West Nile Virus in the City of Toronto, 2004

A Summary of the Toronto Public Health West Nile Virus Program for 2004

March 15, 2005

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Overview

West Nile virus (WNV) belongs to a family of viruses called Flaviviridae. The virus was first isolated in 1937 in the West Nile district of Uganda. Since then, there have been outbreaks in Egypt, Israel, South Africa, and in parts of Europe, Asia and North America. The first recorded outbreak in North America happened in New York City in 1999.[1]

The evidence shows that most people infected with WNV got it from the bite of an infected mosquito. A mosquito becomes infected when it feeds on the blood of a bird that is infected with the virus. The mosquito then becomes capable of passing the virus to people and animals by biting them. The risk of becoming infected is during mosquito season. In Canada, this can start as early as mid-April and last until the first hard frost in late September or October. It is estimated that less than one percent of mosquitoes in any given area are infected with WNV and overall risk of being bitten by an infected mosquito is low.[1] Although it is possible to be bitten by infected mosquitoes whenever WNV is active, to date most human infections in Toronto have occurred during August and September, when infection rates in mosquitoes have reached their peak.

The first reports of WNV activity in Canada came in August 2001, when the virus was found in dead birds and mosquito pools in southern Ontario and Quebec. The City of Toronto had its first confirmed human cases in 2002 when 163 people became ill after being infected with WNV (Table 1-1). Since then, the number of cases and the number deaths from WNV has decreased in Toronto and Ontario. However, in Canada (as a whole) and USA, the number of cases increased from 2002 to 2003 before decreasing in 2004.

Table 1-1: Number of WNV Human Cases in Toronto from 2002-2004

	Toronto		Ontario[2]		Canada[3]		USA[4]	
	Cases	**Deaths**	**Cases**	**Deaths**	**Cases**	**Deaths**	**Cases**	**Deaths**
2002	163	11**	405	18**	426	20**	4156	284
2003	44	0	89	2**	1335	10**	9862	264
2004	6	0	14	0	26	0	2470	81

**People with evidence of WNV infection who died; WNV was not necessarily the cause of death.

In 2004, there were six human cases, eighteen positive birds, and thirty-three positive mosquito pools.[5] Figures 1-1 and 1-2 show the locations of positive humans, birds, and mosquito traps in 2004 and 2003 respectively. There was a concentration of human cases in the West and South regions[6] and a concentration of positive mosquito pools in the West region in 2004. In 2003, there was also a concentration of human cases in the West region; however there were also a high number of positive mosquito pools in the North, West, and South regions (Figure 1-2).

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[1] Public Health Agency of Canada: http://www.phac-aspc.gc.ca/wnv-vwn. Accessed February 20, 2005.
[2] Ministry of Health and Long-term Care of Ontario: http://www.health.gov.on.ca/english/public/program/pubhealth/westnile/wnv_mn.html. Accessed October 30, 2004
[3] Health Canada: http://www.hc-sc.gc.ca/english/westnile/surveillance.html#3. Accessed October 15, 2004
[4] US Center for Disease Control and Prevention: http://www.cdc.gov/ncidod/dvbid/westnile/surv&control.htm. Accessed February 20, 2005.
[5] Trapped adult mosquitoes were grouped by trap and species into pools with a maximum of 50 mosquitoes per pool for WNV testing. When there were more than 50 mosquitoes from the same trap-night and species, additional pool(s) were created.
[6] TPH regions correspond to former city municipalities: North = North York; South = Toronto; East = East York, Scarborough, West = Etobicoke, York

Figure 1-1: West Nile Virus Positive Crows, Blue Jays, Mosquito Traps, and Human Cases in Toronto, 2004

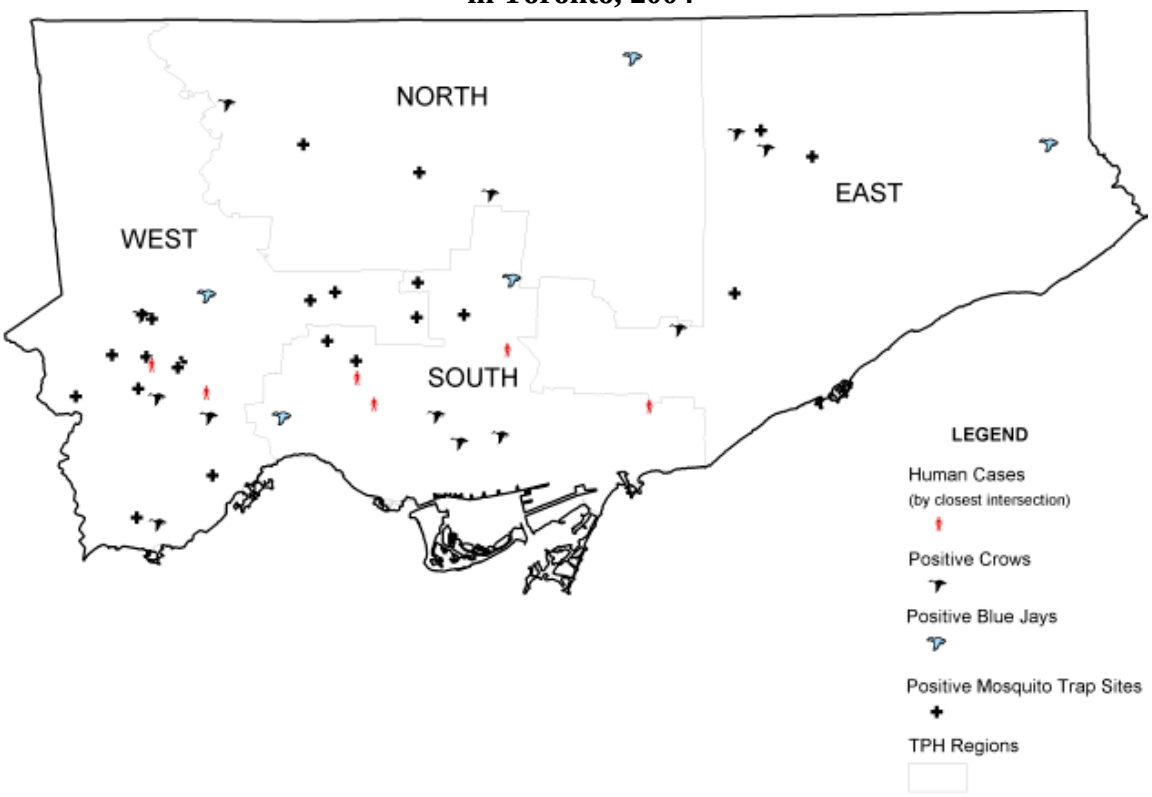
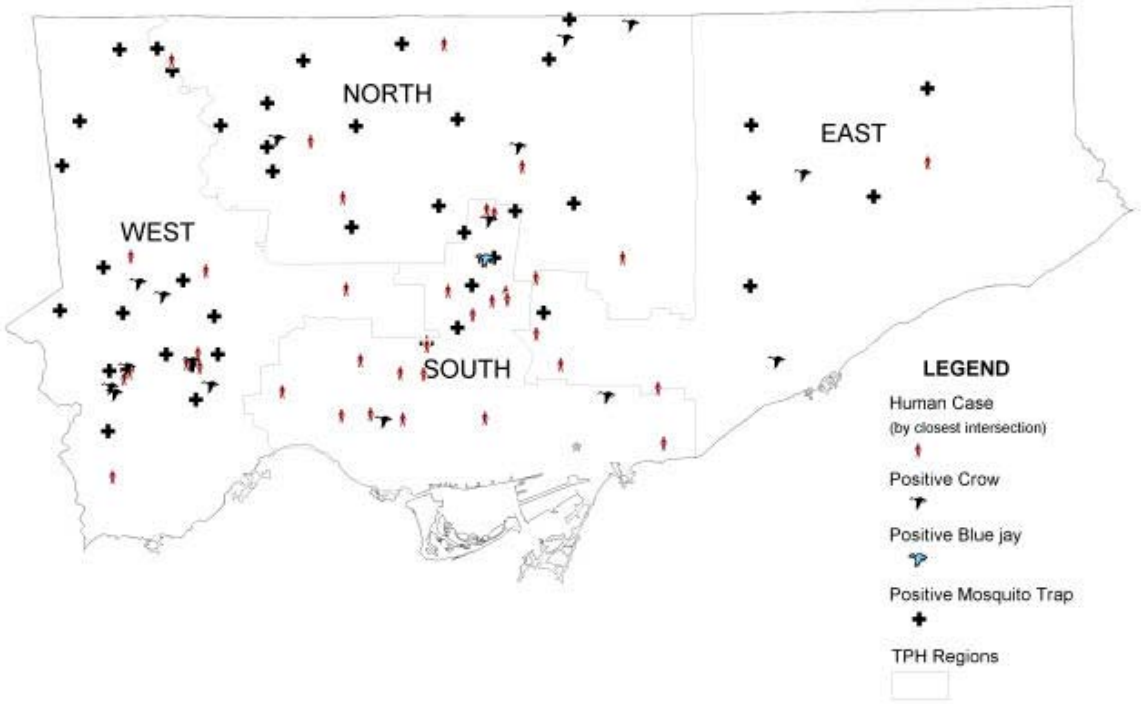
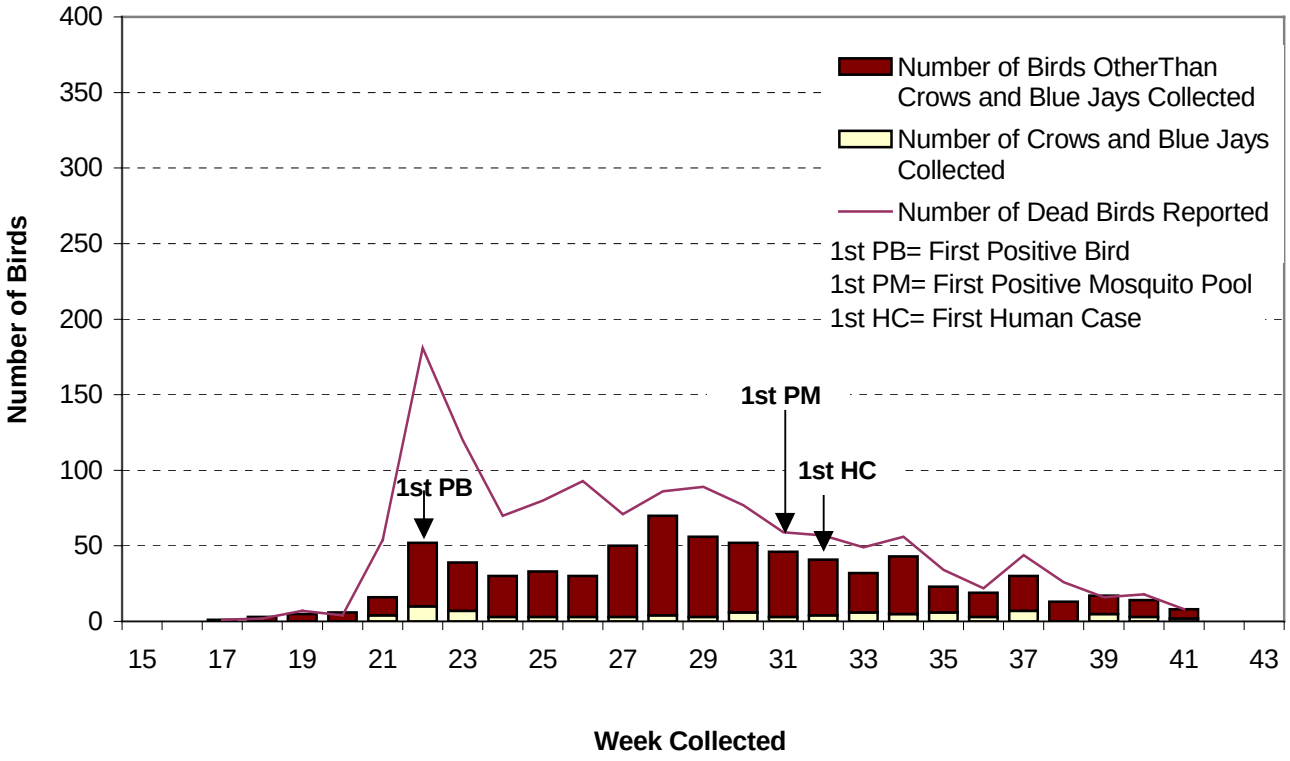


Figure 1-2: West Nile Virus Positive Crows, Blue Jays, Mosquito Traps, and Human Cases in Toronto, 2003



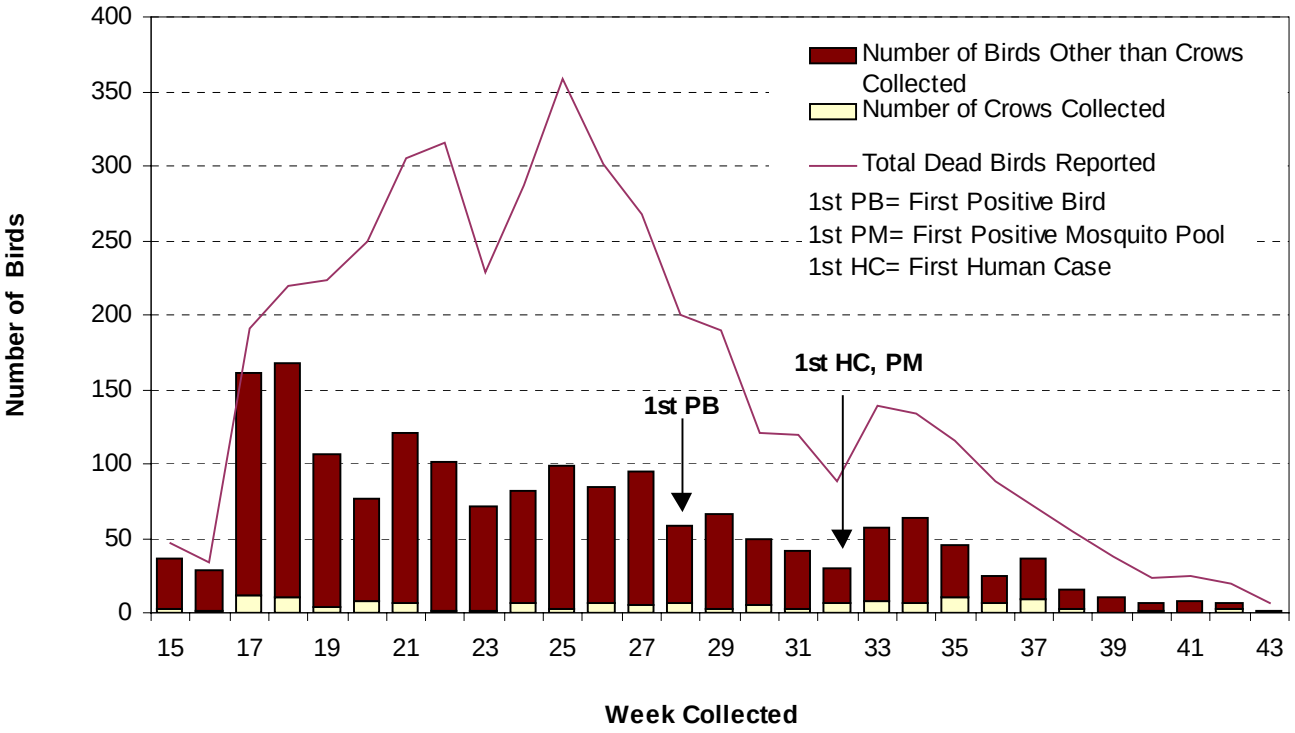
Figures 1-3 and 1-4 compare the number of birds reported and the types of birds collected by week[7] in the 2004 and 2003 seasons respectively. Both the numbers of dead birds reported and the number of dead birds collected were lower in 2004. The number of dead birds reported is affected by media attention given to WNV. Greater media attention may have been given to WNV in 2003 due to the higher number of human cases in 2002. In addition, the 2003 outbreak of Severe Acute Respiratory Syndrome (SARS) in Toronto may have raised media awareness about emerging diseases in Toronto. In turn, greater media attention may have resulted in greater public interest and more dead bird reports.

