West Nile Virus in the Thunder Bay District, 2006

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Table of Contents

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List of Figures

EXECUTIVE SUMMARY

No human cases of West Nile Virus (WNV) were reported from the District of Thunder Bay during 2006. The virus, however, was recovered from 12 dead crows. The general public reported 152 dead birds, 32 of which were submitted for viral testing. Viral testing was terminated in the City of Thunder Bay during week 29 (mid-July), several weeks earlier than during 2005 or 2004. The first bird tested positive for WNV 6 June and the last bird 6 July. No “spike”, a sudden increase of mortality, occurred during the summer, nor was there a “hot spot”, a clustering of several dead birds in one area. Risk to human health was considered minimal and no remedial actions were recommended.

Twelve catch basins were inspected within the City of Thunder Bay on 20 July. Three catch basins contained *Culex restuans*, an enzootic vector of WNV. Enzootic vectors transmit WNV to birds. Two potential breeding sites for mosquitoes were examined. One site contained one mosquito larvae of *Cx. restuans.*

Twenty-one CDC adult mosquito light traps were operated one night per week in the City of Thunder Bay and the Region during the nine week period from 5 July to 29 August for a total of 189 trap-nights. Nine vector species (one enzootic and eight epizootic) were found in the light traps. The traps collected a grand total of 7076 specimens. A total of 4376 individuals were identified from these specimens. The identified specimens contained 3078 vectors. These vectors were pooled by species and then 36 pools (mainly *Cx. restuans*) 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. C*x. restuans*, an enzootic vector, totaled 60 individuals or approximately 0.8% of the 7076 mosquitoes. Epizootic vectors included *Aedes vexans* (n= 517) (7.3%),

Coquillettidia perturbans (n= 5211) (73.6%), and six other species, including *Culex tarsalis* (n= 1) (0.01%).

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 2006. “Spill-over” (the transmission of WNV from birds to mammals) did not occur, which was similar to the situation during 2003, 2004, and 2005. 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 vector *Cx. tarsalis* or possibly *Cx. salinarius* increases significantly.

The average number of mosquitoes collected per trap night during the warm, wet summer of 2006 was substantially lower (37.4) than the number collected during the warm, dry summer of 2005 (60.6) or the cool, wet summer of 2004 (109.8). C*x. restuans* was expected to increase in abundance during the warm, wet summer of 2006 but did not. C*x. restuans* will probably remain a small component of the mosquito community of northwestern Ontario possibly because of vegetation/habitat/ water chemistry/ timing of precipitation or some other unknown factor. Mosquitoes tested positive for WNV in the Algoma Health District to the east of the TBDHU and one human case of WNV was reported from the Northwestern Health Unit to the west of the TBDHU. Although the risk of an individual acquiring WNV in the TBDHU remains low, the probability of a human case is increasing.

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 2006.

History of West Nile Virus in North America

West Nile virus (WNV) first appeared in North America in New York City during August 1999. Subsequently this disease, which is vectored (transmitted) by infected mosquitoes spread across North America. By the end of the summer of 2006, only Alaska remained free of WNV in humans, birds, animals, or mosquitoes in the continental United States (Centres for Disease Control 2007b). A total of 4180 cases of WNV infections occurred in humans in the United States during 2006, resulting in 149 deaths (Centres for Disease Control 2007a).

WNV was first detected in Canada during 2001 when dead birds tested positive for the virus (Region of Peel 2002). The first human cases of WNV in Canada occurred during 2002 in Ontario and Quebec, with a total of 414 WNV cases and asymptomatic infections (Public Health Agency of Canada 2006b). During 2003 the number of WNV cases and asymptomatic infections increased dramatically to 1495 then decreased to 26 during 2004, then increased to 238 during 2005 (Public Health Agency of Canada 2006b). During 2006, the number of WNV cases and asymptomatic infections was 128 (Public Health Agency of Canada 2006a). The number of deaths attributed to WNV in Canada was 11 during 2002, 10 during 2003, 2 during 2004, 12 during 2005 (Deacon 2006), and 2 during 2006 (Public Health Agency of Canada 2006c). WNV however, was still not found in Newfoundland, Prince Edward Island, British Columbia, Yukon, Northwest Territories, or Nunavit (Public Health Agency of Canada 2006c).

