

West Nile Virus in the Thunder Bay District, 2005

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EXECUTIVE SUMMARY

No human cases of West Nile virus (WNV) were reported from the District of Thunder Bay during 2005. The virus, however, was recovered from 10 dead crows. The public reported 159 dead birds, 51 of which were submitted for viral testing. The first bird that tested positive for WNV was collected on 14 June and the last bird was collected on 22 September. A “spike” (a sudden increase in mortality) with a sustained “hot spot” (a clustering of several dead birds in one area) did not occur, indicating that WNV had amplified, but not extensively, within the bird community. Risk to human health from WNV was considered minimal and no remedial actions were recommended.

Twelve catch basins were inspected within the City of Thunder Bay on 12 August. Ten of these catch basins contained mosquitoes, but only the species *Culex restuans*, an enzootic vector which transmits WNV to birds, was present. A more comprehensive survey must be completed before a definitive statement can be made about the incidence of *Cx. restuans* in the catch basins of Thunder Bay and the possible risk to the public. Three potential breeding sites for mosquitoes were examined, but none contained mosquito larvae.

No fewer than 19 CDC adult mosquito light traps were operated one night per week within the City and the Region in the District of Thunder Bay during the 10-week period from 5 July to 7 September, for a total of 201 trap-nights. Nine vector species (one enzootic and eight epizootic) and 16 non-vector species were found in the light traps. Epizootic vectors transmit WNV to birds and mammals. The light traps collected a grand total of 12,185 specimens. A total of 6,000 individuals were identified from these specimens, of which 4,039 were vectors. These vectors were pooled by species and then 315 pools were tested for WNV. No mosquito pool tested positive for WNV indicating minimal risk to the public.

An estimate of the total number of each species of mosquito was calculated from 11,370 identifiable specimens. *Cx. restuans*, an enzootic vector, totaled 52 individuals or approximately 0.5% of the 11,370 mosquitoes. Epizootic vectors included *Aedes vexans*

(19.2% where n= 2,182), *Coquiletidia perturbans* (61.1% where n= 6,969), and six other species, including *Culex salinarius* (0.009% where n= 1) which is now confirmed as occurring in the District of Thunder Bay and *Culex tarsalis* (0.2% where n= 21) which is a new record for the District of Thunder Bay.

The low incidence of *Cx. restuans* and the absence of *Culex pipiens*, the major enzootic vector of WNV in the southern Ontario mosquito community, made the amplification of WNV within the bird community unlikely during the summer of 2005. “Spill-over” (the transmission of WNV from birds to mammals) did not occur, which was similar to the situation during 2003 and 2004. The species composition of the mosquito community; however, was considered adequate to complete the transmission of WNV to humans if the abundance of the only enzootic vector, *Cx. restuans*, or the abundance of the new enzootic/epizootic vectors *Cx. salinarius* and *Cx. tarsalis* increases significantly.

The number of mosquitoes collected during 2005 was substantially lower (n= 12,185) than that collected during 2004 (n= 16,469) despite increased and more consistent trapping effort. Trapping intensity increased from 150 trap-nights during 2004 to 201 trap-nights during 2005. Possibly the differing weather conditions experienced in northwestern Ontario during the summers of 2004 and 2005 account for the variation in the mosquitoes that were collected. The hot, dry summer of 2005 produced even fewer individuals of *Cx. restuans* (n= 52) than the cool, wet summer of 2004 (n= 346).

Cx. restuans, *Cx. salinarius*, and *Cx. tarsalis* were absent or almost entirely absent from the light traps by the end of August; therefore, the risk from WNV was virtually over by early September. Continued trapping after early September is unwarranted.

All data that were collected were stored using GIS, which facilitated risk assessment at the time of data collection. Based on these data, neither larviciding nor adulticiding was considered necessary during 2005.

History of West Nile Virus in North America

West Nile virus (WNV) first appeared in North America during August 1999 in New York City. Subsequently this disease, which is vectored (transmitted) by infected mosquitoes, spread across continental United States. By the end of the summer of 2005, only Alaska remained free of WNV in humans, birds, animals, and mosquitoes (Centers for Disease Control 2005b). A total of 2,775 cases of WNV infections occurred in humans in the United States during 2005, resulting in 98 deaths (Centers for Disease Control 2004a).

WNV was first detected in Canada during 2001 when dead birds tested positive for the virus (Health Canada 2001). The first human cases of WNV in Canada occurred during 2002 in Alberta, Ontario, and Quebec with a total of 204 probable cases, 158 confirmed cases and 11 deaths (Health Canada 2003). During 2003 there were 115 probable cases, 1,220 confirmed cases, and 10 deaths (Health Canada 2004). During 2004 there were only 29 clinical cases of WNV and 2 deaths (Public Health Agency of Canada 2004). During 2005 there were 226 clinical cases of WNV and 12 deaths; however, WNV was still not found in British Columbia, Yukon, Northwest Territories, and Nunavut (Public Health Agency of Canada 2005). There were still no human cases of WNV recorded from the Thunder Bay District Health Unit during 2005.

Illness Caused by West Nile Virus

WNV is vectored by infected mosquitoes. Eighty percent (80%) of people infected with WNV are asymptomatic. The remaining 20% of infected people develop West Nile Fever which consists of fever, tiredness, headache, muscle aches, rash and/or swollen glands. Approximately one in 150 people infected with the virus will develop a serious manifestation called encephalitis, *i.e.* a swelling of the brain. Symptoms of West Nile Encephalitis include fever, headache, stiff neck, disorientation, coma, tremors, muscle weakness and/or paralysis (Elliott *et al.* 2003).

West Nile Encephalitis is more common, but not restricted to people over 50 years of age. The severity of the disease increases with age. From 4% to 14% of people with West Nile Encephalitis die as a result of their infection, whereas others may experience long-lasting, debilitating problems ranging from memory loss to muscle weakness (Elliott *et al.* 2003).

Transmission of West Nile Virus in Humans

West Nile virus is a mosquito-borne flavivirus that infects primarily birds, producing a transient high viraemia that allows transmission of the virus back to feeding mosquitoes in an amplifying cycle. Humans can become infected as a result of bites from mosquitoes that have bitten infected birds. Other less common routes of transmission include: intrauterine, breast milk, blood transfusions, and organ transplants. Factors that determine the prevalence and severity of illness in humans are still not well understood (Elliott *et al.* 2003), although our knowledge about the disease is increasing.

Mosquito Vectors

Mosquitoes either overwinter with the virus or become infected with WNV when they bite infected birds. The virus must replicate within the mosquito before being transmitted to a new host. Infected mosquitoes bite other birds, thus transmitting the infection to these birds in an amplifying cycle that is temperature dependent (Elliott *et al.* 2003). The virus undergoes replication in the newly infected birds, which then become a source of infection for other mosquitoes as the enzootic phase of the disease progresses. If amplification begins during the early spring, a large number of infected mosquitoes and birds are present by mid-summer.

The primary mosquitoes involved in the enzootic amplification process in Ontario are *Culex pipiens* and *Culex restuans* (Alex Timmins pers. com.). These mosquitoes prefer to feed on birds but may also rarely bite humans or other mammals (Wood *et al.* 1979). A third *Culex* species, *Culex tarsalis*, is the main mosquito species responsible for the

transmission of WNV in western North America (Goddard *et al.* 2002). *Cx. tarsalis* is unusual for the genus *Culex* because it feeds freely on both birds and mammals (Wood *et al.* 1979) thus acting as both the enzootic and epizootic vector of WNV. *Cx. pipiens* and *Cx. restuans* prefer to lay their eggs in man-made structures that contain water such as street-side catch basins, road-side ditches, and man-made containers (tires, bottles, buckets, bird baths, roof gutters, swimming pool covers, etc.) where the eggs develop into larvae, then pupae and finally adults (Wood *et al.* 1979). *Cx. tarsalis* lays its eggs in permanent and semi-permanent ponds, irrigation and roadside ditches with emergent vegetation, and even temporary pools or artificial containers (Wood *et al.* 1979).