Figure 1-3: Number of Dead Birds Reported, Number of Crows and Blue Jays, and Other Birds Collected, and First WNV Positive Bird, Mosquito Pool, and Human Case by Week Collected[7] in Toronto, 2004



[7] Weeks were calculated using the first full week in each respective year as week 1.

Figure 1-4: Number of Dead Birds Reported, Number of Crows and Other Birds Collected, and First WNV Positive Bird, Mosquito Pool, and Human Case by Week Collected[8] in Toronto, 2003



The number of positive birds were approximately the same for 2004 and 2003 (18 in 2004 compared to 17 in 2003); however more birds were sent for testing in 2004. Thus, the proportion of positive birds (of those sent for testing) was less in 2004 compared to 2003 although the difference was not statistically significant (Table 1-2).

Table 1-2: Number of Positive Birds and Number of Birds Sent for Testing in 2003 and 2004

Year	Positive Birds	Birds Sent for Testing that were not Positive	Total # Birds Sent for Testing	% Birds that were Positive (of those sent for testing)
2003	17	20	37	45.95 %
2004	18	34	52	34.62 %
Total	**35**	**54**	**89**	**39.33 %**

χ^2=1.16 (p-value=0.2808)

The number of positive mosquito pools was lower in 2004 compared to 2003 (33 in 2004 and 56 in 2003); even though the number of pools tested were greater in 2004 than in 2003. As shown in Table 1-3, the proportion of positive pools (of those tested) was significantly lower in

[8] Weeks were calculated using the first full week in each respective year as week 1.

2004 than in 2003. Thus, there was a decrease in WNV activity in both birds and mosquitoes in 2004 compared to 2003.

Table 1-3: Number of Positive Mosquito Pools and Pools Tested in 2003 and 2004

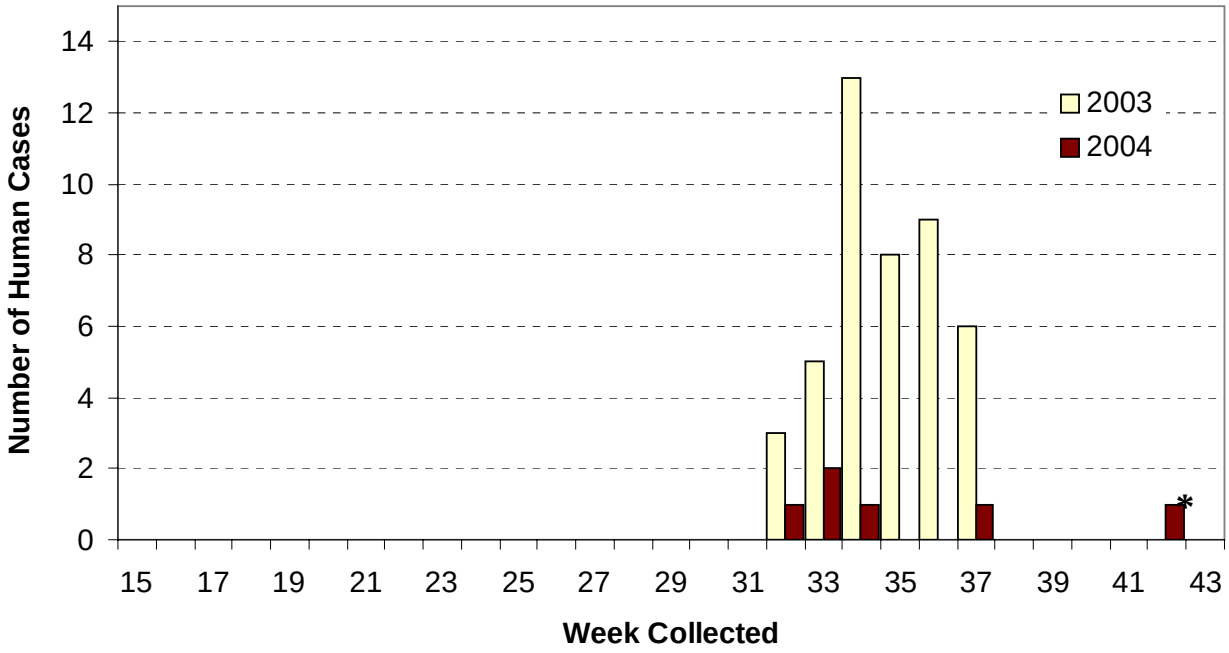
Year	Positive Mosquito Pools	Mosquito Pools that were not Positive	Pools Tested	% Mosquito Pools that were Positive
2003	56	2248	2304	2.43 %
2004	33	3681	3714	0.89 %
Total	**89**	**5929**	**6018**	**1.48 %**

χ^2=23.21 (p-value< 0.0001)

Figure 1-5 shows the distribution of human cases by onset date of WNV for 2004 and 2003. There were fewer human cases in 2004 compared to 2003 (6 in 2004 compared to 44 in 2003). There was one case in 2004 with a reported onset date in October. WNV results were an incidental finding for this client and there was uncertainty about the exact date of onset so specimen collection date was assigned as date of disease onset. All the other cases in both years had onset dates in the months of August and September.

Figure 1-5: Number of WNV Human Cases in 2003 and 2004 by Week[9] of Onset in Toronto

* There was uncertainty about the exact date of onset so specimen collection date was assigned as date of onset

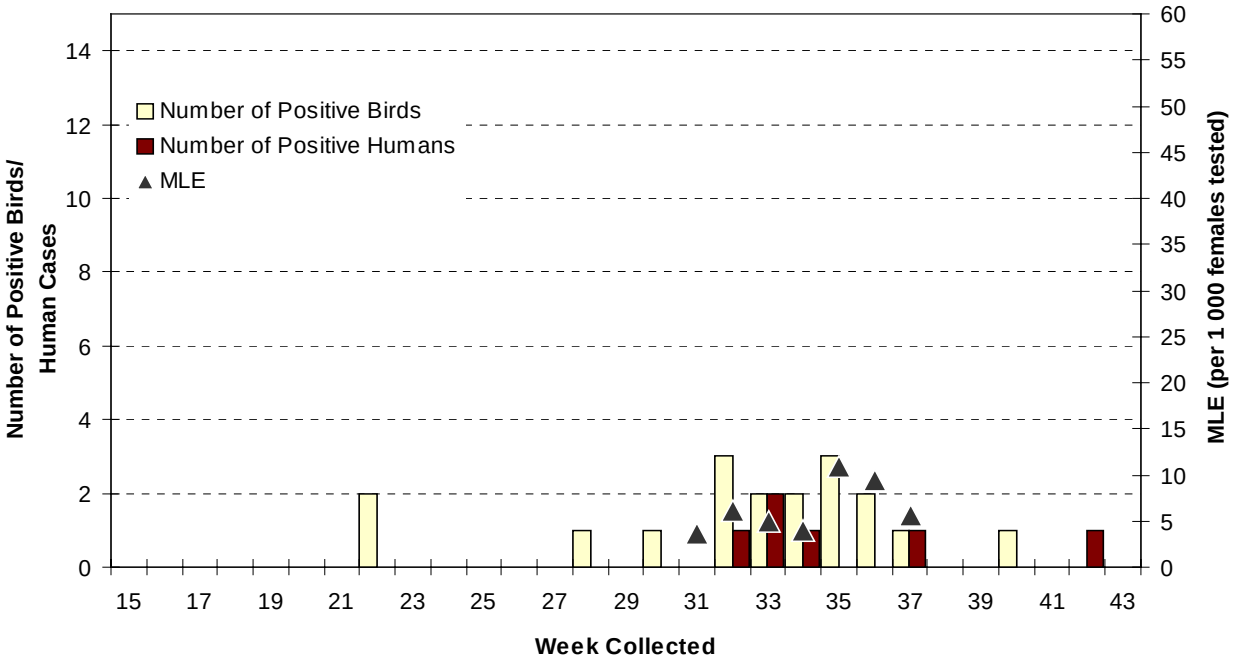


[9] Weeks were calculated using the first full week in each respective year as week 1.

The incubation period[10] for WNV disease in humans ranges from three to fourteen days so we would expect to see an increase in the number of positive birds and mosquito pools one to two weeks prior to the onset of WNV in human cases. In both years, positive birds were found more than four weeks before the onset date for the first human case (Figures 1-7 and 1-8). Thus, positive dead birds appear to be an early indicator of WNV activity in Toronto.

WNV mosquito activity appears to be an indicator of WNV intensity. In 2004 and 2003, there was a correlation between elevated mosquito infection rates[11] and dates of disease onset for human cases.

Figure 1-7: Number of WNV Positive Birds, Humans, and Maximum Likelihood Estimate (MLE) of Mosquito Infection Rates for Enzootic Vectors, by Week Collected[12] in Toronto, 2004

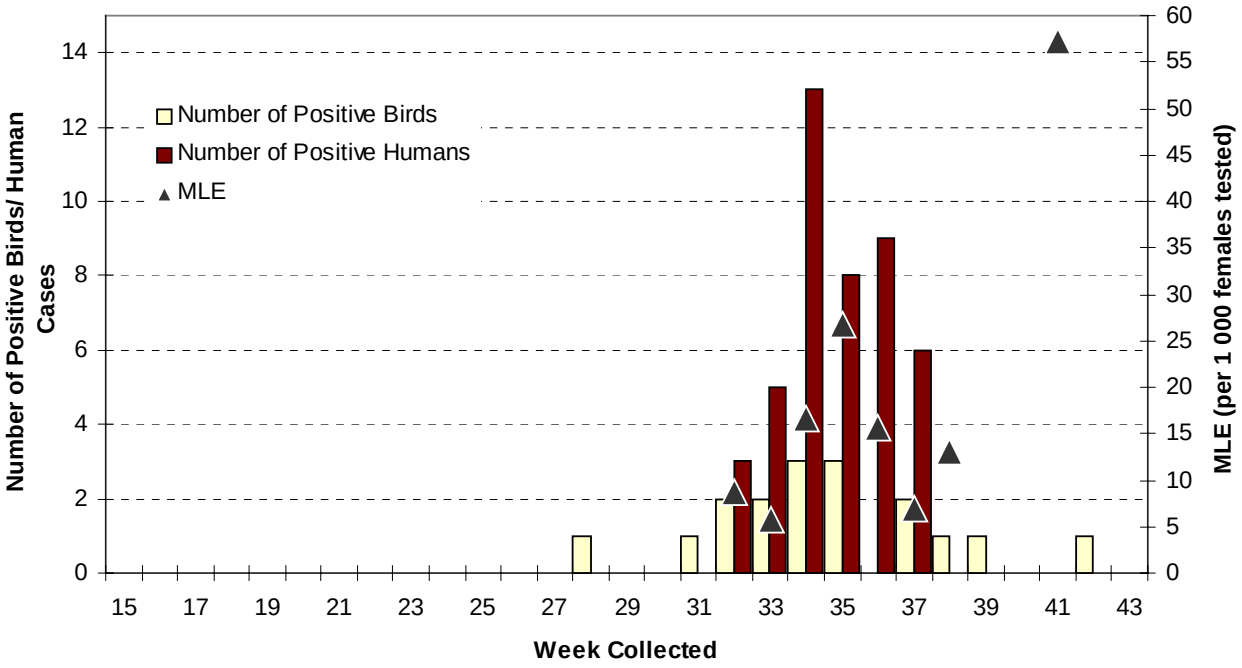


[10]The interval of time between infection and onset of disease (or first symptoms of illness).

[11]A common method of calculating mosquito infection rates is the Minimum Infection Rate (MIR). MIR is the number of positive pools of a species divided by the total number of mosquitoes trapped of that species. The main assumption in calculating MIR is that only one positive mosquito is needed for a pool to test positive. Thus, it is only a good approximation of the true infection rate when the arbovirus of interest is rare. The Maximum Likelihood Estimate of the mosquito infection rate (MLE) is another calculated measure of mosquito infection rates that does not make this assumption and is thought to be a better measure of true infection rates. MLE was calculated using PoolScreen 2.0, developed by Katholi and Barker (2002). Calculated infection rates are denominator-dependent and thus can be misleadingly high for rare mosquito species.

[12] Weeks were calculated using the first full week in each respective year as week 1.

Figure 1-8: Number of WNV Positive Birds, Humans, and Maximum Likelihood Estimate (MLE) of Mosquito Infection Rates for Enzootic Vectors, by Week Collected[12] in Toronto, 2003



Figures 1-9 and 1-10 show the geographic distribution of the density of dead birds reported and positive indicators of WNV activity for 2004 and 2003. In both years, most positive indicators were within 5 kilometres of areas with high dead bird densities (Figure I9). A similar spatial association between density of dead birds reported and human cases was also found in New York City. [13]

In 2004, there were areas with higher dead bird densities in the South and West regions. Also, elevated densities of dead birds reported in 2004 were reported in a smaller area than in 2003. Further, the indicators of WNV activity (positive birds, mosquito pools, and human cases) were less dispersed throughout the city in 2004 compared to 2003. Also, the magnitude of the densities was lower in 2004 compared to 2003, which is another indication of the decrease in WNV activity in 2004.