There were still no human cases of WNV recorded from the Thunder Bay District Health Unit during 2006.

Illness Caused by West Nile Virus

WNV is vectored by infected mosquitoes. Eighty percent (80%) of people infected with WNV are asymptomatic. Twenty percent (20%) of infected people will 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 (Drebot & Artsob 2006). From 4% to 14% of people with West Nile Encephalitis will 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 which 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, organ transplants, as well as needle stick or sharps injuries. Factors that determine the prevalence and severity of illness in humans are still not well understood, although our knowledge about the disease is progressing (Drebot & Artsob 2006).

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. These birds then become a source of infection for other mosquitoes as this enzootic phase of the disease progresses. If amplification begins during the early spring, then by mid-summer a large number of infected birds and mosquitoes are present.

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), but this species is also found in the Thunder Bay District (Deacon 2006). *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, 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 can be transmitted to humans.

Objectives of the West Nile Virus Surveillance Programme, 2006

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, picked up for submission to the Canadian Cooperative Wildlife Health Centre, Guelph, for viral testing.

4. Mosquitoes in the Thunder Bay District were to be collected using Centres for Disease Control (CDC) adult mosquito light traps and identified to species.

5. West Nile Virus prevalence in adult mosquito vector species was to be determined using Reverse Transcription-Polymerase Chain Reaction (RT-PCR).

6. The occurrence of *Culex tarsalis* in the District of Thunder Bay was to be studied.

7. Larval mosquito habitat was to be identified and inspected in the City of Thunder Bay.

8. Human cases within the District of Thunder Bay were to be noted.

9. 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

10. 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.

11. Science-based information was to be used to determine the need for chemical control of larval and/or adult mosquitoes.
12. The 2006 report on West Nile Virus activity in the Thunder Bay District was to be completed.