“Bridge vectors”, mosquitoes that are generalist feeders, bite both birds and mammals. “Bridge vectors” are responsible for transmitting WNV to humans during a “spill-over”, the epizootic phase of the disease, which occurs during the late summer. The “spill-over” occurs only when a large number of infected birds are present. There are 11 bridge vector species that have tested positive for WNV in Ontario (Alex Timmins pers. com.). From 2002 to 2005, tests for WNV on 79,728 pools of mosquitoes in Ontario identified 1,091 (1.4%) positive pools. Of these positive pools, 966 (88.5%) were *Cx. pipiens/restuans* and the remainder were “bridge vectors”. Of the 125 positive “bridge vectors”, 64 were *Aedes* spp, primarily *Aedes. vexans* (Alex Timmins pers. com.); however, this species is only moderately effective as a bridge vector (Turell *et al.* 2001). *Ae. vexans* breeds in temporary pools, marshes, and swamps (Wood *et al.* 1979).

Cx. pipiens, *Cx. restuans*, *Cx. tarsalis*, and *Ae. vexans* are found in proximity to human populations, which makes these mosquitoes important vectors in the transmission of WNV. Both enzootic and epizootic vectors are required in high numbers near humans before WNV becomes a risk to public health.

Objectives of the West Nile Virus Surveillance Programme, 2005

1. A risk analysis of West Nile Virus activity in the Thunder Bay District was to be completed.
2. A toll-free “Crow Line” was to be established by the Thunder Bay District Health Unit (TBDHU) to facilitate the reporting of dead birds by the general public.
3. Dead birds were to be investigated, and if warranted, submitted to the Canadian Cooperative Wildlife Health Centre in Guelph for viral testing.
4. Mosquitoes in the Thunder Bay District were to be collected using Centers for Disease Control (CDC) adult mosquito UV light traps and identified to species.
5. West Nile Virus prevalence in adult mosquito vector species pools was to be determined using Reverse Transcription-Polymerase Chain Reaction (RT-PCR).
6. Larval mosquito habitat was to be identified and inspected in the City of Thunder Bay.
7. Human cases within the District of Thunder Bay were to be noted and remedial action taken, if necessary.
8. Geographic Information Systems (GIS) mapping was to note:
 - Dead bird locations and viral testing results
 - Mosquito species distributions
 - Larval habitat locations
 - Catch basin data
 - High-risk locations
9. All municipalities within the District of Thunder Bay were to be offered a West Nile Virus information presentation outlining the TBDHU Action Plan and research findings.
10. Science-based information was to be used to determine the need for control of larval and/or adult mosquitoes.
11. A 2005 report on West Nile Virus activity in the Thunder Bay District was to be completed.

Dead Bird Monitoring

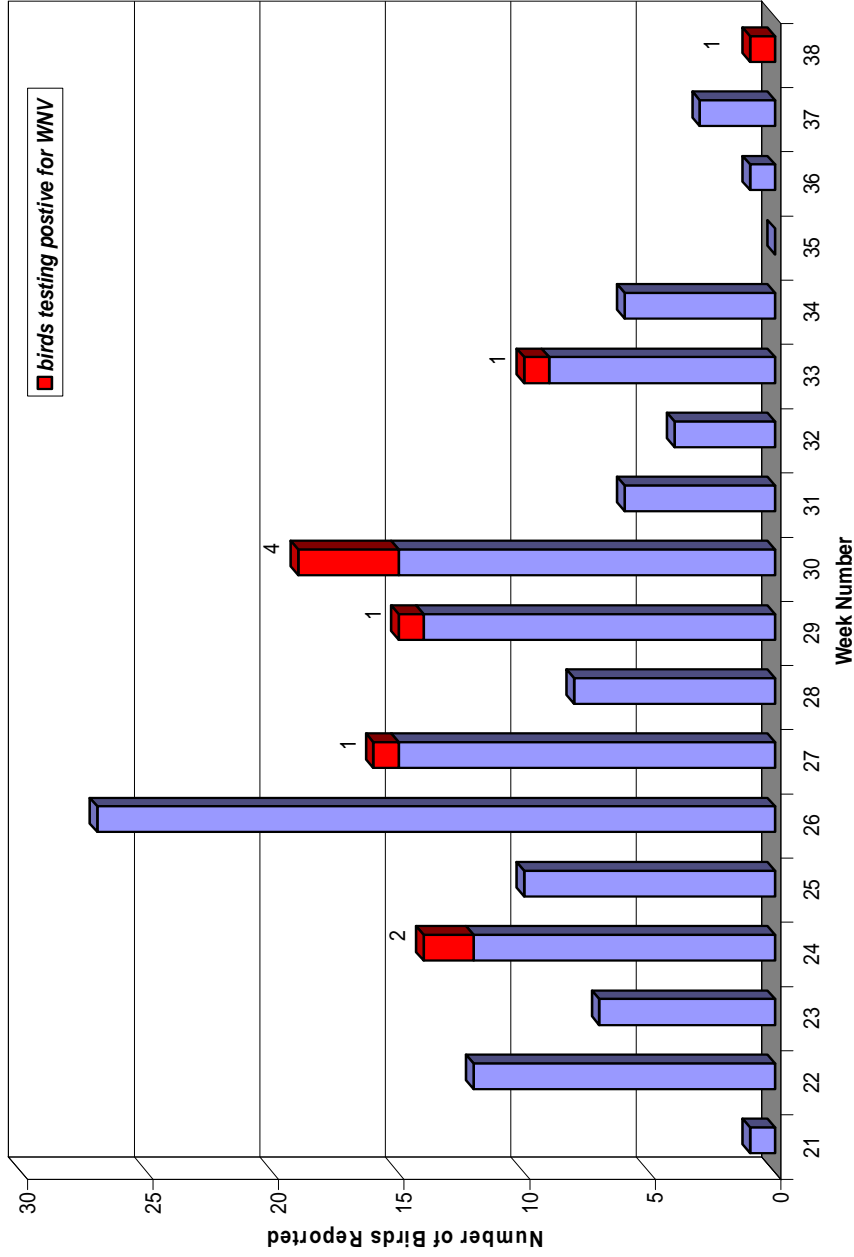
Dead crows are a good indicator of WNV activity. Dead bird sightings peak or “spike” (indicating a sudden increase in bird mortality) just before human cases begin to appear. Clusters of dead birds, known as a “hot spots”, also indicate increased WNV activity in the area (Elliott *et al.* 2003) with increased risk to human health.

Ten birds tested positive for WNV in Thunder Bay during 2005. Monitoring continued from 24 May to 4 October 2005, during which time 159 dead birds (primarily crows) were reported by the public to the “Crow Line”, a toll-free number initiated and maintained by the Thunder Bay District Health Unit (TBDHU). Callers were interviewed for details about the birds, leading to the inspection of 159 birds, and finally 51 birds were selected for viral testing by the Canadian Cooperative Wildlife Health Centre in Guelph. The first bird to test positive was collected on 14 June (week 24) (Fig. 1), one week earlier than the first positive bird in 2004 (21 June). The last bird to test positive was collected on 22 September (week 38) (Fig. 1), which was much later than in 2004 (16 August) and probably resulted from the warmer summer and extended mild autumn that occurred in northwestern Ontario during 2005.

The 159 dead birds that were inspected were distributed from Lac Des Mille Lacs in the west to Longlac in the east (a linear distance of approximately 300 km). Seventeen of the dead birds were submitted from the Region. Two of these birds tested positive for WNV, one from Shuniah Township and the other from Manitouwadge.