[13] Constandinos NT, SC Ahearn, S Grady, M Merlino. 2003 "Identifying West Nile Virus Risk Areas: The Dynamic Continuous-Area Space-Time System". American Journal of Epidemiology (157/9): 843-854

Figure 1-9: WNV Positive Birds, Mosquito Trap Sites, Human Cases and the Density of Dead Birds Reported in Toronto, 2004

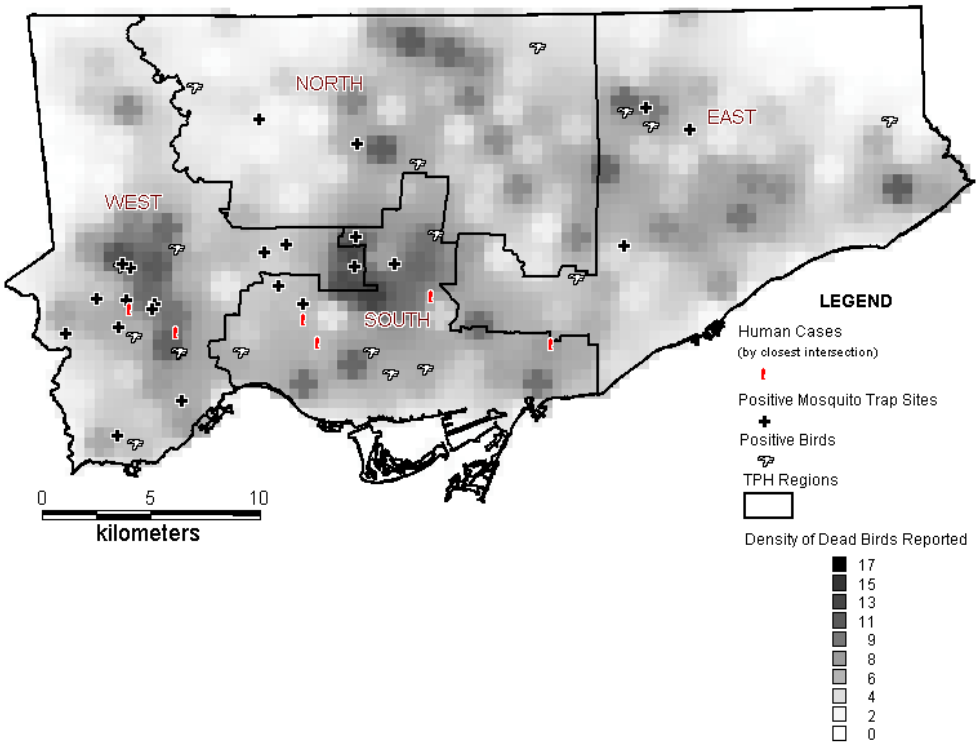
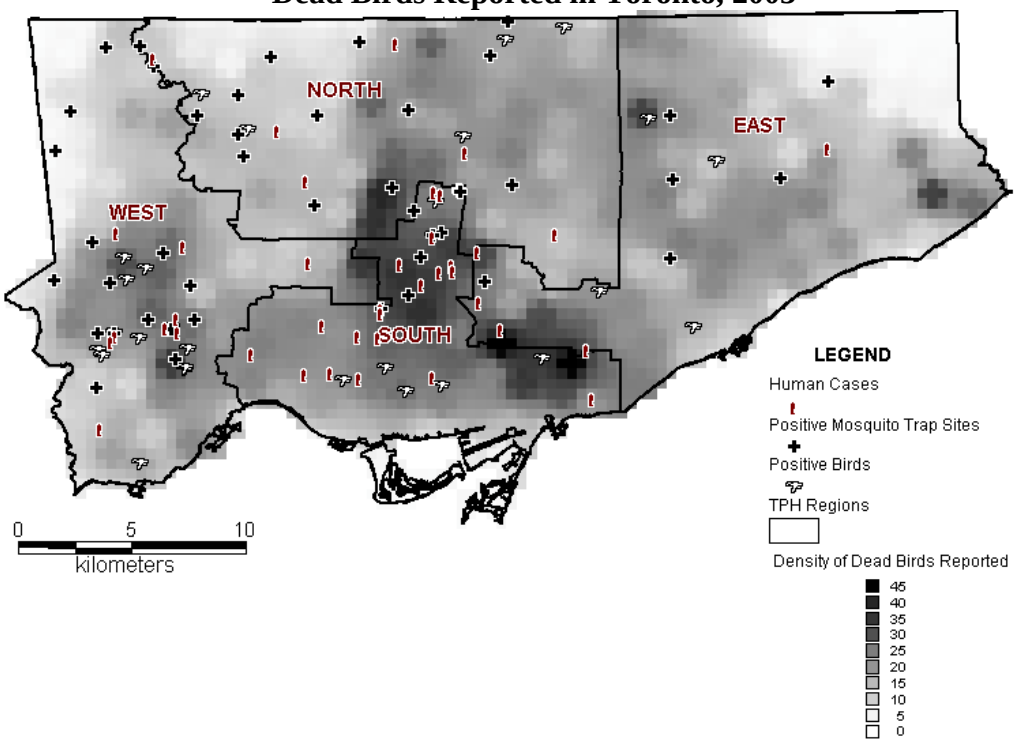


Figure 1-10: WNV Positive Birds, Mosquito Trap Sites, Human Cases and the Density of Dead Birds Reported in Toronto, 2003



Figures 1-11 and 1-12 display the cumulative number of human cases, positive mosquito pools, and positive birds for the 2004 and 2003 seasons, respectively. Overall, WNV activity was lower in 2004 compared to 2003.

Figure 1-11: Cumulative Number of WNV Positive Birds, Mosquito Pools, and Human Cases, by Week Collected[14] in Toronto, 2004

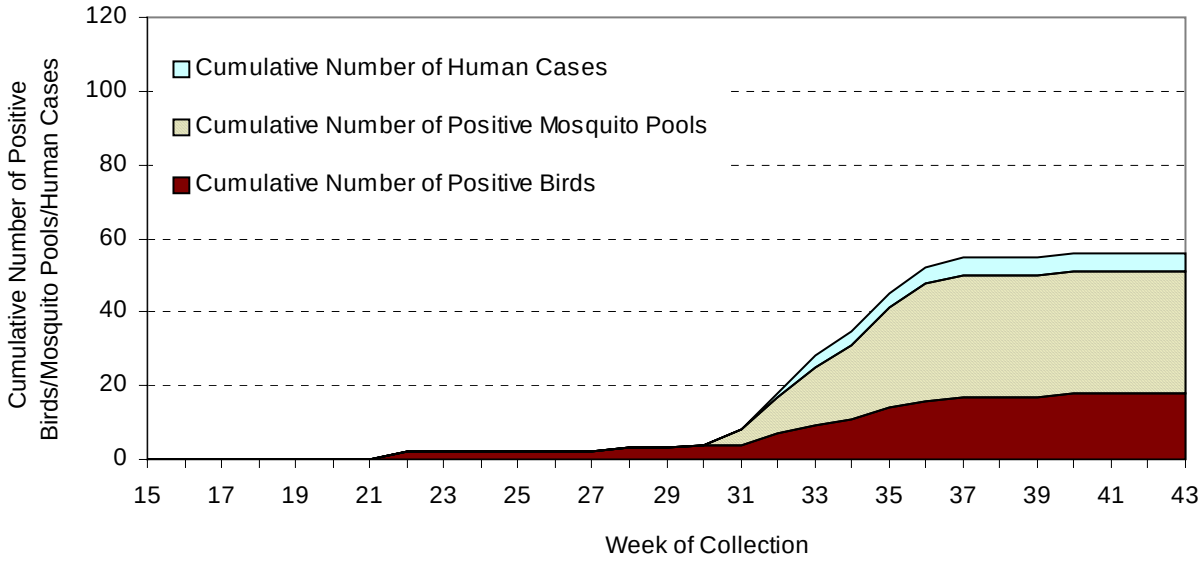
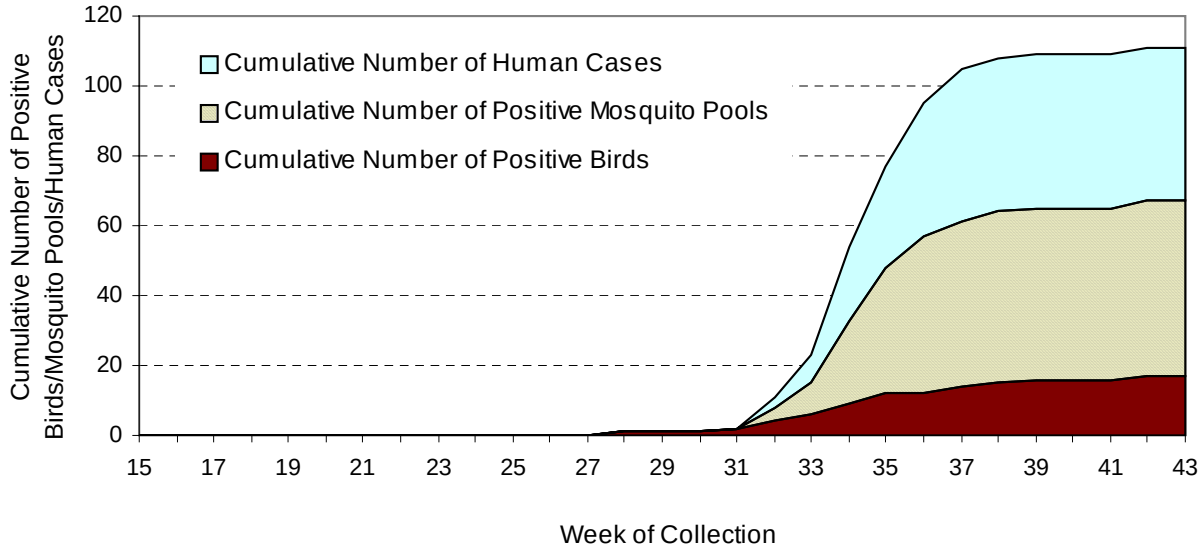


Figure 1-12: Cumulative Number of WNV Positive Birds, Mosquito Pools, and Human Cases, by Week Collected[14] for Toronto, 2003



[14] Weeks were calculated using the first full week in each respective year as week 1.

West Nile Virus Communications Campaign

Background

In 2004, the City of Toronto implemented a West Nile virus (WNV) mosquito control program comprising of surveillance activities, public education and mosquito control activities. Education and outreach is a primary intervention within an integrated pest management program for the prevention and control of WNV. The public education component included community outreach and public education. The plan was aimed at keeping the public informed and provided information regarding personal protective measures that individuals could take to minimize risk of infection.

Goals

Effective communication to the public is critical to the successful resolution of any type of health issue. Broad public health campaigns include a range of communication tools, which are used to promote behaviour change. The goals of the City's 2004 WNV communication campaign were as follows:

- To disclose information to the public without causing alarm or fear regarding the risks associated with the arrival of mosquito and WNV season
- To inform the public of appropriate measures to reduce mosquito breeding grounds
- To educate the public on personal protection measures
- Inform residents and the business sector of measures they can take to reduce breeding grounds on their private property.

To achieve these goals the communications strategy was comprised of three stages where different communication activities were undertaken:

- Stage One: Mid-spring - before detection of the virus
- Stage Two: Late spring - testing of catch basins and open bodies of standing water for larvae and larviciding
- Stage Three: Human illness/death(s) in Toronto

Outreach and Education Activities

The campaign included a variety of communication vehicles: information sessions, existing City publications and on-line information, paid advertising, and advertising in library and recreation centre publications. This information emphasized both what the City was doing and what residents, businesses and institutions could do to help prevent human infection.

Strategies to reduce mosquito-breeding sites were promoted to the private sector and to City staff and institutional partners such as school boards, hospitals, TTC, Toronto Community Housing Corporation and Toronto Hydro.

An information line was also available everyday for general information and to report stagnant water and dead birds. Toronto Health Connection staff answered questions during regular business hours, and an automated service was available 24 hours a day.

Information on WNV was also available to the public on the Toronto Public Health (TPH) website. The site was updated weekly from May 1 until October 31 with information on the status of WNV in Toronto and included a list of current larviciding locations. All media releases were posted on the website. Fact sheets were also translated into eight languages. People who did not have access to the Internet could also call the WNV information line (416-338-7600); the telephone number was listed on all of TPH's WNV literature.

The direct outreach activities consisted of presentations to community groups, displays in hospitals and promotion at community events including the CNE. Information packages were sent to community agencies, libraries and community centres.

In addition, a number of other communication strategies were employed. In May, July, and August media releases were developed and posted on the news wire service. These releases covered a number of topics, including encouraging the adoption of personal protective measures against mosquito bites, eliminating standing water, announcing larvicide application, reporting WNV positive mosquito findings and the first human case in Toronto, As well, TPH WNV staff participated on a number of TV and radio call-in shows.

The chart in Appendix 1 shows that the website is an important tool for public information. From May 1 to October 31 there were over 36,000 visits to the WNV homepage and visits to the entire WNV web site totalled over 50,000. The announcement of the first human case, at the end of August, showed a significant peak in the number of visits to the website. The Toronto Health Connection (THC) line was also an important tool for public education and for surveillance activities as residents reported standing water and dead birds to TPH staff via THC. There were over 2,800 calls to the THC line from May 1 to October 31.

Other communication activities included:

- WNV letter and fact sheet distribution to schools, day-care centres, and long-term healthcare facilities
- Distribution of information on WNV to all Toronto households via "Water Watch", the Works and Emergency Services Newsletter
- Production of an eleven-page Q&A document on WNV by the inter-departmental communications group. This document provided answers to questions City service providers may encounter in speaking with the public as well as questions staff may have. The Q&A was made available on the City's Intranet
- Working closely with inter-departmental colleagues in neighbouring municipalities in applying provincial guidelines and directives on communications
- As per Ministry of the Environment regulations, TPH placed ads in the Toronto Sun and the Toronto Star notifying residents of larviciding

In addition to these public education activities, a print advertising campaign ran in Toronto papers from June 30 until September 5. Two ads were placed, the first ad provided residents with information on what they could do to reduce the risk of WNV and what the city was doing to reduce the risk and the second ad, which ran in papers in September, informed residents that mosquitoes were still present during cool weather so precautions were still necessary. Ads ran in major dailies, ethnic papers and community papers over the summer months and were placed on 60 transit shelters in July, August and September.

Rapid Risk Factor Surveillance System Survey[15]

Surveys can provide helpful information to assess public knowledge and behaviour changes. For the past four years, TPH has used the Rapid Risk Factor Surveillance System (RRFSS) survey to monitor the progress in raising awareness of WNV and measuring the use of protective behaviours that can reduce the chance of exposure to infected mosquitoes. Toronto residents aged 18 years and over were surveyed by telephone each month. The average annual response rate for the Toronto survey, which is conducted in English, was 56%. From May to September 2004, RRFSS surveyed 900 Toronto residents regarding WNV awareness and personal and household protective behaviours. General household weights were applied to the data to adjust for the effect of household size on probability of selection. Response estimates are accompanied by 95% confidence intervals, which means that the estimate is within this range 19 times out of 20. The difference between estimates is statistically significant if the confidence intervals do not overlap.

Data collection periods and sample size for West Nile Virus questions:
July-September 2001 (n=300); May-September 2002 (n=500); May-September 2003 (n=500), May-September 2004 (n=900). The analysis of the personal protection questions is based on the data collected from June to September each year (n=800 for 2004).

West Nile Virus Rapid Risk Factor Surveillance System Survey Results:

Awareness
In 2004 most Toronto residents had heard about WNV (96% ± 1.4%). This was unchanged from 2003 (96% ± 1.7%).

Transmission
The proportion of Toronto residents who knew that WNV is transmitted to humans by mosquitoes was 85% (± 2.4%) in 2004. This was unchanged from 2003 (85% ± 3.1%).

Perceived Risk
In 2004, 20% (± 2.7%) of Toronto residents who had heard about WNV felt they were at risk for becoming ill because of WNV. This is a significant decrease over 2003 when 29% (± 4.0%) felt they were at risk.