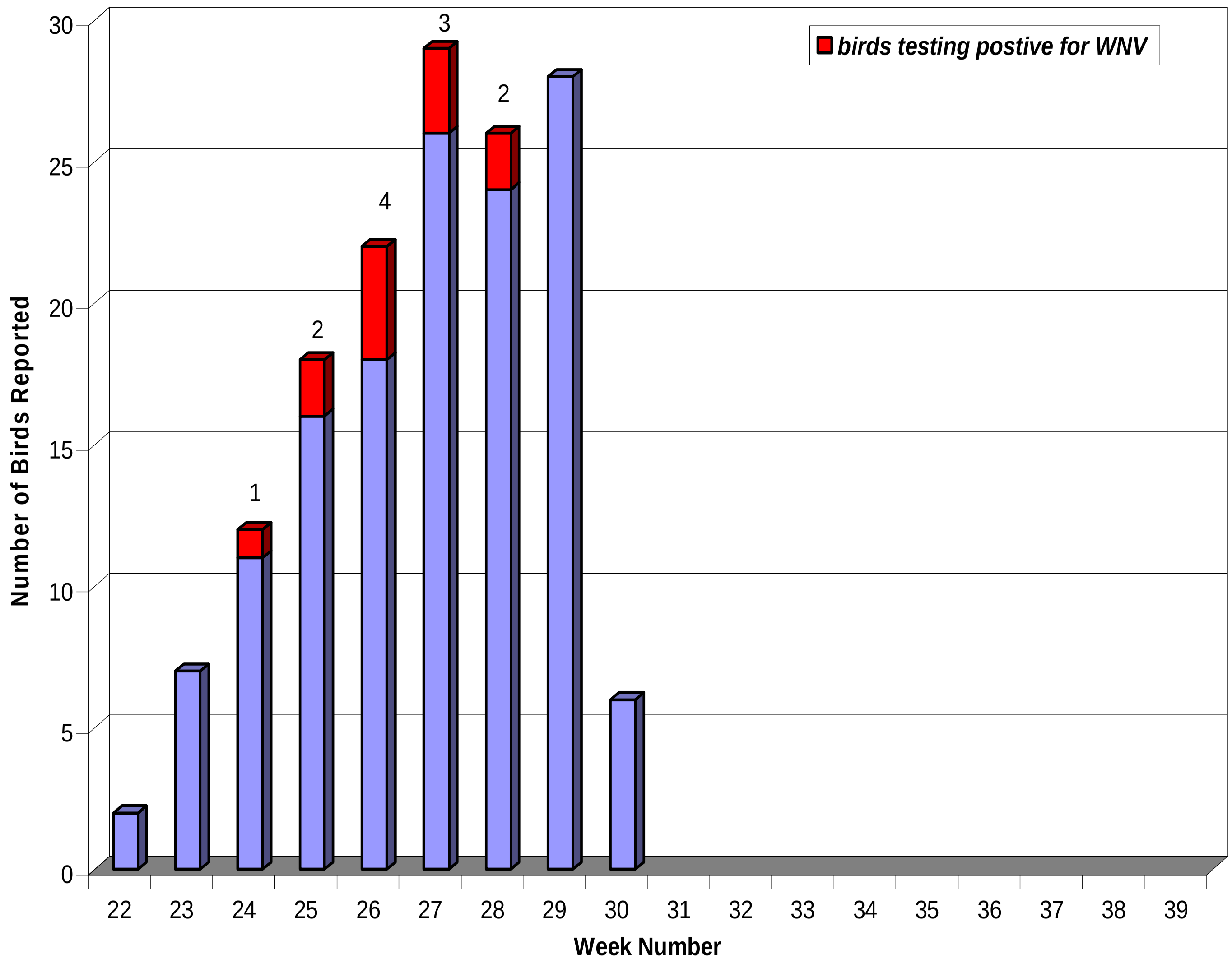
Dead Bird Monitoring

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

Monitoring occurred from 23 May to 1 September 2006, during which time 152 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 and 32 birds were selected for viral testing. Twelve birds tested positive for WNV in Thunder Bay during 2006. The first bird to test positive was 6 June (week 23) (Fig 1) which was one week earlier than in 2005 (14 June). The last bird to test positive was picked up on 6 July (week 27) (Fig 1) which was much earlier than in 2005 (15 September).

The viral testing programme was terminated in the City of Thunder Bay by the Canadian Cooperative Wildlife Health Centre during week 29 (mid-July), several weeks earlier than during 2005 because 10 birds had already tested positive for WNV by 7 July 2006. The purpose of the programme is simply to establish that WNV is present in the bird community of a given area. A subsequent media release by the TBDHU requested that the general public no longer report dead birds within the city because the birds were no longer eligible for testing. The number of submissions from the public fell dramatically after mid-July, making the data from the remainder of the season inconsistent with the earlier part of the season, or with previous years. Reports of dead birds fell to six during

Fig. 1 Birds reported to the Crow Line, Thunder Bay District Health Unit, 2006. Number of positive birds indicated.



week 30 (Fig. 1) from 28 during week 29. Only 14 additional calls occurred during the remainder of the season. These data are not considered comparable with previous years. Consistent effort encouraging the public to report dead birds must be maintained throughout the entire season in the future to ensure a meaningful reflection of WNV activity within the bird community.

The rate of mortality increased slowly from week 22 to week 27 (Fig. 1) and then leveled off at about 30 birds per week through weeks 28 and 29. There was no apparent "spike" in mortality (a sudden increase in the number of bird deaths) during 2006. A "spike" in mortality is thought to indicate increased WNV activity and increased human health risk. However, the rate of mortality (greater than 20 birds per week during weeks 27 to 29) was higher than reported for a similar period during previous years (Deacon 2004, 2005, 2006). WNV activity may be increasing within the bird community, or the hot summer of 2006 may have created conditions ideal for transmission of the disease to birds.

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

Seventeen of the 152 dead birds were located in the Region, ranging in distribution from Neebing Township in the southwest to Terrace Bay in the southeast and Long Lac in the northeast (Fig. 3). Two of the birds from the Region (one from Oliver Paipoonge and one from Geraldton) tested positive for WNV.