Week 26 showed an apparent “spike” in mortality with 27 dead birds reported, compared with 10 to 20 birds per week reported during the rest of the period from June to August (Fig. 1). Although there was a higher rate of mortality within the bird community during Week 26, there were no birds that tested positive for WNV (Fig. 1). The number of dead birds reported during the rest of the summer remained below 20 per week, a number that is considered relatively low. A “spike” in mortality is thought to

**Fig. 1 Birds reported to the Crow Line, Thunder Bay District Health Unit, 2005.
Number of positive birds indicated.**



indicate increased WNV activity and increased human health risk. The spatial pattern of distribution of the dead birds showed no sustained “hot spots” within the City (Fig. 2) or the Region (Fig. 3, Longlac). A “spike” with a sustained “hot spot”, especially one that was associated with birds testing positive for WNV, would have required intervention because of potential increased risk to human health.

The presence of WNV was once again confirmed in the bird community, and the spatial distribution of the positive birds indicated that WNV was established and widely distributed within the City of Thunder Bay and the Region. A “spike” in mortality with a sustained “hot spot” did not occur indicating that WNV had not amplified extensively within the bird community. Risk to human health from WNV was, therefore, considered minimal. Our GIS software and computing facilities enabled data entry of locations, dates of bird mortality, and the results of the viral tests. The identification of “spikes” or “hot spots” of dead birds was possible; however, as mentioned, no intervention was considered necessary.

Larval Mosquito Surveillance

Catch basins, ponds, pools, and containers were examined to identify mosquito breeding sites within the City of Thunder Bay. The locations, species present, and stage of development of mosquitoes were recorded using GIS mapping. GIS mapping increased our ability to note sites that contain mosquitoes, especially vector species. These sites can be monitored in the future, and treated if required.

Catch basins were examined after seven rain-free days, which provides sufficient time for mosquito eggs to hatch and the larvae to develop to an identifiable stage. The seven-day interval was the same as during the survey of 2004, a reduction from the ten-day interval used during the 2003 survey. Frequent rainfall prevented adequate examination of catch basins during 2003 (Deacon 2004). During the summer of 2005,

Fig.2 Distribution of dead birds and location of birds that tested positive for West Nile Virus in the City of Thunder Bay, 2005.

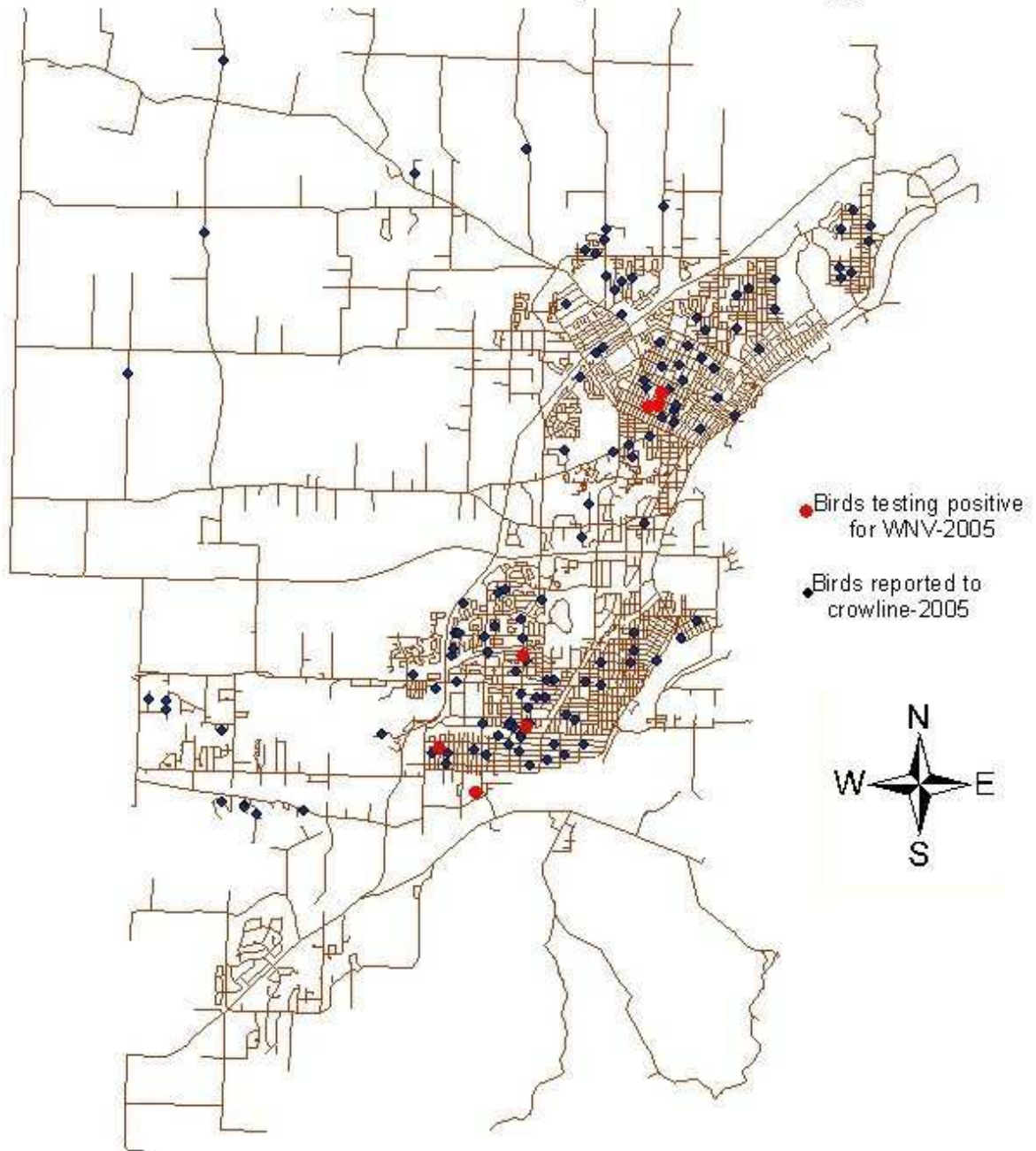
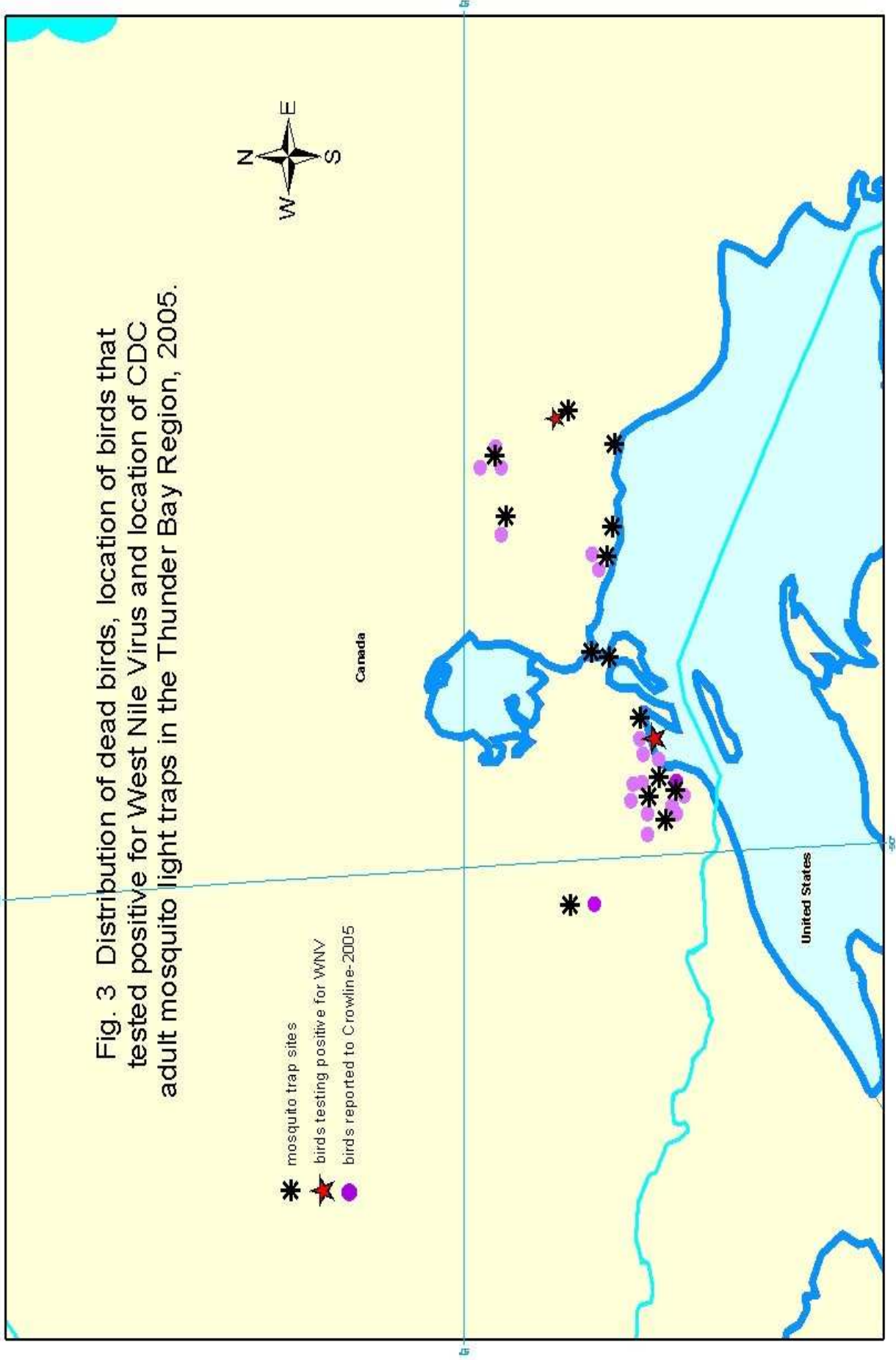