[15]RRFSS – Rapid Risk Factor Surveillance System, July 2001-September 2004, Health Information and Planning, Toronto Public Health and Institute for Social Research, York University

Behaviour Change
Residents who had heard about WNV were asked about the change in their behaviour towards mosquitoes. In 2004, 32% (± 3.1%) said they had made more of an effort to avoid mosquitoes and 32% (± 3.1%) said they have always tried to avoid mosquito bites. Twenty eight percent (± 3.0%) said that hearing about WNV made no difference in their behaviour. These findings were similar to those in 2003.

Risk Groups
Residents who had heard about WNV were asked which age group they felt was most at risk of becoming seriously ill from WNV. In 2004, approximately one quarter (26% ± 2.9%) correctly reported that adults aged 50 and older are at most risk of serious illness. Forty one percent (± 3.3%) felt there was no real difference based on age. These findings were similar to those in 2003.

Personal Protective Behaviours
For all the personal protective behaviours, findings were similar to those in 2003.

- In 2004, approximately half of Toronto residents (53% ± 3.5%) said that they stayed away from shaded or wooded areas or areas of stagnant water, all or most of the time to protect themselves from being bitten by mosquitoes.

- In 2004, 25% (± 3.0%) of residents reported that they limited their outdoor activities from early evening to early morning all or most of the time to avoid mosquitoes.

- In 2004, 28% (± 3.2%) of residents reported that they covered up with long sleeves, long pants, and socks all or most of the time during outdoor activities to protect themselves from mosquitoes.

- In 2004, 12% (± 2.3%) of residents reported that they used insect repellent with DEET all or most of the time during outdoor activities to protect themselves from being bitten by mosquitoes.

- Respondents who reported covering up or using DEET only half of the time or less during outdoor activities (62%± 3.5%) were asked the main reason why they did not practice these behaviours more often. In 2004, the most common reason given for not covering up was that mosquitoes were not a problem or there were no mosquitoes out (29%± 4.1%). Other reasons for not covering up were: they avoid or are not exposed to mosquitoes, not worried about mosquitoes or WNV, too hot to cover-up, can't be bothered or forgot, or felt there was no need. The reasons for not using DEET were very similar with the most common again being that mosquitoes were not a problem or there were no mosquitoes out (28%± 4.1%). Other reasons for not using DEET were: they don't like using DEET, they avoid or are not exposed to mosquitoes, not worried about mosquitoes or WNV, can't be bothered or forgot, or felt there was no need. When asked about alternatives, 5.8 % (±1.7 %) of residents reported that they used insect repellent that did not contain DEET all or most of the time during outdoor activities to protect themselves from being bitten by mosquitoes. These questions about reasons for not using DEET and use of alternatives were not asked in previous years.

Household Protective Behaviours

In 2004, 96% (± 1.3%) of households reported that they did not have containers outside of their homes where water was allowed to stand for more than 7 days. These findings were similar to those in 2003.

- In 2004, 80% (± 2.6%) of households reported that, during the summer, windows or doors were not left open or that windows or doors had screens with no tears or holes. These findings were similar to those in 2003.
- Other protective behaviours practiced in 2004 included: adding a larvicide to standing water outside the home, using a bug zapper or magnet, and putting up a bat house. These measures were practised by fewer than six percent of the households.

Conclusion

The 2003 and 2004 RRFSS survey results indicate that most residents in the City of Toronto had a very high level of awareness about WNV (96% have heard of WNV and 85% know how it is transmitted). Awareness levels remained high likely as a result of advertising by various levels of government and by the private sector such as drug and hardware stores. The media, both print and broadcast, have also shown a high level of interest in WNV which has helped with public education efforts.

Behaviour change is key to virus prevention and our campaign continues to reinforce protection measures. Ongoing public education including media, face-to-face communication, information distribution, and advertising are necessary to reduce the burden of illness as well as to ensure communications are timely and contain understandable messages.

Dead Bird Surveillance

Background

Dead bird surveillance provides the earliest indicator for West Nile virus (WNV) activity. Many bird species are relatively resistant to WNV and serve to maintain the virus in the avian population by acting as a reservoir for the virus.[16] Susceptible avian species, in particular corvids (e.g. crows and blue jays), are the focus of surveillance as they have a high mortality rate upon infection, are readily recognised by the public, and are common in areas where they are endemic.[17,18] Thus, corvids are used as an early indicator of WNV presence in Toronto. A vital component of adult mosquito surveillance is trapping around positive indicators (including positive corvids) and testing of mosquitoes around positive indicators helps to determine the species of mosquitoes that are infected with WNV. Thus, the ongoing collection and testing of dead birds plays an important role in adult mosquito surveillance. [17] Toronto Public Health (TPH) collected dead birds and tested corvids throughout the WNV season, even though provincial guidelines state that testing could cease once one bird was found positive in a health unit.

Purpose

The purpose of dead bird surveillance is to provide an early indicator of the presence of WNV as well as showing the geographic distribution within a jurisdiction. This information serves to inform decision-makers about areas with potentially elevated WNV risk for targeted intervention.

Methods

In 2004, the WNV bird surveillance program ran from May 1 to October 31. Although most dead birds that were reported were also picked-up, emphasis was placed on the collection and WNV testing of dead crows and blue jays. In addition, dead raptors (e.g. eagles, hawks, and falcons) and small mammals (e.g. racoons) exhibiting abnormal neurological signs were also sent for WNV testing. Blue jays were put back on the list of species tested for WNV in 2004 to adjust for declines in local crow populations in 2002 and 2003.[17]

The City of Toronto relied on the public to report dead bird sightings throughout the City. Toronto residents were asked to call the Public Health WNV hotline, Toronto Health Connection, to arrange for dead bird collection or disposal. Toronto Animal Services (TAS) staff responded to calls regarding dead birds, between the hours of 8:30 a.m. and 7:00 p.m., Monday to Sunday, including holidays. Outside these hours, callers received a message about the proper procedure for storing the bird until a collection could be arranged and were instructed to call back the following day. TAS recorded data on telephone reports of dead bird sightings

[16] US Centre for Disease Control and Prevention: http://www.cdc.gov/ncidod/dvbid/westnile/resources/wnv-guidelines. Accessed October 31, 2004

[17] "2004 West Nile Virus Preparedness and Prevention Plan for Ontario", Ministry of Health and Long-term Care of Ontario

[18] Emerging Disease Issues, State of Michigan: http://www.michigan.gov/emergingdiseases/0,1607,7-186-25805-75267--,00.html. Accessed November 10, 2004

including caller name, address, phone number, and bird species. In response to the calls, birds were collected or callers were advised on the proper disposal of the carcass. Birds of the species of interest that were collected and deemed in adequate condition for testing were sent to the Canadian Co-operative Wildlife Health Centre (CCWHC) for testing. The birds were tested for WNV using a VecTest and the first birds found positive were confirmed by the Polymerase Chain Reaction (PCR) test.

Results

From April to October, TAS staff responded to 2,311 WNV-related calls. The breakdown by month is shown in Table 3-1. Of these calls, 741 resulted in dead bird collection (49 crows, 41 blue jays), 618 resulted in the collection of sick/injured birds, and 606 were to report dead birds where the caller was advised about the proper disposal of the bird as per CCWHC guidelines. Of the dead birds collected, 51 were sent for testing[19] (26 crows, 23 blue jays, and 2 hawks). Thirteen crows and five blue jays tested positive for WNV.

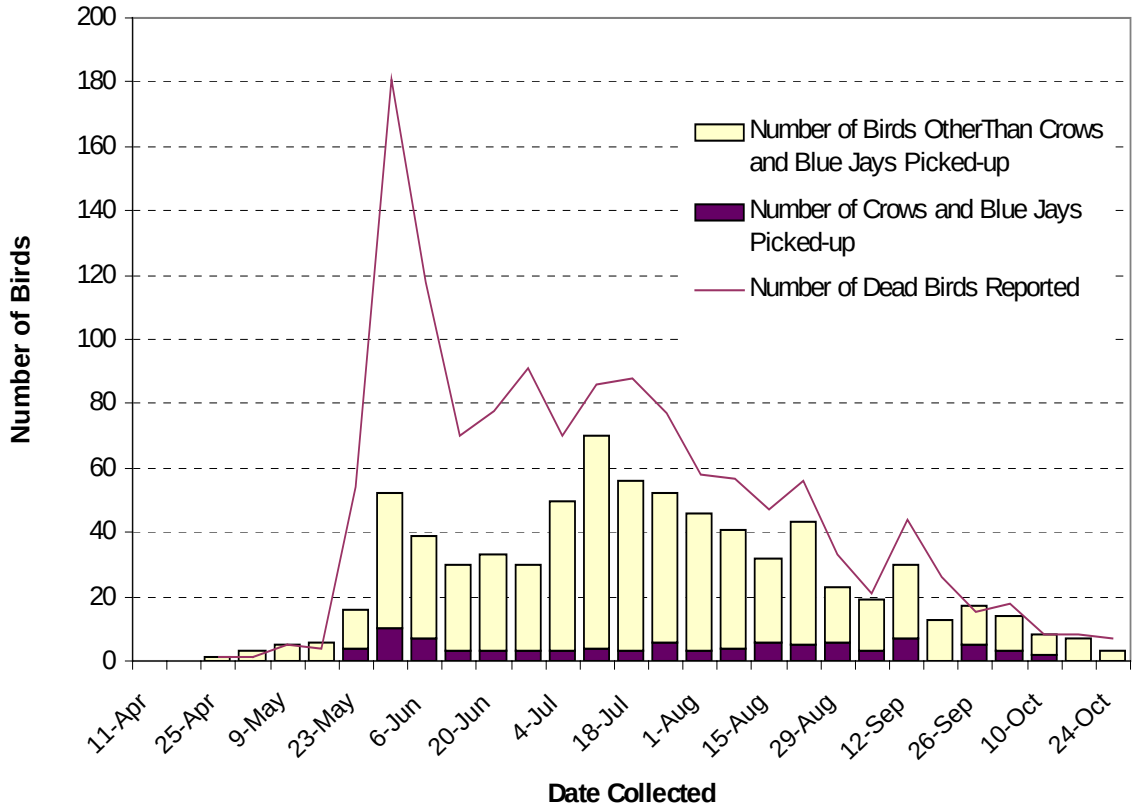
Table 3-1: Distribution of Calls to TAS Regarding Dead or Sick Birds, by Month in Toronto, 2004

Month	Dead Bird Calls that Resulted in Bird Collection	Sick & Injured Birds	Education on Bird Disposal	Other	Total Calls
May	38	70	76	40	224
June	161	137	298	80	676
July	244	113	119	84	560
August	174	129	62	73	438
September	89	89	43	44	265
October	35	80	8	25	148
Total	**741**	**618**	**606**	**346**	**2,311**

Figure 3-1 shows the distribution of reported dead birds and the number of birds (corvids and other birds) collected in 2004. The number of dead birds collected was associated with the number of dead birds reported during most of the surveillance season. The reports of dead birds peaked on May 30, 2004, were moderately high throughout July, and declined in September. The majority of dead birds collected were non-corvid birds (87.9%).

[19] One racoon was also sent for testing. It was found to be negative for WNV.

Figure 3-1: Comparison of the Number of Dead Birds Reported, Number of Crows and Blue Jays, and Other Birds Collected in Toronto, 2004



The distribution of reported dead birds, dead birds collected, and positive birds, by TPH region[20] are shown in Table 3-2. Although the East region had the highest number of reports of dead birds and dead birds collected, it had the lowest proportion (25.0%) of positive birds (of those sent for testing). Conversely, the South region had the lowest number of dead birds reported and the highest proportion (50.0%) of positive birds (of those sent for testing). The East region is the largest region by area and the South the smallest, which explains the differences in dead bird reports and collections. For the distribution of positive birds, the opposite effect was seen with the smallest region having the largest number and proportion of positives.

Only four percent of the dead birds reported were crows, this is about the same proportion as in 2003; however it is less than was found in other jurisdictions. For example, in New York City eight percent of reported dead birds were crows in 2003.

[20] TPH regions correspond to former municipalities: North = North York; South = Toronto; East = Scarborough, East York; West = Etobicoke, York

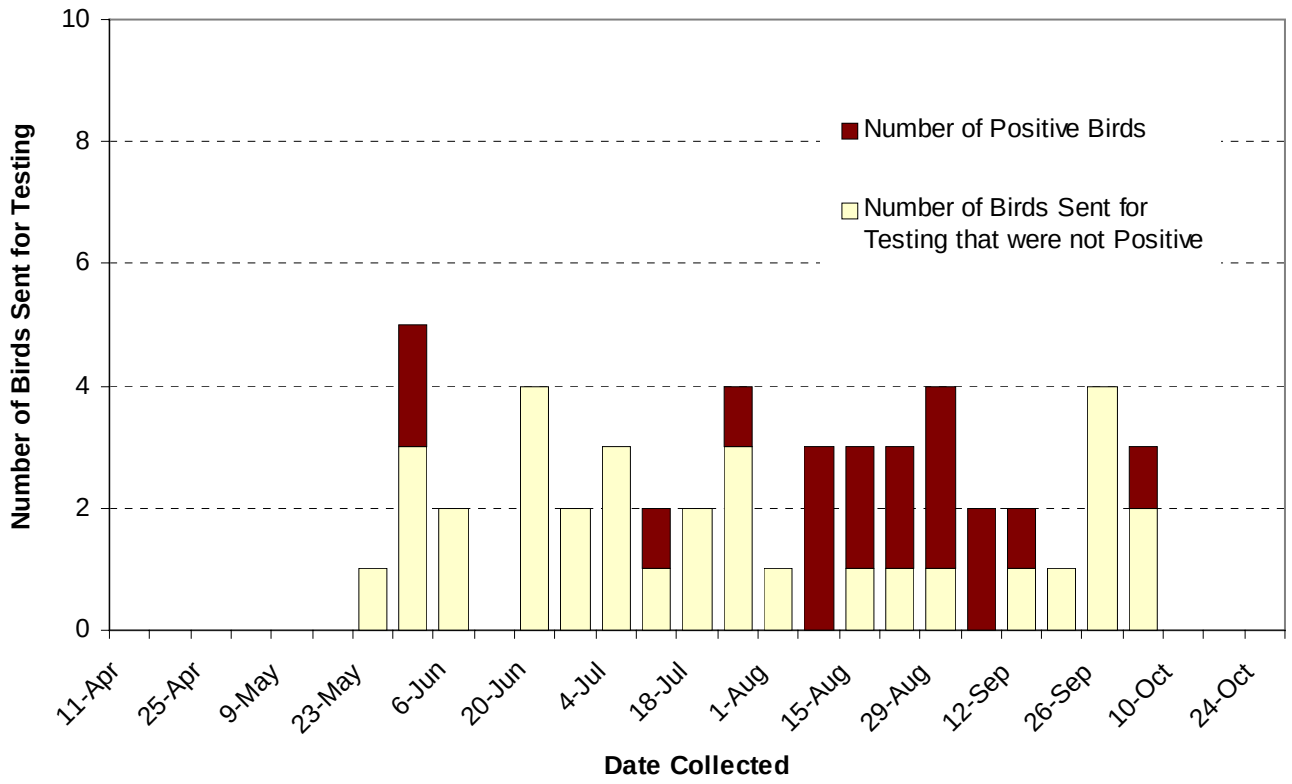
Table 3-2: Distribution of Dead Birds Reported and Collected and WNV Positive Birds, by TPH Region in Toronto, 2004

