unit, Ontario, 2003

Region	Total Cases
Brant	2
Chatham-Kent	1
Haliburton-Kawartha-Pine Ridge	1
Hamilton-Wentworth	4
Kingston	1
Middlesex-London	1
Niagara	5
Ottawa	4
Peel	10
Peterborough	1
Renfrew	1
Simcoe	1
Toronto	44
Waterloo	1
Windsor-Essex	10
York Region	2
ONTARIO TOTAL	89

Data as of November 4, 2003.

Source: Ontario Ministry of Health and Long-Term Care. Available from URL:

http://www.health.gov.on.ca/english/providers/program/pubhealth/westnile/wnv_03/wnv_humans.html



Appendix G

Horse Surveillance for West Nile Virus by Health Unit, Ontario, 2003

Health Unit	No. of presumptive* or confirmed positive horses†
Durham	1
Eastern Ontario	1
Halton	1
Niagara	2
Peel	1
Perth	1
Peterborough	1
Unknown	31
Windsor	2
Ontario	41

* Requires additional testing before it can be considered a confirmed result

† In addition to provincial/territorial sources, data is provided by the Canadian Food Inspection Agency.

Data as of January 12, 2004

Source: Health Canada / Canadian Food Inspection Agency

Available from URL: http://www.hc-sc.gc.ca/pphb-dgspsp/wnv-vwn/pdf_sr-rs/2004/surveillance_table_011204_hr.pdf



Appendix H Definition of Terms

Ataxia: difficulty coordinating movement or body functions ⁴⁶

Encephalitis: inflammation of the brain ⁴⁶

Flavivirus: the genus in which the WNV is classified. WNV is a single-stranded RNA virus of the family *Flaviviridae* ⁴⁷

Host: an animal or plant having received a parasite which then resides within the animal or plant ⁴⁶

Hot Spot: in WNV programs, a collection of two or more local positive findings among dead birds, mosquito pools or mammals, as opposed to an isolated finding ⁴⁸

Malaise: bodily discomfort, especially without development of a specific disease ⁴⁶

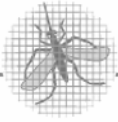
Meningitis: inflammation of the lining of the brain or spinal cord ⁴⁶

Myalgia: muscle soreness or pain ⁴⁶

Neuropathogen: an agent which causes disease of the nervous system ⁴⁶

Sighting: a report of a dead crow received from the public with species being confirmed by animal control authorities at time of carcass pick-up ⁴⁹

Vector: carrier of disease or infection from one organism to another ⁴⁶



WEST NILE VIRUS IN THE REGION OF PEEL 2003