Fig. 3 Distribution of dead birds, location of birds that tested positive for West Nile Virus and location of CDC adult mosquito light traps in the Thunder Bay Region, 2005.



the number of opportunities to examine catch basins was adequate to complete an extensive survey; however, understaffing prevented a comprehensive examination of catch basins.

Twelve catch basins were inspected on 12 August (Fig. 4) in areas where dead birds had tested positive for WNV. Ten of these catch basins (83%) contained mosquitoes, but only the species *Cx. restuans*, an enzootic vector of WNV, was present. An 83% incidence rate is comparable to the 70% incidence rate that was found in catch basins in Winnipeg (Randy Gadawski pers. com. *in* Deacon 2004). The 83% incidence rate found during 2005 was much higher than the 12% incidence rate (n=25) found in a general survey of catch basins in Thunder Bay during 2003. A more comprehensive survey must be completed before a definitive statement can be made about the incidence of *Cx. restuans* in the catch basins of Thunder Bay and the possible risk to public health.

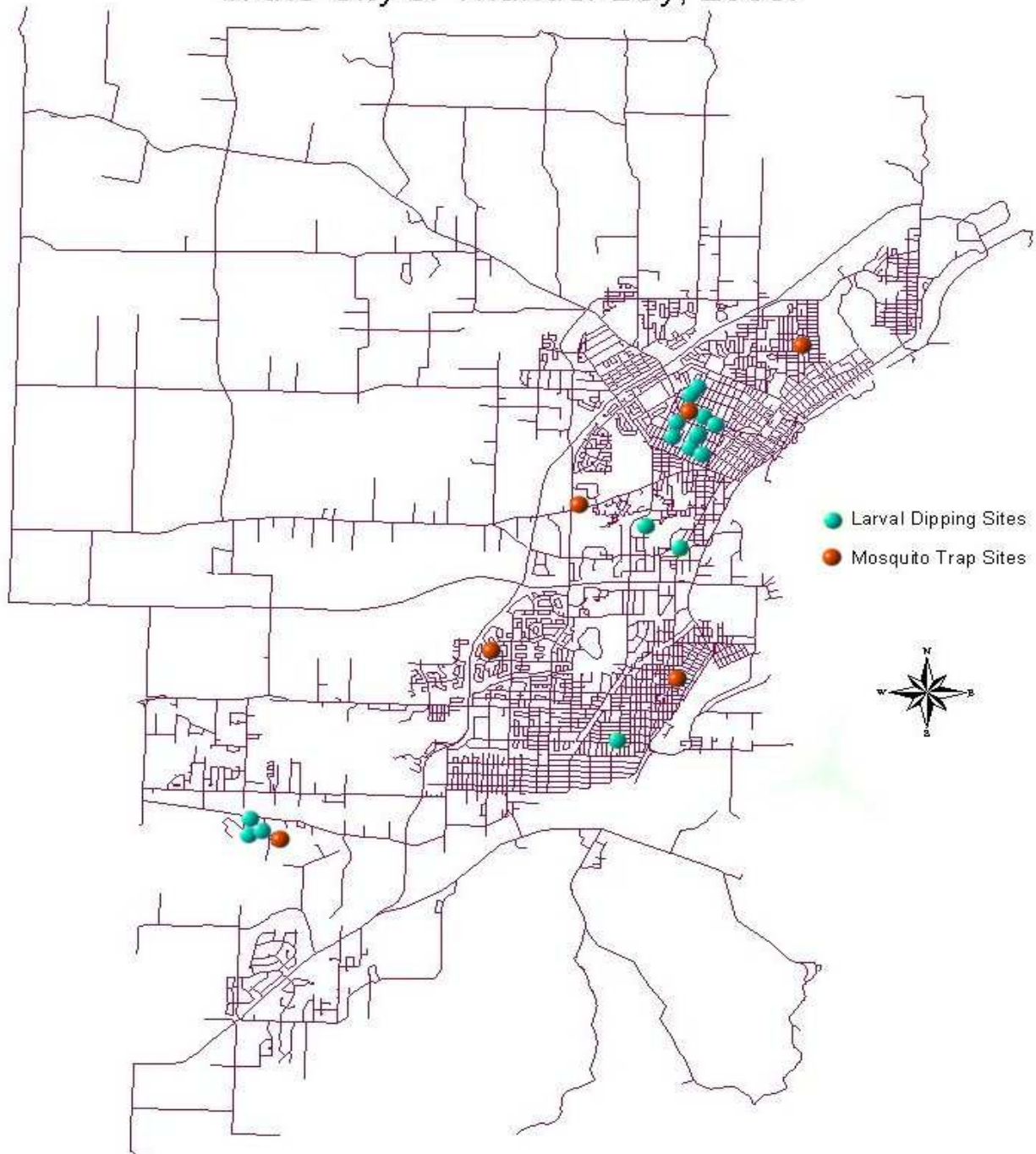
Three potential breeding sites (Fig. 4) contained no mosquito larvae; however, the presence of *Cx. restuans* in the catch basins indicates the potential for enzootic transmission and possible amplification of WNV within the bird community in the City of Thunder Bay.

GIS mapping has greatly increased our ability to note areas of concern within the city, which facilitates precise larval control if the need should arise. Increased sampling of catch basins and potential breeding sites is essential to provide a better understanding of the mosquito species present and their abundance in the City; therefore, additional staffing is required to complete a survey during 2006.

Adult Mosquito Surveillance

No fewer than 19 CDC adult mosquito light traps were operated one night per week at fixed, secure locations within the City and the Region in the District of Thunder Bay

Fig. 4 Mosquito larval dipping sites and location of CDC adult mosquito light traps in the City of Thunder Bay, 2005.



(Figs 3 & 4) from 5 July to 7 September, for a total of 201 trap-nights. The period of sampling was reduced during September based on data collected during 2003 and 2004. Sampling was considered adequate to monitor the species composition of the mosquito community and to determine the potential risk of WNV to the public. Historically the number of mosquitoes in the traps after the beginning of September is greatly reduced, never more than 10% of the number collected per night during July.