TPH Region	Dead Birds Reported	Dead Birds Collected	Dead Birds Sent for Testing	Positive Birds* n (%)
South	275	183	14	7 (50.0%)
North	333	181	7	2 (28.6%)
East	386	205	16	4 (25.0%)
West	329	172	14	5 (35.7%)
Total	**1323**	**741**	**51**	**18 (34.6%)**

*of those sent for testing

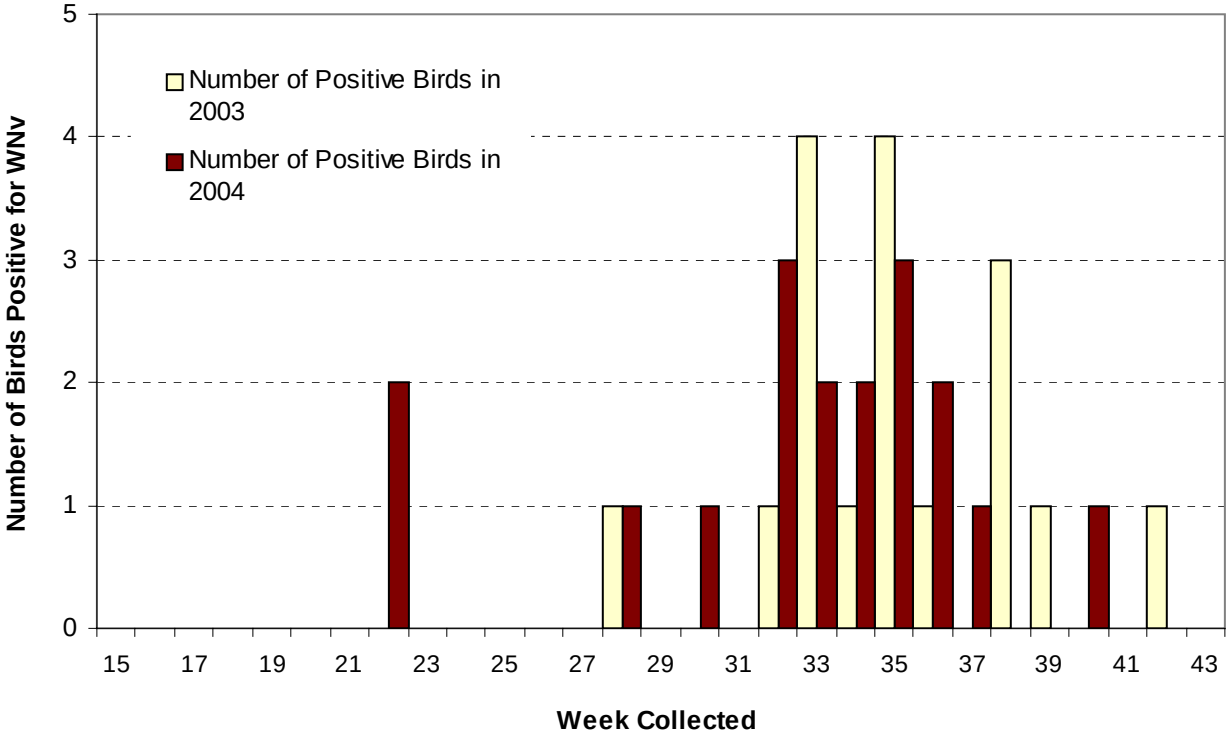
In August, approximately 70 % of birds (of those sent for testing) were WNV positive, but in September, less than 35 % of birds (sent for testing) were WNV positive (Figure 3-3).

Figure 3-3: Number of WNV Positive Birds of those Sent for Testing in Toronto, 2004



There were approximately the same numbers of positive birds in both years (Figure 3-4). In 2004, both the first and last positive bird were found earlier than in 2003. Thus, it appears that the WNV season started and ended earlier in 2004. The majority of positive birds were found between weeks 32 and 37 in both years. This was also the time period when most of the positive mosquito pools and human cases were found.

Figure 3-4: Comparison of WNV Positive Birds in 2003 and 2004, by Week Collected[21] in Toronto



[21] Week numbers are calculated using the first full of the year as week one.

Adult Mosquito Surveillance

Background

Although surveillance of dead birds has been shown to provide an early warning of West Nile virus (WNV) presence in an area, adult mosquito surveillance remains the primary tool for quantifying WNV activity in the area. Mosquitoes become infected when they bite, or take a blood meal, from a bird carrying WNV; the infected mosquito then transmits the virus to another bird or mammal through a second bite. Only female mosquitoes are used for surveillance, as males do not take blood meals and thus are not involved in the cycle of WNV transmission.

Mosquitoes are vectors of the disease and help amplify the virus and maintain the cycle of transmission. Mosquito vectors of the disease have been categorised as enzootic vectors[22] and bridge vectors.[23] Enzootic vectors feed predominately on birds; however, they may occasionally feed on mammals. They are involved in the amplification of the virus and thus help elevate viral levels. Bridge vectors are indiscriminate in their biting habits and feed on both birds and mammals, and are therefore important for WNV transmission to humans.

Surveillance consisted of trapping adult mosquitoes from Spring to Fall throughout the City of Toronto. Species that tested positive in the past (from 2001 to 2003 in Ontario) were the focus for testing in 2004.

Purpose

The purpose of adult mosquito surveillance is to determine the distribution and counts of mosquitoes throughout the City of Toronto and to establish the intensity of WNV activity, in order to ascertain the risk of transmission to humans.

Methods

CO_2-baited CDC miniature light-traps were used for trapping adult mosquitoes and were set out from June 1 to October 13, 2004. Trained staff set out the traps in the early afternoon and retrieved them the following morning.

Trapping was done on a routine and ad hoc basis. Sites were chosen for routine trapping if they were likely to trap *Culex pipiens* and *Culex restuans* mosquitoes, as they are important vectors of WNV in Toronto. Routine sites were monitored on a weekly basis to observe levels of mosquito species throughout Toronto.

There were two types of ad hoc trapping sites: hot spot and other. Hot spot sites were locations with increased WNV activity (i.e. surrounding positive birds, mosquito traps, and human cases) and were used to characterise infected mosquitoes. 'Other' ad hoc trapping was performed at sites of ecological interest to identify mosquitoes in the area.

[22] *Cx. pipiens, Cx. restuans* are the enzootic vectors of interest in Toronto.
[23] *Ae. vexans, An. punctipennis, An. walkeri, Cq. perturbans, Cx. salinarius, Oc. stimulans, Oc. triseriatus, Oc. trivittatus* are the bridge vectors of interest in Toronto.

Trapped adult mosquitoes were sent to Brock University for counting, speciation (identification), and WNV testing[24]. When it was not possible to differentiate species, numbers were reported at the genus level (e.g. *Culex* spp.). Sometimes it was also difficult to distinguish between related mosquito species, so they were reported as combined groups[25] (e.g. *Culex pipiens/restuans).*

The results from speciation and testing were posted on a secure website, which was created and maintained by Brock University with input from Toronto Public Health and other health units. In addition, there was e-mail notification to health units of positive results 48 hours prior to being posted on the website.

Results

Mosquito Identification

Mosquito vector[26] densities were used to determine the population levels of mosquito species capable of acting as WNV vectors in Ontario. Trapped mosquitoes were put into three groups: enzootic vectors, bridge vectors, and other species.

Figure 4-1 shows the distribution of the enzootic vector densities for the 2003 and 2004 surveillance seasons. In 2004, enzootic vector densities were very low in June, increased in July, then gradually decreased through August and September. Although a similar pattern was seen in 2003, the magnitude of enzootic vector densities were lower in 2004 compared to 2003 through June and July, which is the period of time when levels of enzootic vector levels have the greatest impact on WNV activity. The decrease in enzootic vector densities is likely due to below-average temperatures and above-average rainfall in 2004.[27] Mosquitoes are less likely to fly in colder or wetter conditions and thus fewer adult mosquitoes would be captured in the traps.[28] In hot, dry years there is a concentration of organic matter in catch basins promoting breeding of *Culex* mosquitoes. It is also suspected that WNV amplification in birds is higher in these years because birds congregate around scarce water where even a few infected mosquitoes can result in WNV transmission, and the warm temperatures allow for rapid replication of the virus in mosquitoes.[28]

Figure 4-2 shows the distribution of bridge vector densities for the 2003 and 2004 surveillance seasons. Bridge vector densities usually peak in early June and again at the end of August, which was found in both the 2003 and 2004 surveillance seasons.

A limitation with the analysis is the level and consistency of adult mosquito trapping, which was greater in 2004 compared to previous years.

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[24] Up to 150 mosquitoes were counted and speciated for each trap-night. Mosquitoes were then grouped by trap and species into pools with a maximum of 50 mosquitoes per pool for WNV testing. When there were more than 50 mosquitoes from the same species and trap-night, additional pool(s) were created.

[25] Thus, for analyses, *Culex pipiens* and *Culex restuans* were often grouped as the *Culex pipiens/restuans* complex

[26] Mosquito densities were calculated using per-trap per-night (PTPN) densities.

$$PTPN = \frac{\text{Total number of mosquitoes captured in all traps}}{(\text{Total number of traps}) \times (\#\text{ days the trap was left out})}$$

[27] Environment Canada: http://www.climate.weatheroffice.ec.gc.ca. Accessed November 10, 2004.

[28] Epstein, Paul R. 2001 "West Nile Virus and the Climate" Journal of Urban Health: Bulletin of the New York Academy of Medicine. (78/2): 367-371.

Figure 4-1: Enzootic Vector Densities in Routine Trap Sites in Toronto, 2003 and 2004

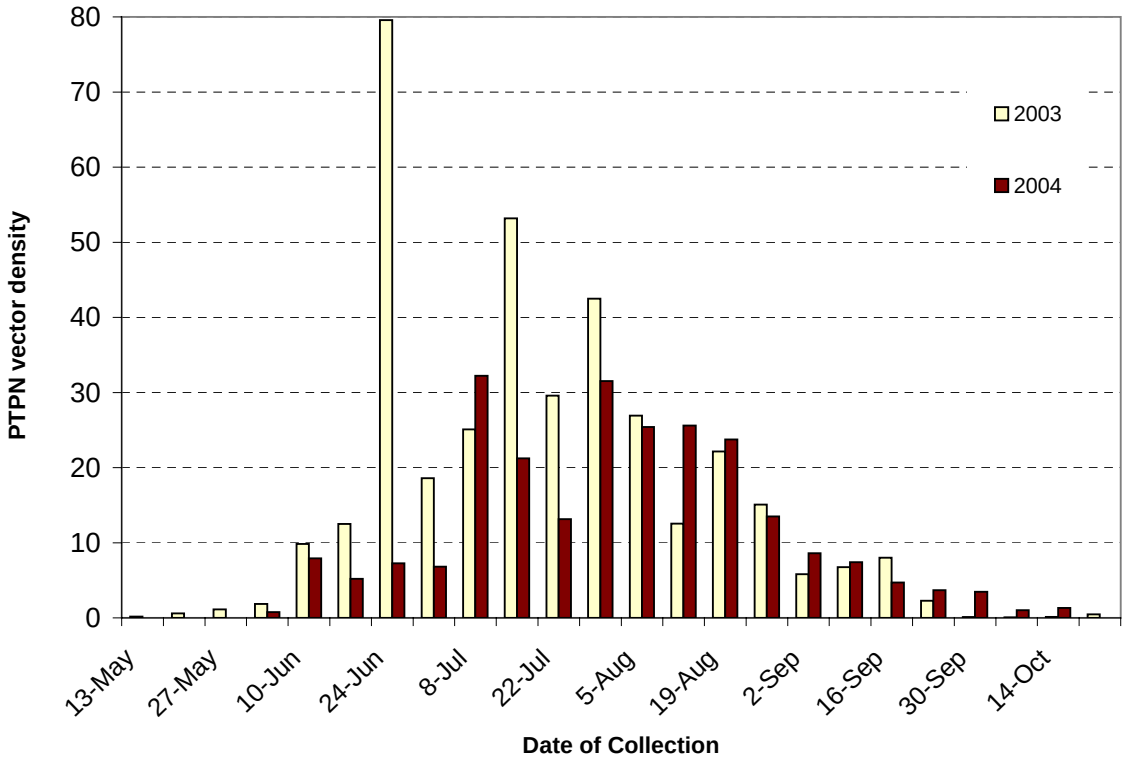
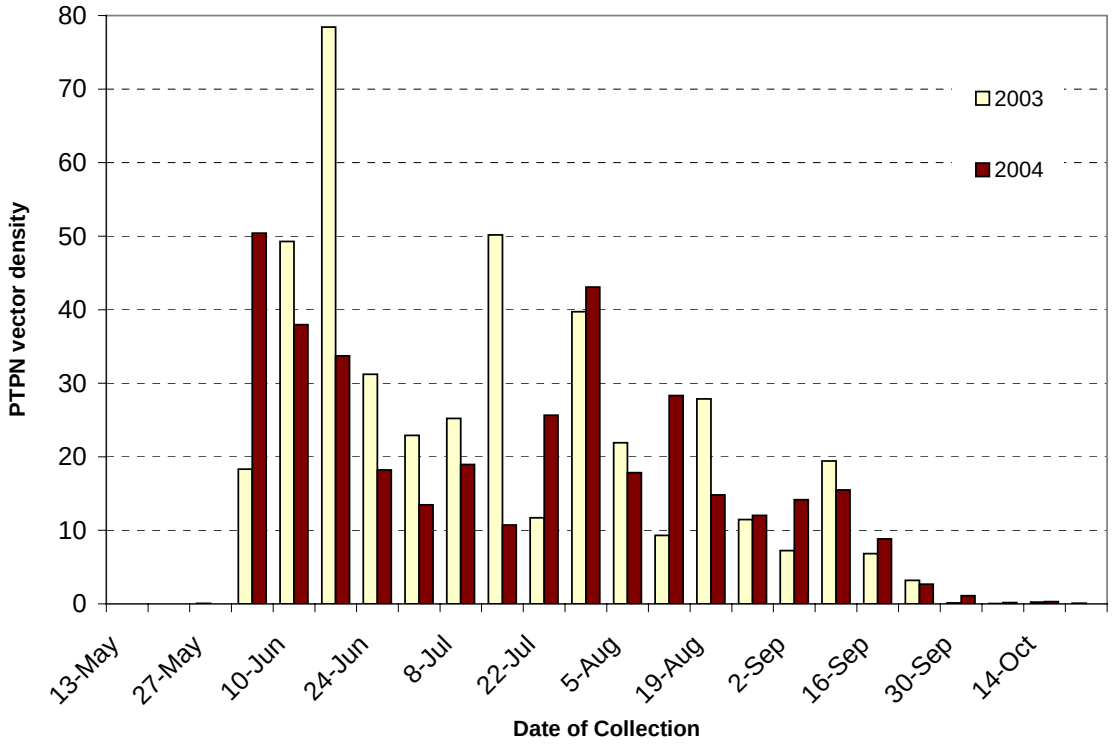


Figure 4-2: Bridge Vector Densities in Routine Trap Sites in Toronto, 2003 and 2004



WNV Testing

Traps tested positive for WNV on 31 occasions for a total of 33 positive pools in 2004. The first pools to test positive for WNV in Toronto were collected from three different traps on August 4: one in the East TPH region[29] and two in the South region (all three pools were *Culex pipiens/restuans* complex). The last trap-night testing positive for WNV was collected in the West region on September 14. Most positive pools (and trap-nights) were found during the month of August (Table 4-1), which is historically the month with the highest WNV activity. August is also the month with the most mosquito trapping in Toronto as a result of hot spot trapping triggered by the positive mosquito pools, birds, and human cases.

Table 4-1: Collection Date for WNV Positive Mosquito Pools and Trap-Nights by Mosquito Species in Toronto, 2004

Collection Date	Species	Number of Positive Trap-Nights	Number of Positive Pools
4-Aug-04	*Culex pipiens/restuans* complex	3	3
5-Aug-04	*Culex spp.*	1	1
10-Aug-04	*Culex pipiens/restuans* complex	1	1
12-Aug-04	*Culex pipiens/restuans* complex	1	1
13-Aug-04	*Culex pipiens/restuans* complex	3	4
17-Aug-04	*Culex pipiens/restuans* complex	1	1
19-Aug-04	*Culex pipiens/restuans* complex	5	5
24-Aug-04	*Culex pipiens/restuans* complex	1	1
26-Aug-04	*Culex pipiens/restuans* complex	2	2
	Culex spp.	1	1
31-Aug-04	*Culex pipiens/restuans* complex	4	3
	Culex spp.		1
3-Sep-04	*Aedes vexans*	2	1
	Culex pipiens/restuans complex		2
8-Sep-04	*Culex pipiens/restuans* complex	3	2
	Aedes vexans		1
10-Sep-04	*Culex pipiens/restuans* complex	2	2
14-Sep-04	*Culex pipiens/restuans* complex	1	1

Table 4-2 shows the number of mosquitoes tested and the number of positive pools by species (or species group). *Culex pipiens/restuans* complex accounted for a large proportion of mosquitoes tested (38.9%) and an even larger proportion of positive pools (84.9%). There were three mosquito species responsible for positive pools in Toronto: two enzootic vectors[30] (*Culex pipiens*, *Culex restuans*) and one bridge vector (*Aedes vexans*).

[29] TPH regions correspond to the former city boundaries: East = East York, Scarborough; West = Etobicoke, York; North = North York; South = Toronto

[30] *Culex* spp. was also responsible for positive mosquito pools in Toronto; however this group of mosquitoes are most likely *Culex pipiens* or *Culex restuans* mosquitoes.

Table 4-2: Positive Pools and Number of Mosquitoes tested for WNV in Toronto, 2004

Mosquito species/Species group	Positive Pools n (%)	Mosquitoes tested n (%)
Culex pipiens/restuans complex	28 (84.8)	9568 (38.9)
Aedes vexans	2 (6.1)	8612 (35.0)
Ochlerotatus stimulans		2825 (11.5)
Coquillettidia perturbans		1218 (4.9)
Culex spp.[31]	3 (9.1)	1055 (4.3)
Ochlerotatus triseriatus		506 (2.1)
Anopheles punctipennis		401 (1.6)
Ochlerotatus trivittatus		365 (1.5)
Aedes cinereus		43 (<1.0)
Culex salinarius		6 (<1.0)
Ochlerotatus japonicus		6 (<1.0)
Anopheles walkeri		5 (<1.0)
Anopheles spp.		2 (<1.0)
Total	**33**	**24612**

The highest proportion of positive trap-nights was found in the West region and the lowest in the North region (Table 4-3). Since the number of positive trap-nights is affected by the total number of trap-nights in each region, the distribution of positive trap-nights were compared with TPH region after adjusting for the number of trap-nights in the region (Table 4-4). There was a significant relationship between the proportion of trap-nights that were positive and region. Also, the South region had the highest proportion of trap-nights that were positive.

Table 4-3: WNV Positive Trap-Nights by TPH Region[32] in Toronto, 2004

TPH Region	Positive Trap-Nights	Percent (%)
East	4	12.9
North	2	6.4
South	10	32.3
West	15	48.4
Total	**31**	**100**

[31] *Culex* spp. mosquitoes are most likely the species *Culex pipiens* or *Culex restuans*.

[32] TPH regions correspond to former municipalities: North = North York; South = Toronto; East = Scarborough, East York; West = Etobicoke, York

Table 4-4: WNV Positive and Negative Trap-nights by TPH Region in Toronto, 2004

TPH Region	Positive Trap-Nights	Negative Trap-Nights	Total Trap-Nights[33]	Proportion of Trap-Nights that were Positive
East	4	289	293	1.4 %
North	2	313	315	0.6 %
South	10	122	132	7.6 %
West	15	290	305	4.9 %

$\chi^2 = 22.34$ (p-value<0.0001)

Table 4-5 shows the mosquito infection rates[34] for enzootic vectors on dates that positive mosquito pools were collected. Infection rates for bridge vectors were not included in this analysis as bridge vector species were rare, and thus calculated infection rates for these species are unlikely to be reliable. Infection rates for hot spot traps were higher than routine traps as hot spot traps are placed in areas where WNV activity has already been detected. Thus, the likelihood of finding positive mosquitoes is higher in hot spot traps than in routine traps. Also, the number of hot spot traps and the number of mosquitoes trapped in them were lower than for routine traps potentially resulting in higher calculated infection rates.[35]

For enzootic vectors, infection rates in routine traps were low (Maximum Likelihood Estimate of infection rate (MLE) < 5 per 1,000 females tested) throughout August and peaked on August 31(MLE =11.43 per 1,000 females tested). There was a sustained increase of infection rates in early September and the last positive mosquito pool in a routine trap was collected on September 14.

In hot spot traps, enzootic vector infection rates peaked on August 12 and 13 (MLE > 20 per 1,000 females tested) and declined at the end of August. After this decline there was an increase in rates in early September.

The increase of infection rates in early September in both trap site types may have been partially due to the low number of enzootic vectors trapped in the month, which may have artificially increased calculated infection rates.

[33] 95 trap-nights were not included as no mosquitoes were trapped at those sites on those nights

[34] A common method of calculating mosquito infection rates is the Minimum Infection Rate (MIR). MIR is the number of positive pools of a species divided by the total number of mosquitoes trapped of that species. The main assumption for MIR is that only one positive mosquito is needed for a pool to test positive. Thus, it is only a good approximation of the true infection rate when the arbovirus of interest is rare. The Maximum Likelihood Estimate of the mosquito infection rate (MLE) is another measure of mosquito infection rates that does not make these assumptions and is thought to be a better measure of true infection rates. MLE was calculated using PoolScreen 2.0, developed by Katholi and Barker (2002). Calculated infection rates are denominator-dependent and thus can be misleadingly high for rare mosquito species.

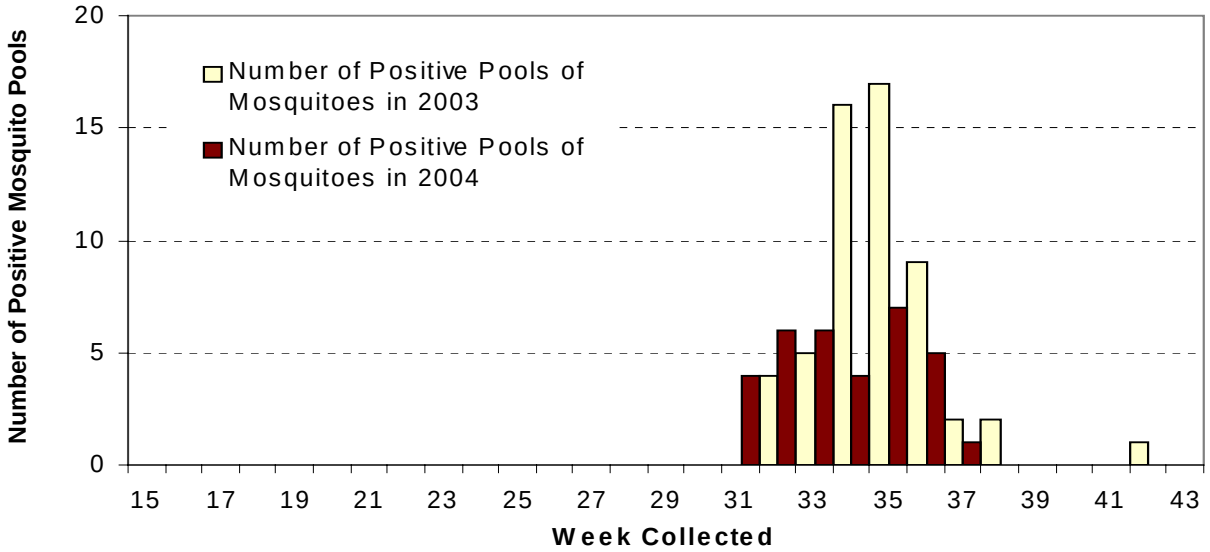
[35] Infection rates are calculated for all traps in Toronto stratifying by trap site type with the total number of enzootic vectors trapped as the denominator. Therefore, infection rates in routine traps would be expected to be lower than infection rates in hot spot traps as there are more routine traps than hot spot traps.

Table 4-5: WNV Minimum Mosquito Infection Rates (MIR) and Maximum Likelihood Estimates (MLE) of Mosquito Infection Rates by Date and Trap Site Type for Enzootic Vectors in Toronto, 2004

Date of Collection	Number of Positive Pools	Total Enzootic Vectors Trapped	MIR (per 1000 females tested)	MLE (per 1000 females tested)	MLE Lower 95% Confidence Limit	MLE Upper 95% Confidence Limit	Trap Site Type
Aug 4	3	868	3.46	3.56	0.70	10.30	Routine
Aug 5	1	273	3.66	3.70	0.11	18.93	Hot spot
Aug 10	1	775	1.29	1.31	0.04	6.70	Routine
Aug 12	1	44	22.73	23.84	0.74	117.09	Hot spot
Aug 13	4	219	18.27	24.59	6.17	64.14	Hot spot
Aug 17	1	883	1.13	1.16	0.04	5.93	Routine
Aug 19	5	394	12.69	14.74	4.44	34.73	Hot spot
Aug 24	1	558	1.79	1.83	0.06	9.38	Routine
Aug 26	3	468	6.41	6.60	1.28	19.03	Hot spot
Aug 31	4	365	10.96	11.43	2.90	29.16	Routine
Sept 3	2	213	9.39	9.89	1.17	34.33	Hot spot
Sept 8	2	319	6.27	6.51	0.77	22.68	Routine
Sept 10	2	122	16.39	17.42	2.07	59.95	Hot spot
Sept 14	1	202	4.95	5.62	0.17	28.94	Routine

In both years, the majority of positive mosquito pools were found between weeks 32 and 36 (Figure 4-3). It appears that similar to WNV bird activity, mosquito activity started and ended earlier in 2004 compared to 2003. Also, based on the number of positive mosquito pools WNV activity was less intense in 2004.

Figure 4-3: Comparison of WNV Positive Mosquito Pools in 2003 and 2004, by Week[36] in Toronto



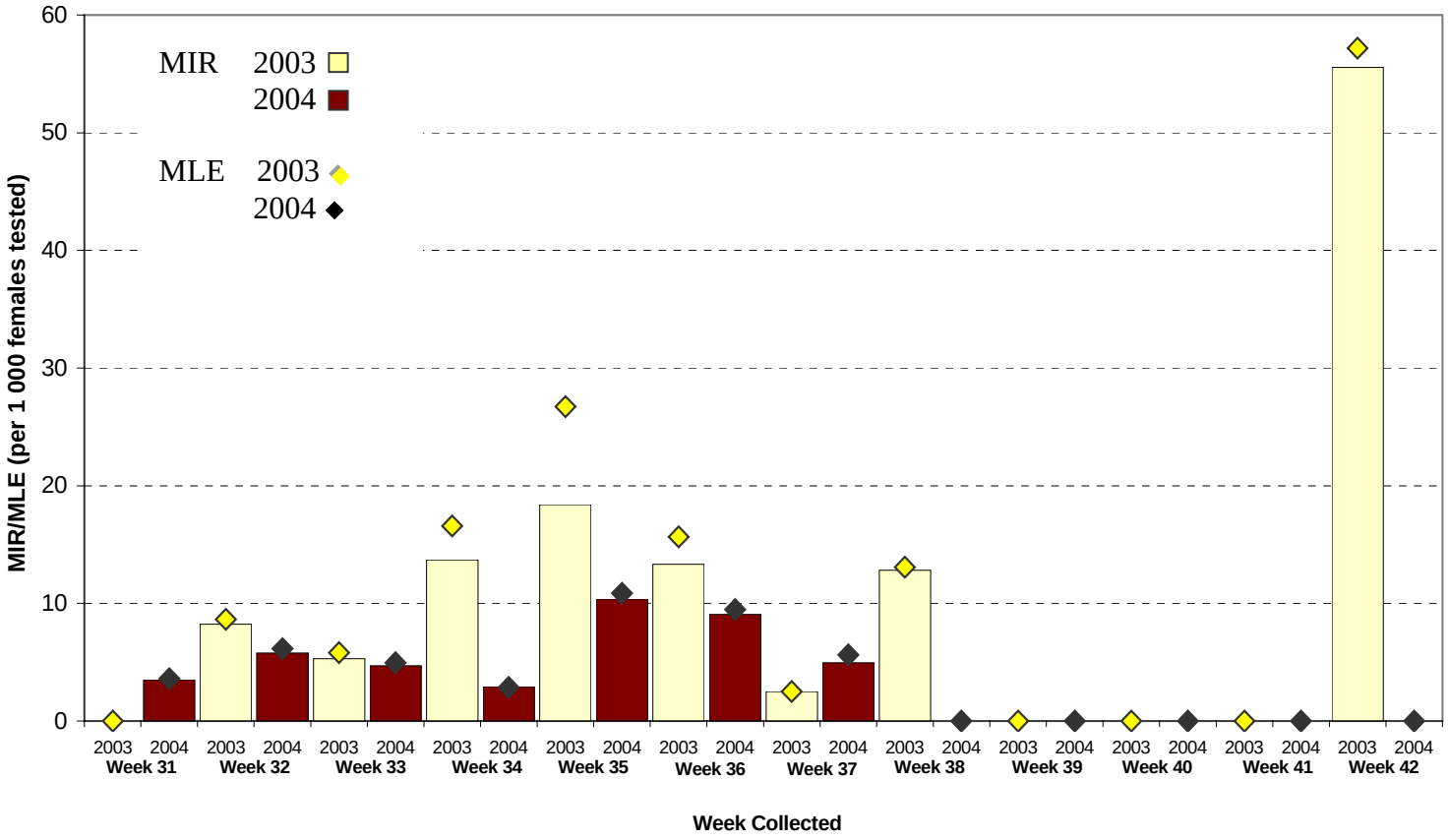
[36] Weeks are calculated using the first full week of the year as week 1.