The contents of the light traps were analysed by Entomogen Inc. The species of mosquitoes were identified and counted unless the trap contained more than 100 individuals. These larger samples were counted and subsampled with at least 100 individuals identified. Pools of vector mosquitoes (all the individuals of one species) were tested for WNV using Reverse Transcription-Polymerase Chain Reaction (RT-PCR).

Nine vector species (one enzootic and eight epizootic) and 16 non-vector species were found in the light traps. The light traps collected a grand total of 12,185 specimens. Of this grand total, 815 individuals were unidentifiable or were unidentified males (males do not blood feed; therefore, they do not transmit WNV) leaving 11,370 specimens for species determination. A total of 6,000 individuals were identified from these specimens, of which 4,039 were vectors. These vectors were pooled by species and then 315 pools were tested for WNV. No mosquito pool tested positive for WNV.

The light traps collected more than 100 individuals on 14 occasions during the summer. The total number of each species of the unidentified specimens was estimated based on the ratio of the individuals identified to the individuals designated as extras in the light traps. The number of identified individuals of each species was multiplied by this factor to obtain an estimate of the total number of individuals collected on that night. After this conversion, vector species numbered approximately 9,315 individuals, whereas non-vector species numbered 2,055 individuals. *Cx. restuans*, the only enzootic vector recovered from the light traps, totaled 52 individuals which was about

0.5% of all the individuals collected (Fig. 5) and much lower than the incidence of *Cx. restuans* (2.0%) during 2004. The epizootic vectors were *Ae. vexans* (19.2% where n= 2,182), *An. punctipennis* (0.2% where n= 22), *Anopheles walkeri* (0.1% where n= 14), which was a new record for Thunder Bay during 2004 (Deacon 2005), *Coquilletidia perturbans* (61.1% where n= 6,969), *Ochlerotatus stimulans* (0.4% where n= 40), *Ochlerotatus triseriatus* (0.1% where n= 9), *Ochlerotatus trivittatus* (0.04% where n= 4), and *Culex salinarius* (0.009% where n= 1) (Fig. 5). *Culex pipiens*, one of the main enzootic vectors of WNV in southern Ontario, has not been recovered from the light traps after three years of monitoring. The low incidence (0.5%) of the enzootic vector *Cx. restuans* and the absence of *Culex pipiens* from the mosquito community made the amplification of WNV within the bird community to the point of “spill-over” an extremely unlikely event during the summer of 2005.

Two additional *Culex* species, *Culex salinarius* and *Culex tarsalis* are now of concern with regards to WNV in Thunder Bay. *Cx. salinarius* was previously reported from Red Rock during 2003 (Deacon 2004) and now again from Thunder Bay in 2005 (Figs 5 & 6). *Cx. salinarius* is normally found in estuarine areas, but is apparently expanding its range due to salinization of habitat because of extensive use of road salt during winters (Fiona Hunter pers. com. in Deacon 2004). The additional specimen of *Cx. salinarius* from 2005 confirms the establishment of this species in the District of Thunder Bay. Although *Cx. salinarius* is a competent vector of WNV, the numbers of this species in the District of Thunder Bay appear extremely low at present. Only two individuals have been recovered from 15,952 specimens identified during monitoring from 2003 to 2005. Monitoring must continue to determine changes in the abundance of *Cx. salinarius* and the potential threat this species may pose to public health.

The second *Culex* species, *Cx. tarsalis*, is of even greater concern as a vector of WNV. *Cx. tarsalis* is a competent vector of WNV (Goddard *et al.* 2002) readily feeding on both birds and mammals, including humans (Wood *et al.* 1979). These characteristics make

Fig. 5 Number of individuals of vector mosquito species and non-vector mosquito species collected in the District of Thunder Bay, 2005

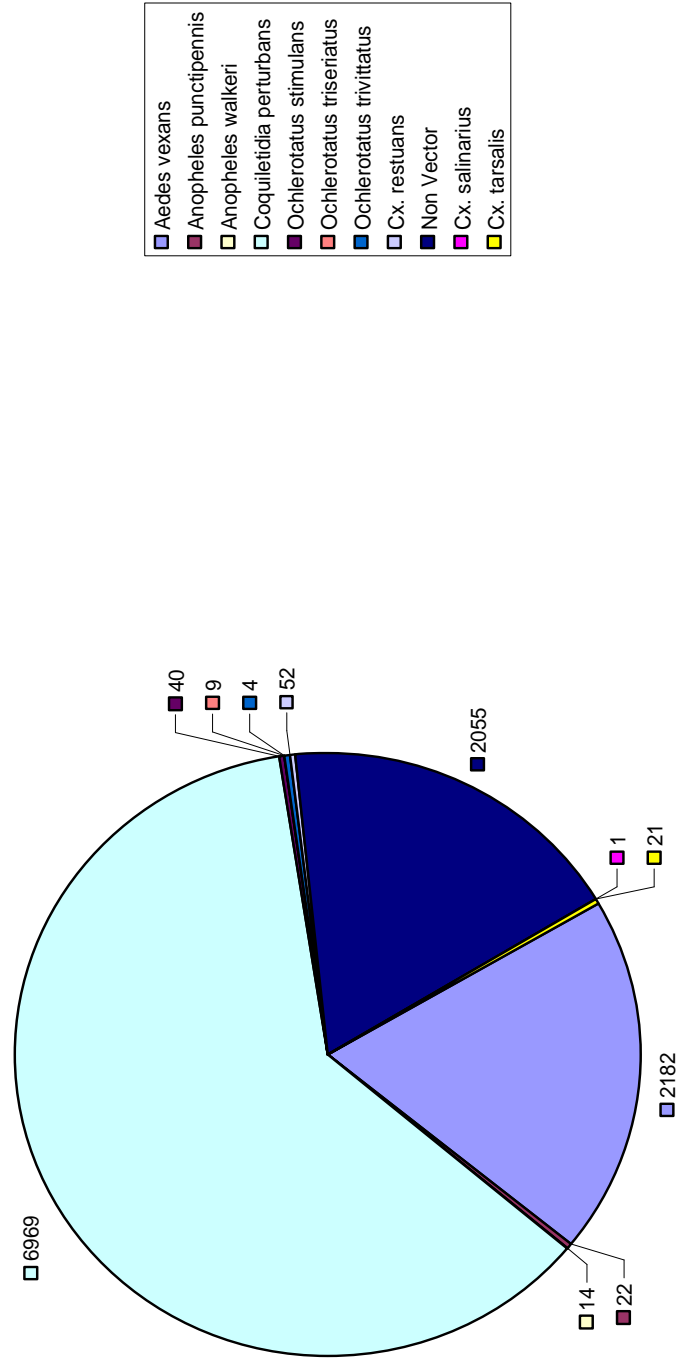
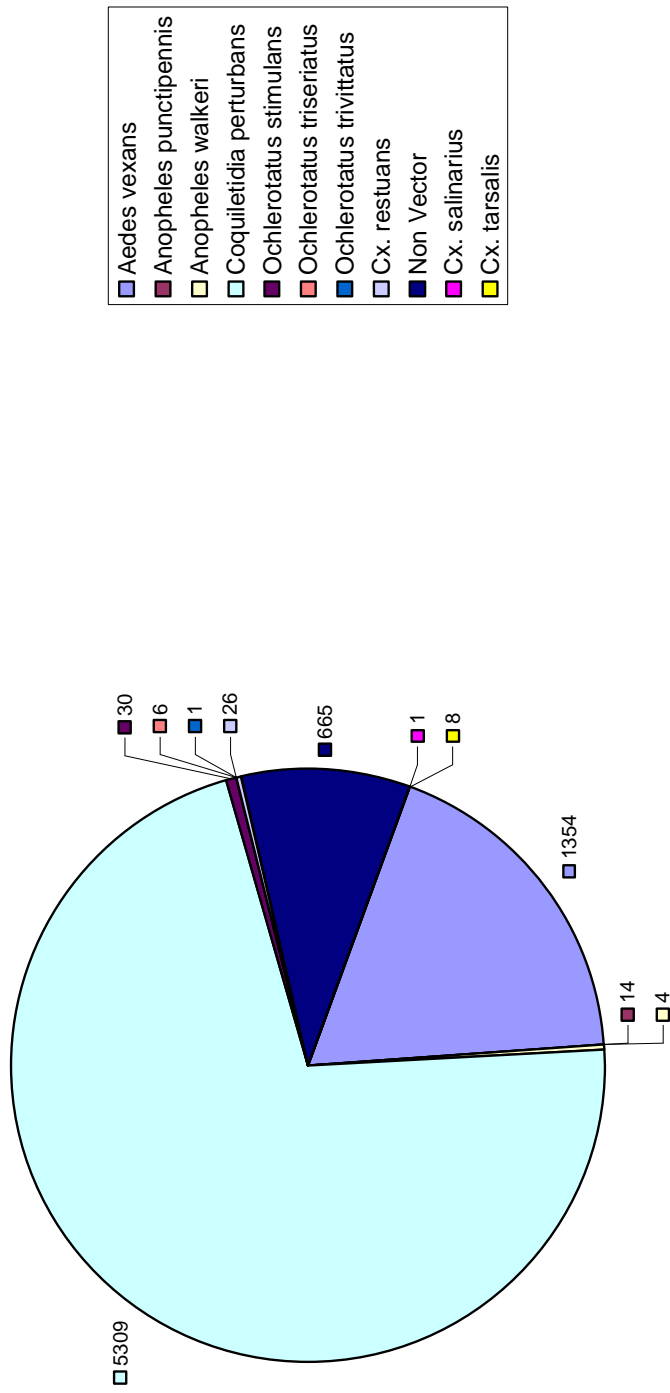