Figure 4-4 displays the distribution of mosquito infection rates in 2003 and 2004 calculated as the Minimum Infection Rate (MIR) and Maximum Likelihood Estimate of the mosquito infection rate (MLE).

In 2003, there was a peak in infection rates (as measured by both MIR and MLE) in week 35, another increase later, which may have been partly due to limitations in calculations. In 2004, there was a similar peak in infection rates only in week 35. Although infection rates were high during weeks 35 to 36 in both years, the rates in 2004 were lower than rates in 2003.

The main assumption in calculating MIR is that only one positive mosquito is needed for a pool to test positive. Thus, it is only a good approximation of the true infection rate when the virus is rare. The MLE does not make this assumption; thus it is a better approximation of the true mosquito infection rate when the virus is not rare. The MIR and MLE were almost identical in Weeks 31 to 33 in both years demonstrating that the disease was still rare during that period. However in Weeks 34 to 36, in 2003, the MLE was much higher than the MIR demonstrating the increased prevalence of the disease during the period.

Figure 4-4: WNV Minimum Infection Rate (MIR) and Maximum Likelihood Estimate (MLE) of Infection Rates for Mosquitoes Tested, by Week[37] in Toronto for 2003 and 2004



[37] Weeks were calculated using the first full week in each respective year as week 1.

Human Surveillance

Overview

During the 2004 West Nile Virus (WNV) season, 117 clients were reported to Toronto Public Health (TPH) with suspected WNV illness. Six of those clients were diagnosed with confirmed WNV and the remaining 111 clients were determined not be acutely infected with WNV. Of these 111 individuals, 18 had a previous WNV or flavivirus infection (the laboratory tests can not accurately separate WNV from other related flaviviruses). The remaining 93 were initially diagnosed with WNV based on their clinical presentation, but WNV was ruled out using laboratory testing. There were significantly fewer cases in 2004 compared to the two previous seasons. In 2003, TPH received reports of 44 confirmed WNV cases and in 2002 130 confirmed and 36 probable WNV cases were reported.[38]

In 2004, as in the previous years, one high priority focus of TPH WNV case investigation was the detection of possible transmission through receipt or donation of blood/blood products and organs/tissue transplants. Clients were also interviewed to determine the locations of any possible exposure to mosquitoes, which may have lead to infection, and to determine the use of insect repellents. The possible environmental exposure locations identified through these interviews were forwarded to the Healthy Environments WNV team for further follow-up.

Summary of cases

The case definitions used in 2004 were refined from the previous year. In 2004, the Ministry of Health and Long-Term Care eliminated the 'possible WNV' category and the following WNV case categories were used by all Ontario Health Units:

- Confirmed West Nile Neurological Syndromes (WNNS)
- Confirmed West Nile Fever (WNF)
- Confirmed West Nile Asymptomatic Infection (WNAI)
- Probable WNNS
- Probable WNF
- Probable WNAI
- Suspect WNNS
- Suspect WNF

These categories describe the symptoms experienced by those infected with WNV (Neurological Syndromes, Fever, or Asymptomatic (i.e. no symptoms) as well as the method of diagnosis and the type of laboratory tests used to make a diagnosis for a WNV case. Appendix 2 provides an explanation for each of these categories.

The gender and case definition for the six cases are presented in Table 6-1. The mean age of the six reported cases was 61.2 years as compared with 50.1 years for the 2003 WNV confirmed cases (Table 6-2).

[38]There was a change in case definitions between 2002 and 2003 and further refinements in 2004.

Table 6-1: Distribution of WNV Cases by Gender and Case Definition, 2004

Gender	Confirmed WNAI	Confirmed WNF	Confirmed WNNS	Total
Female	1	0	3	4
Male	0	0	2	2
Total	**1**	**0**	**5**	**6**

Table 6-2: Average Age of Cases by Gender and Case Definition, 2004

Gender	Confirmed WNAI	Confirmed WNF	Confirmed WNNS	All Cases
Female	76	-	54.7	60
Male	-	-	63.5	63.5
Average age by case type	76	-	58.2	61.2

This is the first year that TPH received a report of a confirmed WNV asymptomatic case. This client was hospitalized for other reasons and WNV results were deemed to be an incidental finding.

Of the six confirmed WNV cases reported in 2004, three required hospitalization due to their WNV illness and one person required intubation. The status of the hospitalized cases was followed daily by staff of the TPH, Communicable Disease Liaison Unit to gather information on the severity of WNV illness amongst Toronto cases and to support reporting of the morbidity and mortality due to WNV to the public and the Ministry of Health and Long-term Care.

Appendix 3 provides an epidemic curve of the six WNV cases reported in 2004 by the date of onset of illness. The mean length of time from illness onset until report to TPH was 11 days (ranging from 3 to 26 days).

Larval Surveillance & Control of Mosquito Breeding Grounds

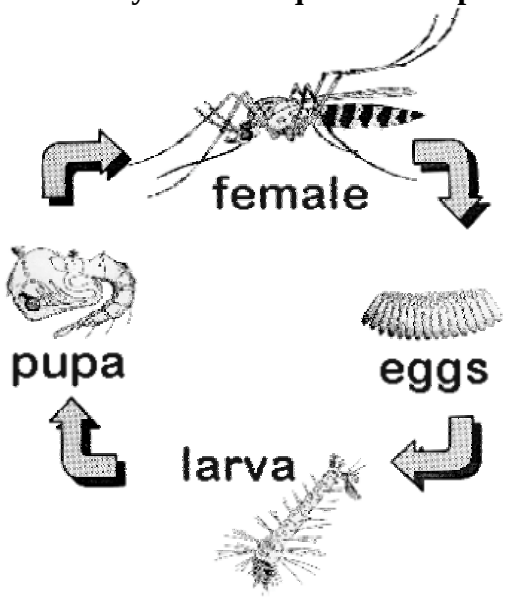
Background

There are more than 2,500 species of mosquitoes around the world. Two hundred of these species can be found in the United States and Canada, but there are only 43 known carriers of West Nile Virus (WNV).[39] Approximately 20 species/groups of species were tested for WNV in 2004; they were species that had tested positive for WNV in Ontario from 2001 to 2003. In Toronto, there was a focus on *Culex pipiens* and *Culex restuans* mosquitoes, as they are responsible for much of the WNV amplification, which is needed for elevated levels of WNV activity.

Mosquito species go through four separate and distinct stages of development: egg, larva, pupa, and adult; they spend their larval and pupal stages in water (Figure 5-1). *Culex* mosquitoes lay their eggs on the surface of fresh or stagnant water. This includes natural and artificial surface waters. Mosquitoes can lay 200-300 eggs at a time. Larvae emerge from the eggs and live in water. The larvae then develop into pupa after molting several times. Mosquito pupa live in water until development is complete, at which point the pupal skin splits and the mosquito emerges as an adult. In the hot summer months, larvae grow rapidly, become pupa, and can emerge one week later as flying adult mosquitoes.[39]

Toronto Public Health is responsible for conducting a larviciding program to reduce the population of WNV-carrying mosquitoes. The work is performed under the direction of Toronto's Medical Officer of Health under the authority of the Health Protection and Promotion Act.

Figure 5-1: Cycle of Mosquito Development[39]



[39] Department of Environmental Protection, Montgomery County, Maryland: http://www.montgomerycountymd.gov/deptmpl.asp?url=/content/dep/mosquito/facts.asp. Accessed February 28, 2005

Purpose

The purpose of larval surveillance and control is to minimize mosquito numbers and prevent WNV transmission. Toronto Public Health (TPH) employs an integrated pest management approach that has been recognised as the most effective and environmentally sound manner in which to conduct a mosquito control program. It consists of larval surveillance and control of mosquito breeding grounds using mechanical means and the use of pesticide only when necessary.

Larval surveillance serves to identify mosquito-breeding sites and includes larval dipping in City-owned catch basins and surface waters. Control of mosquito breeding grounds includes larviciding of City of Toronto-owned catch basins and surface waters with elevated larval counts.

Surface Waters

The City of Toronto received and investigated reports of standing water on both private and City-owned properties at the call-centre, Toronto Health Connection. Over 2 800 calls were received, 816 of which were related to standing water complaints. The call centre re-directed these complaints and/or enquiries to the appropriate department based on a response protocol for follow-up. All complaints were resolved by the season's end. The majority of calls (60%) were re-directed to Healthy Environments and the other 40% were referred to other departments. Of the 487 calls re-directed to Healthy Environments, 7 were unwarranted, 45 were referred, 100 were resolved without an inspection and 335 proceeded to an inspection. In addition to calls via Health Connection, Healthy Environments Area Offices received 118 complaints. Of which two were unwarranted, seven were referred, 40 were resolved without inspecting and 69 proceeded to inspection.

Municipal Licensing and Standards investigated 203 complaints, which led to 96 by-law notices/orders being issued and 12 emergency orders being issued involving TPH assessment indicating the presence of a health hazard.

Works and Emergency Services investigated 62 complaints and Parks and Recreation received 7 complaints.

Potential mosquito breeding sites were also identified when environmental scans were conducted around WNV positive birds, mosquito pools, and human cases.

WNV Field Operators in Healthy Environments, investigated complaints of natural areas breeding mosquitoes on public land. An inspection and assessment of the site determined the extent and rating of the breeding site. Only when a mechanical or maintenance method of correction was determined to be ineffective or not feasible, use of a pesticide was considered.

In the City of Toronto, Bti[40], a larvicide that kills mosquitoes during the larval stage of development was used in surface waters. If a site qualified for Bti treatment, then it was referred to TPH's contractor for Bti treatment. There were 55 distinct sites closely monitored resulting in 96 treatments to 37 distinct sites. The first Bti treatment was on June 15 and the last treatment was on Sept 27.

[40] *Bacillus thuringiensis israelensis* (*Bti)* is a larvicide that kills mosquito larvae. It is made from a naturally occurring bacterium that is common in soils in Canada and throughout the world.

Catch basins

Methods

In urban areas like Toronto, *Culex* mosquitoes often breed underground in standing water in city drains and catch basins. Catch basins are part of the storm water run-off system where surface water enters the sewer system. They are designed to collect water and debris and allow the debris the opportunity to settle out of the water before the water enters the sewer system. During periods of low rainfall, the water in catch basins is usually still serving as a good breeding environment for mosquitoes.

During a drought, these pools become even richer in the rotting organic material that *Culex* mosquitoes need to thrive; rainfall flushes the drains and dilutes the pools and prevents larvae from maturing.[41] *Culex pipiens* and *Culex restuans* mosquitoes are the most common WNV vectors in Toronto are often found in catch basins.

In 2004, larval dips of City-owned catch basins were conducted weekly from June 3 to August 5 and on September 1 and 15 for a total of 12 different collection dates. Each week, the same 90 catch basins were sampled with larval dips. The number of mosquito larvae in these dips were counted and identified at TPH.

To control mosquito larvae counts, methoprene (Altosid™) was used in City-owned catch basins once mosquito larvae were found. Methoprene arrests development of mosquitoes at the pupal stage preventing mosquitoes from developing into adults. It was applied to catch basins during two rounds of larviciding. Methoprene is up to 96% effective against mosquito larvae for up to 21 days after its application to a catch basin.[42,43]

Results

In City-owned catch basins, *Culex pipiens* and *Culex restuans* larval counts increased from June to the beginning of July, and remained at those levels for most of July (Figure 5-2). Larval counts peaked at the end of July, after which they declined. In September, larval counts were higher than levels in June.

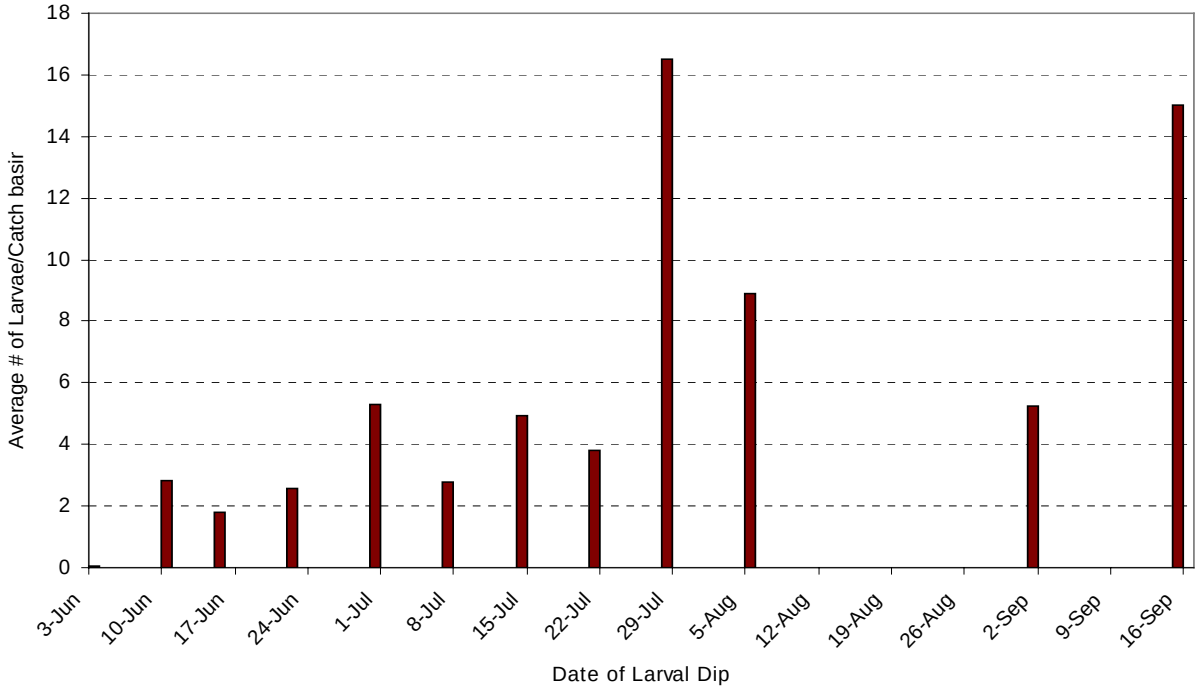
[41] Epstein, P. 2001 "West Nile virus and the climate" Journal of Urban Health (78/2): 367-371

[42] Baker, S and A Hayton. 2003. 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.