Fig. 6 Number of individuals of vector mosquito species and non-vector mosquito species collected in the City of Thunder Bay, 2005

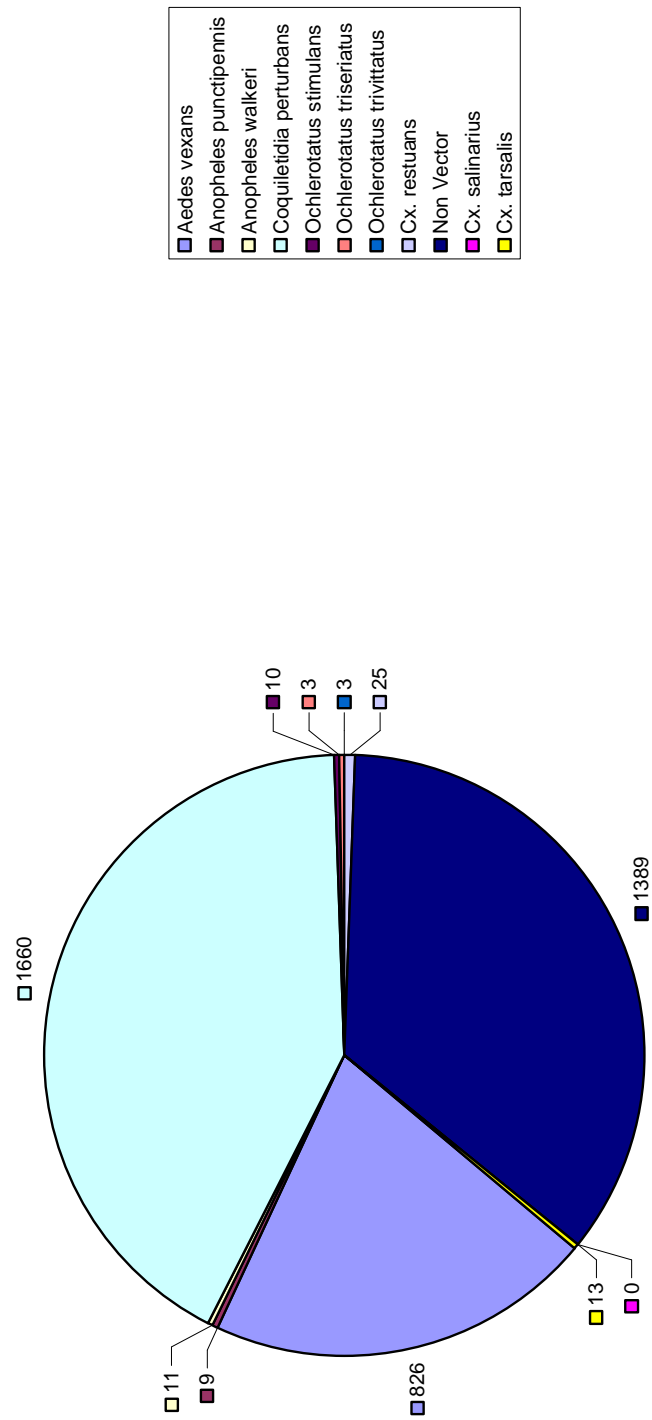


Cx. tarsalis both an enzootic and epizootic vector of WNV. The distribution of *Cx. tarsalis* is described as western North America with some populations found in southeastern Ontario, or even Florida (Wood *et al.* 1979). *Cx. tarsalis* has not been previously collected from the Boreal forest. The collection of 21 specimens from Kakabeka to Geraldton, a linear distance of about 250 km, indicates that this species is not only present but also widespread within the Boreal forest. We need more information about the biology of *Cx. tarsalis* to explain the occurrence of this species in the Boreal forest. Additional information will help us predict the nature of the threat to public health posed by this species.

The probable cycle of WNV in the District of Thunder Bay remains as suggested for 2004 (Deacon 2005) with the addition of the two *Culex* species (*Cx. salinarius* and *Cx. tarsalis*). Transmission and amplification of WNV occurs within the bird community by *Cx. restuans* with transmission to mammals by *Ae. vexans*, *An. punctipennis*, *An. walkeri*, *Cq. perturbans*, *Cx. salinarius*, *Oc. stimulans*, *Oc. triseriatus*, and *Oc. trivittatus*. *Cx. tarsalis* is capable of transmission both to birds and to mammals thus increasing the risk to public health.

The light traps were separated into two groups, one from the City of Thunder Bay (Fig. 4), an urban environment and the other from the Region (Fig. 3), a rural environment with a substantial forest element. The Region included all light traps located outside the city limits of Thunder Bay. During 2004 the abundance of several vector species differed noticeably between these two environments. *Cx. restuans* was more abundant within the City (n= 311) than the Region (n= 30) and *Cq. perturbans* was more abundant in the Region (n= 6,235) than the City (n= 2,496) (Deacon 2005). The occurrence of these vector species differed markedly during 2005. *Cx. restuans* showed approximately the same abundance in the City (n= 25) (Fig. 6) as in the Region (n= 27) (Fig.7). The abundance of *Cq. perturbans* was actually the reverse of that found during 2004. *Cq. perturbans* was more abundant in the City (n= 5,309) (Fig. 6) than in the Region (n= 1,660) (Fig. 7) during 2005.

Fig. 7 Number of individuals of vector mosquito species and non-vector mosquito species collected in the Thunder Bay Region, 2005



The 19 to 21 light traps were situated in almost the same locations during both years with only three minor changes of location within the city. The explanations regarding the effect of habitat and man-made structures on the composition of the mosquito community in the City and the Region during 2004 (Deacon 2005) were evidently incorrect. Habitat and man-made structures remained similar in the City and the Region from 2004 to 2005; however, the species composition changed dramatically. One noticeable difference between the two years was the weather. The weather during 2004 was cool and wet; whereas, the weather during 2005 was hot and dry. The number of degree days (the number of days when the maximum temperature exceeded 20°C) was 48 during the 10-week period of surveillance from 1 July to 8 September 2004, whereas the number of degree days was 60 during this period in 2005 (Environment Canada 2005). Precipitation was 162.5 mm during 2004, whereas precipitation was 99.0 mm during 2005. Weather plays a critical role in determining the distribution and abundance of organisms (Smith and Smith 2006). Evidently cooler, wetter summers favour some mosquito species, for example, *Cq. perturbans*. This climate change might explain the change in abundance of *Cq. perturbans* from 8,730 individuals collected during 2004 (Deacon 2005) to 6,969 individuals collected during 2005 (Fig. 5).

The hot, dry summer of 2005 saw even fewer individuals of *Cx. restuans* (n= 52, Fig. 5) than during 2004 (n= 346, Deacon 2005) and there were still no *Cx. pipiens* present in the mosquito community of northwestern Ontario. The warmer summers and higher temperatures of southern Ontario are thought to favour the development of both *Cx. restuans* and *Cx. pipiens* where these species often comprise a third of the mosquitoes in the light traps (Deacon 2005). Possibly vegetation/habitat/water chemistry also play an important role in determining the distribution and abundance of these two species. If *Cx. restuans* remains at low levels within the mosquito community of northwestern Ontario whether the summer is hot and dry or cool and wet, then there is little risk from WNV in the District of Thunder Bay. However, the summer of 2005 saw the first appearance of *Cx. tarsalis*. If the climate continues to be hot and dry, then there may be

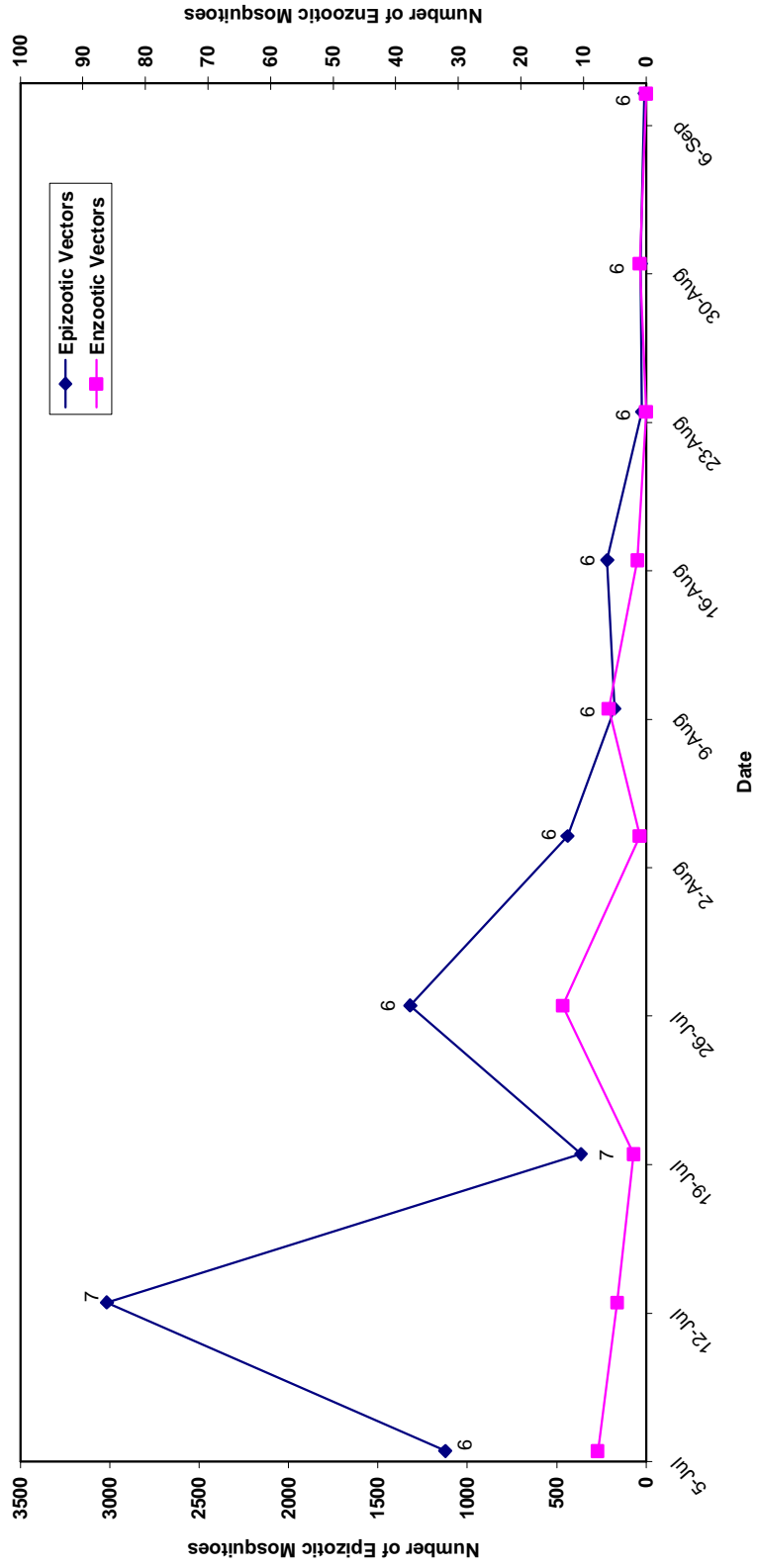
increased risk from WNV because of the appearance of and increase in *Cx. tarsalis*, a competent vector and an aggressive biter. Any change to a climate more similar to that of southern Ontario or western Canada is of concern. The result could be an outbreak of WNV in the District of Thunder Bay. Amplification in the enzootic cycle could occur and the “bridge vectors”, especially *Ae. vexans* and *Cq. perturbans*, could transmit WNV to humans. Continued monitoring of the adult mosquito community is necessary.

The overall number of mosquitoes trapped during 2004 and 2005 also differed. A total of 16,469 mosquitoes were collected during 2004 (Deacon 2005) versus 12,185 during 2005 (Fig. 5). As well, *Cx. salinarius* and *Cx. tarsalis* were not found during 2004 but were found during 2005. Trapping intensity actually increased from 2004 to 2005. Trap-nights during the 10-week period from early July to early September changed from 150 during 2004 to 201 during 2005. We would have expected to collect more mosquitoes during 2005. Possibly the very different weather conditions experienced in northwestern Ontario during the summers of 2004 and 2005 account for the differences in the numbers and species of mosquitoes that were collected. Only continued monitoring will provide insight into the role that weather plays in determining the abundance of mosquito species from year-to-year.