[43] Funnell, K, H Shapiro, KP Wong, and A Smith. 2003. West Nile Virus in the Region of Peel. Weblink: http://www.peelregion.ca/health/westnile/pdfs/wnv-full-version.pdf. Accessed November 10, 2004

Figure 5-2: Average Number of Mosquito Larvae per Sampled Catch basin in Toronto, 2004

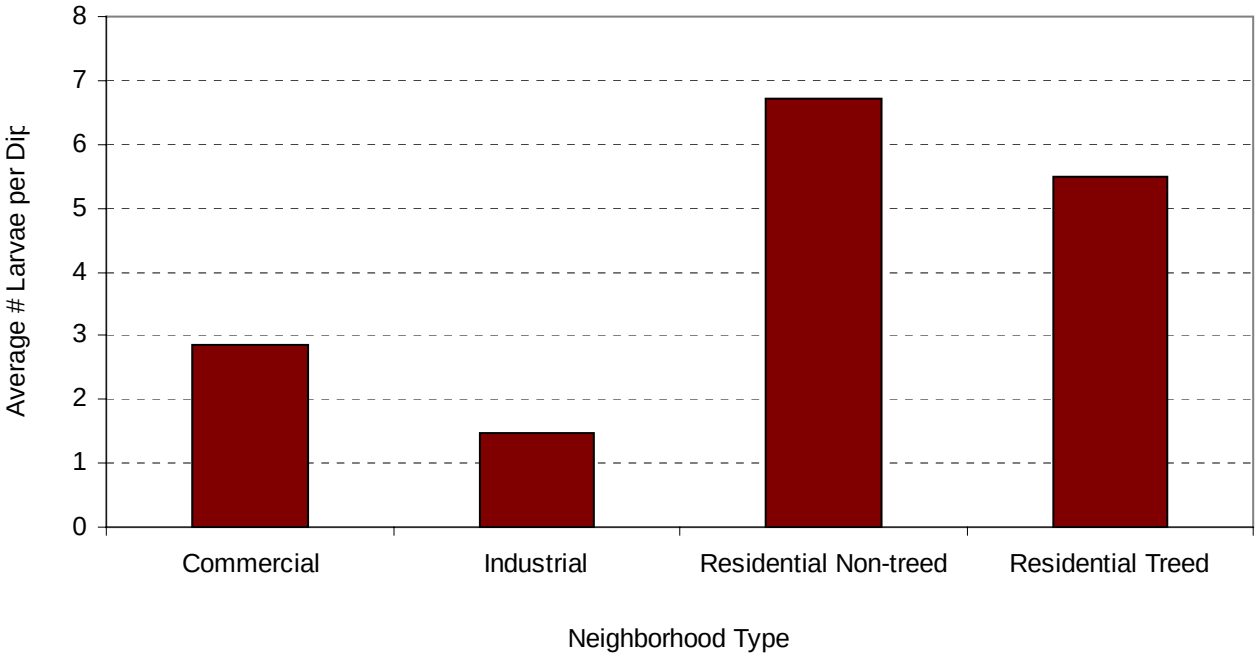
(Larval surveillance conducted weekly form June 3-August 5 and on September 1 and 15)



Analysis of 2004 larval surveillance data suggests that the surroundings of a catch basin have an effect on larval counts (Figure 5-3). Catch basins in residential areas were found to have higher larval counts than catch basins in both commercial and industrial areas. Mosquito larvae prefer standing water to develop thus catch basins in commercial and industrial areas with greater vibration are less likely to promote mosquito. Thus, it appears that vibration plays a role on mosquito breeding in Toronto catch basins.

Once high levels of mosquito larvae were detected in City of Toronto catch basins, treatment with methoprene commenced. Approximately 200,000 applications of methoprene were made during two rounds of larviciding to City of Toronto catch basins.

Figure 5-3: Average Number of Mosquito Larvae per Dip Collected in Toronto, 2004

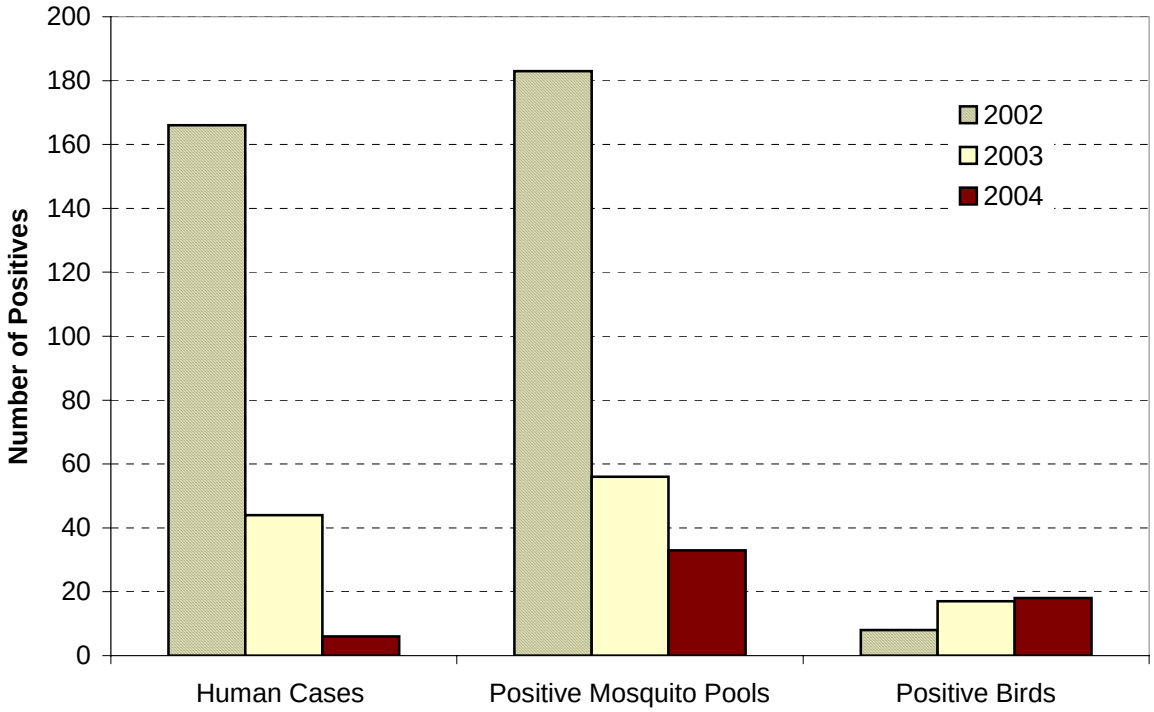


Conclusions

There has been an overall decrease in West Nile Virus (WNV) activity in the City of Toronto in 2004, compared to the previous two years. The number of positive mosquito pools and human cases have declined over the past two years demonstrating the decline in risk for humans and intensity of WNV activity (Figure 7-1). The number of positive birds has stayed approximately the same from 2002 to 2004. However, positive birds are used to evaluate for the presence of WNV in an area and are not a good measure of intensity.

Figure 7-1: WNV Positive Indicators in Toronto for 2002, 2003, and 2004

*There was disruption in WNV surveillance for dead birds and adult mosquitoes in 2002.



There has been a decline in WNV activity in Toronto, Ontario, and Canada (Table 7-1). However, the human incidence rate[44] in Toronto (0.24 cases per 100,000 people) is higher than the incidence rates[44] in Ontario (0.12 per 100,000) and Canada (0.08 per 100,000). Thus, ongoing vigilance in the surveillance and management of WNV in Toronto is important.

[44] Based on 2001 census data from Statistic Canada: www.statscan.ca. Accessed February 20, 2005

Table 7-1: Number of Human Cases, Positive Dead Birds, and Positive Mosquito Pools in Toronto, Ontario, and Canada

	Toronto	Ontario[45]	Canada[46]
Human Cases[47]	6	14	26
Positive Mosquito Pools	33	70	176
Positive Dead Birds	18	250	416

Other Findings:

- Key mosquito species in determining the level WNV activity are the enzootic vectors, *Culex pipiens* and *Culex restuans* in Toronto, as they were responsible for most of the positive mosquito pools. Thus, intervention aimed at reducing counts of these species should continue in Toronto.
- South region[48] is an area of interest for WNV activity as it contains a high proportion of the human cases and positive birds and mosquito pools. Further, *Culex pipiens* and *Culex restuans* mosquitoes are key vectors of WNV and are primarily found in urban areas like the South region in Toronto.
- August and September are the months with the most intense WNV activity, thus interventions targeted at public education and awareness should be increased during this time period.

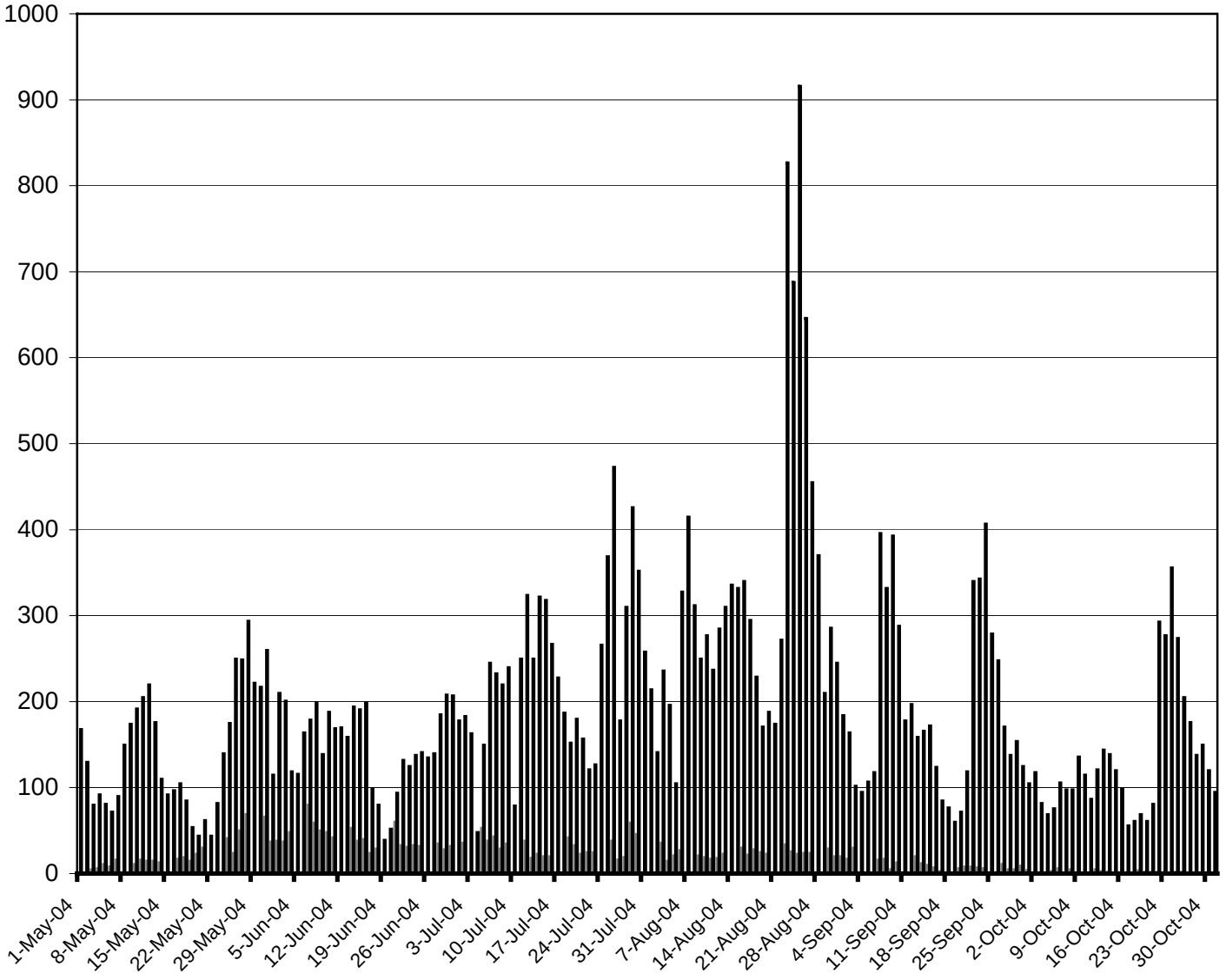
[45] Ministry of Health and Long-term Care of Ontario: http://www.health.gov.on.ca/english/public/program/pubhealth/westnile/wnv_mn.html. Accessed February 20, 2005

[46] Public Health Agency of Canada: http://www.phac-aspc.gc.ca/wnv-vwn. Accessed February 20, 2005

[47] Confirmed and probable cases

[48] TPH regions correspond to former municipalities: North = North York; South = Toronto; East = Scarborough, East York; West = Etobicoke, York

Appendix 1: West Nile Virus Homepage Visits & Calls to Toronto Health Connection May – October 2004



Significant dates:

April 30: Peel Region media release on reducing WNV - Report Dead Crows and Stagnant Water
May 13: MOHLTC WNV program launch (media release and media event at Allan Garden's)
May 26: TPH WNV program launch (media release)
May 31: York Region first bird tests positive (media release)
June 11: TPH lariviciding notification ads in the Star & Sun
June 17: York Region starts larviciding program (media release)
June 25: MOHLTC consumer briefing on WNV myths and protection measures (first long weekend)
June 30: Peel Health Sends Important Information About West Nile Virus To All Peel Residents (media release)
June 30-Sept 5: TPH ad campaign (60 placements in major dailies, ethno-cultural papers, community papers and transit shelters)
July 9: Peel Region announces Brampton crow confirmed positive forWNV (media release)
July 23: MOHLTC media release on personal protection measures and EEE
July 29: TPH announces first positive mosquitoes (media release)
July 30: WNV activity on the rise in Peel (media release)
July 30: MOHLTC media release on personal protection measures
July 31: York Region reports first positive mosquitoes (media release)
Aug. 6: MOHLTC announces first positive human case in Windsor-Essex (media releaase)
Aug. 23: TPH announces first positive human case (media release)

Appendix 2: West Nile Virus Case Definitions – 2004

	Level of severity of illness		
Level of Laboratory Certainty	Neurological Syndromes	Fever	Asymptomatic Infection (no symptoms)
Confirmed*	Have symptoms of encephalitis with laboratory evidence, which for the first 3 cases are PRNT positive after initial testing with IgM ELISA and after the first 3 PRNT confirmed cases in a jurisdiction for the current year are WNV IgM reactive.	Two or more symptoms of WNV illness including fever, rash, myalgias and arthralgias without encephalitis with laboratory evidence of infection which for the first three positive cases are PRNT positive after initial testing with WNV IgM ELISA and after the first three confirmed cases in a jurisdiction for the current year are WNV IgM reactive. Note that starting in 2004 individuals did not have to have demonstrated fever to be classified as a case of WNV fever.	No symptoms of WNV but laboratory evidence which for the first three positive cases are PRNT positive after initial testing with IgM ELISA and after the first three confirmed cases in a jurisdiction for the current year are WNV IgM reactive.
Probable	Have symptoms of encephalitis and are one of the first 3 cases testing WNV IgM positive (ELISA test), in a jurisdiction for the current year awaiting confirmation by PRNT.	Have symptoms of WNV fever such as rash, myalgias and arthralgias without encephalitis, and is one of the first three cases to test positive using IgM ELISA in a jurisdiction for the current year, awaiting confirmation by PRNT.	No symptoms of WNV and are one of the first positive cases in a jurisdiction for the current year using IgM ELISA, awaiting confirmation with PRNT.
Suspect	Have symptoms of encephalitis with no laboratory evidence of WNV.	Have symptoms of WNV fever such as rash, myalgias and arthralgias without laboratory evidence for WNV.	Not Applicable

Note:
* Once 3 clients who have tested WNV IgM reactive (ELISA) are PRNT confirmed, within a jurisdiction (health unit area), then all additional clients who test WNV IgM reactive are deemed to be confirmed WNV cases within that jurisdiction.

Appendix 3: Epidemic Curve of Cases for 2004

** There was uncertainty about the exact date of onset so specimen collection date was assigned as date of disease onset.