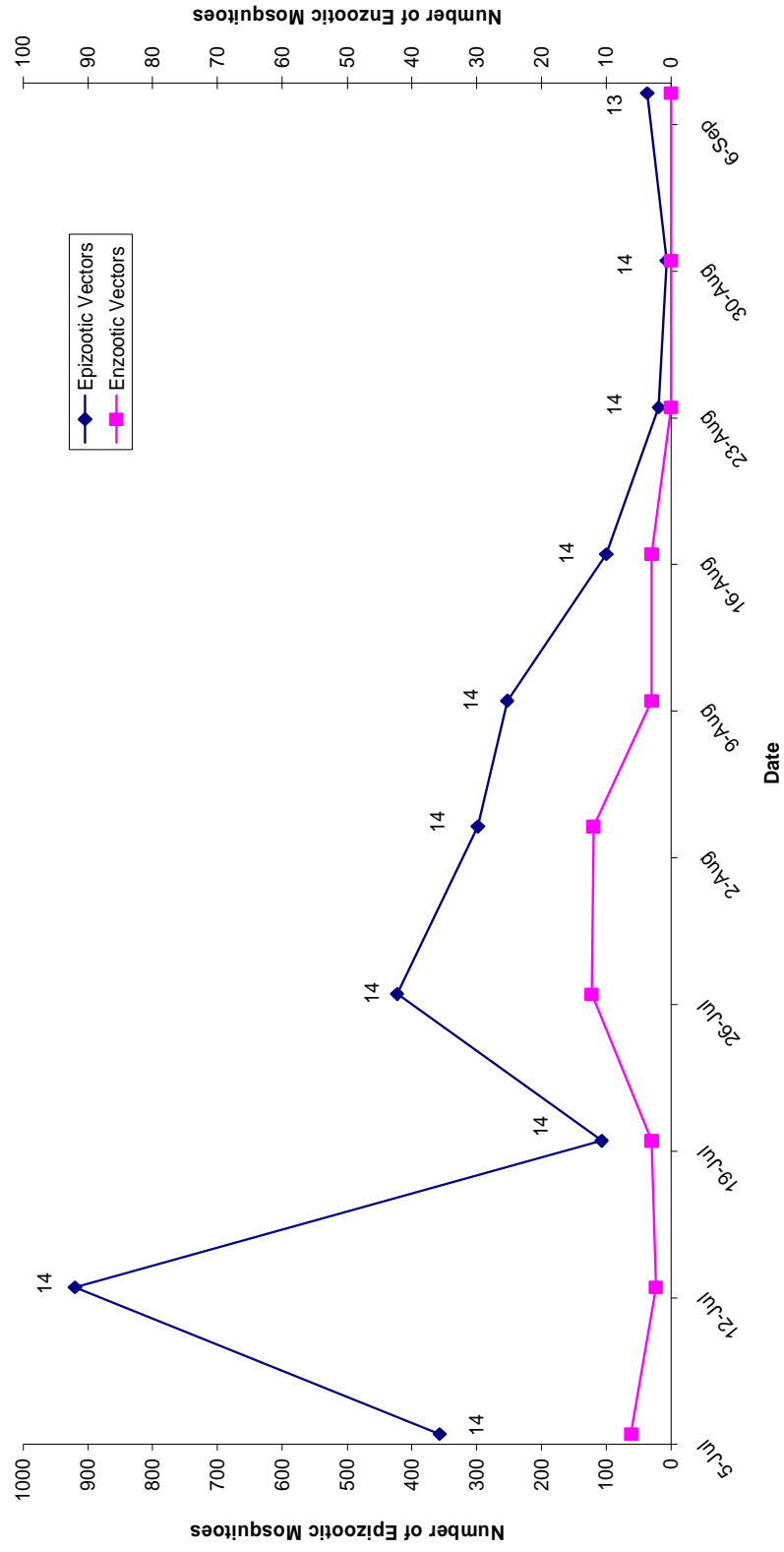
Light traps were consistently set during 2005 (Figs 8 & 9), unlike 2004 (Deacon 2005); therefore, missing data are not of concern for 2005. The numbers of enzootic and epizootic vectors were calculated for each week for the City and for the Region to determine the patterns of emergence, as was done for 2004. The numbers of light traps that were set each week are indicated on the graphs (Figs 8 & 9).

The number of light traps set in the City remained almost constant at five to six throughout the summer (Fig. 8). The pattern of emergence indicated that the epizootic vectors reached their peak of emergence by mid-July followed by a second, smaller peak of emergence by late July (Fig. 8), as was observed during 2004 (Deacon 2004). The numbers of the enzootic vector (*Cx. restuans*) were too low ($n= 26$) for meaningful comment about the pattern of emergence; however, peak abundance occurred late-July

Fig. 8 Number of epizootic and enzootic mosquito vectors collected per week in the City of Thunder Bay, 2005. Number of CDC adult mosquito light traps indicated.



**Fig. 9 Number of epizootic and enzootic mosquito vectors collected per week in the Thunder Bay Region, 2005.
 Number of CDC adult mosquito light traps indicated.**



to early-August with a decline to zero individuals collected on the final trapping night, 7 September (Fig. 8). The risk for amplification of WNV is over for the season when the enzootic vector decreases in abundance.

The number of light traps set in the Region remained almost constant at 13 to 14 (Fig. 9). The pattern of emergence indicated that the epizootic vectors reached two peaks of emergence similar to those of the epizootic vectors in the City (Fig. 8). The numbers of the enzootic vector were again too low (n= 25) for meaningful comment; however, peak abundance occurred late-July to early-August (Fig. 9), similar to that observed in the City (Fig. 8). The rate of decline of *Cx. restuans* was even faster in the Region than in the City (Fig. 8). No enzootic vectors were collected after mid-August.

The risk from WNV was virtually over by early September because the enzootic vectors, including *Cx. restuans*, *Cx. salinarius*, and *Cx. tarsalis*, had disappeared or were disappearing from the various mosquito communities throughout the District of Thunder Bay. Continued trapping after early September is unwarranted.

West Nile Virus Control Measures

Neither larviciding nor adulticiding was required within Thunder Bay District during 2005. WNV control measures in Thunder Bay District focused on reducing mosquito-breeding sites on private and municipal property, and on providing information to the public about the prevention of mosquito bites. During 2005, this information was disseminated to the public through pamphlets and the media. Pamphlets and/or posters were distributed to elementary school students, child care centres, long-term care facilities, doctors' offices, pharmacies, libraries, golf courses, municipal offices, campgrounds, conservation areas and beer stores. WNV information was also published in Community and Seasonal newspapers.

The TBDHU conducted a number of media releases about WNV during the spring and summer of 2005. Personnel visited homes for seniors and attended community events in the City of Thunder Bay, such as “The Yard and Garden Show” and “What’s Bugging You”, an event delivered by EcoSuperior at which the general public is encouraged to bring mystery “bugs” for identification. A poster about WNV was displayed and pamphlets conveying essential information about the risk from WNV in Thunder Bay were distributed at these events.

Conclusions

The data collected during 2005 have again demonstrated the potential for an outbreak of WNV when environmental conditions become ideal. The hot, dry summer that occurred during 2005 led to a decrease in the abundance, as well as substantial changes in the species composition of the mosquito communities in the City as well as the Region.

Ten dead crows tested positive for WNV in the District of Thunder Bay during 2005; however, no human cases were reported. A “spike” of bird mortality was seen, although not associated with a sustained “hot spot” of dead birds. *Cx. pipiens* was not collected, and *Cx. restuans* continued to comprise a small component of the mosquito community. These observations indicated that WNV posed a minimal risk to human health during 2005. However, two additional *Culex* species, *Culex salinarius* and *Culex tarsalis* are now of concern with regards to WNV in Thunder Bay. *Cx. salinarius* and *Cx. tarsalis* are capable of transmission to both birds and mammals, increasing the risk of WNV to public health.

More information is required about catch basins, larval breeding sites, the effects of weather on the development of mosquito larvae, and the species composition of the mosquito communities. Public outreach encouraging personal protection measures to reduce exposure to mosquitoes and the reduction of artificial breeding sites should

continue. A larviciding programme to augment proposed actions should be considered only if there are signs that humans may be infected by WNV. Contingency plans for pesticide treatment should be developed now to prepare for the possibility that changing weather related to global climate change could create conditions ideal for the transmission of WNV.

Recommendations for 2006

1. Continue the use of GIS mapping to store all dead bird, pond, catch basin, and mosquito trap locations and data.
2. Expand the catch basin monitoring program to identify the mosquito species that are present and the abundance of those mosquitoes within the City of Thunder Bay.
3. Expand the identification of larval mosquito habitat within the City of Thunder Bay.
4. Revisit and monitor larval mosquito habitat that has been reported by, and is of concern to, the public.
5. Continue the adult mosquito surveillance programme within the District of Thunder Bay using CDC UV light traps.
6. Obtain continuous temperature data from at least two trap sites, one from the City and one from the Region, to permit better monitoring of the temperatures experienced at the traps.
7. Determine details about the biology of *Cx. tarsalis* to explain why this species occurs in the Boreal forest.

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