The presence of WNV was again confirmed in the bird community and the spatial distribution of the positive birds indicated that WNV was established and widely present within the City of Thunder Bay and the Region. A "spike" in mortality with a sustained "hot spot" did not occur together, indicating that WNV had not amplified extensively within the bird community. Location and date of bird mortality, and the results of the

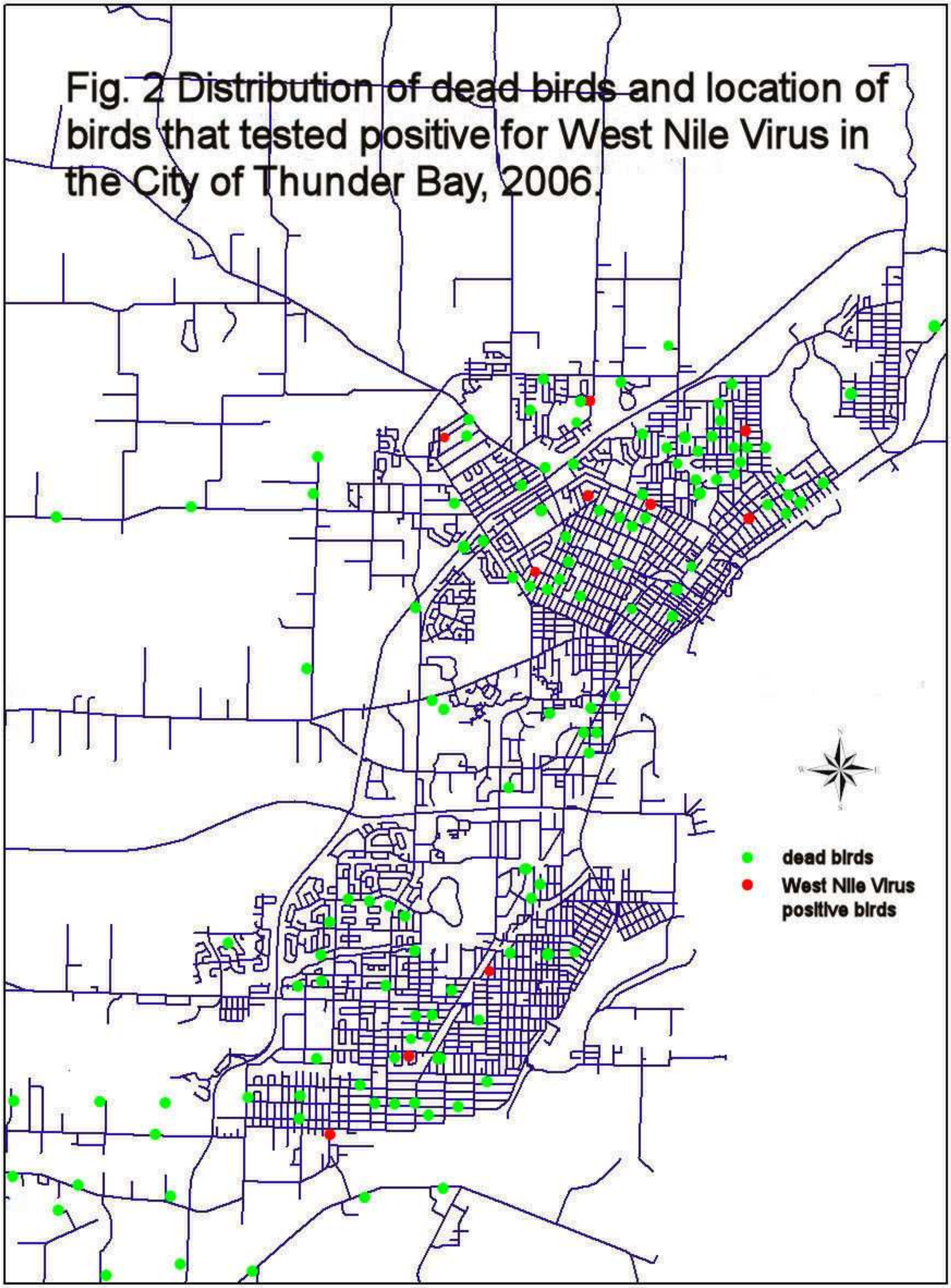
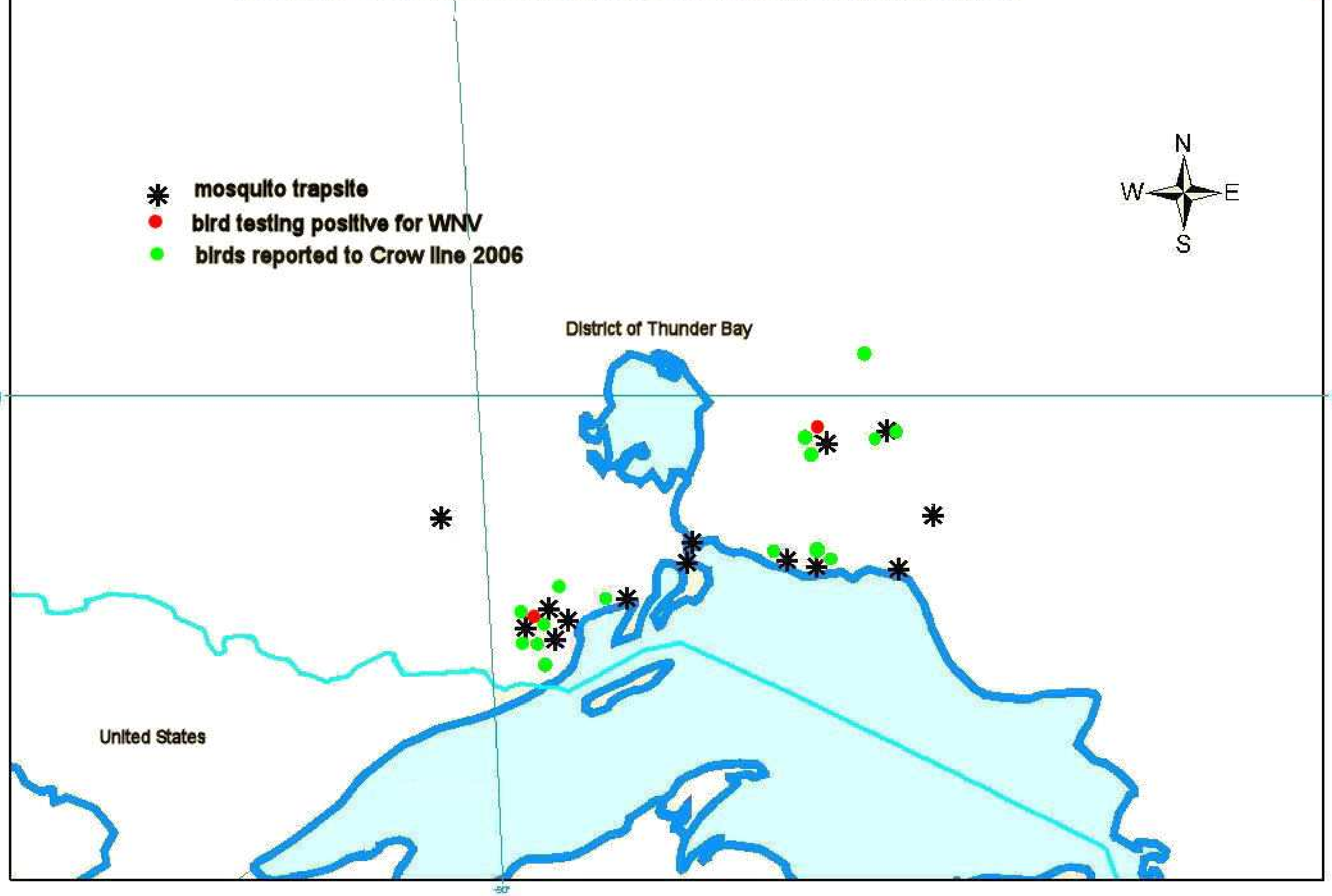


Fig. 2 Distribution of dead birds and location of birds that tested positive for West Nile Virus in the City of Thunder Bay, 2006.
dead birds
West Nile Virus positive birds

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, 2006.



viral testing were entered on a GIS database.   Risk to human health from WNV was considered minimal.

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 with larvicide 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 a stage that facilitates identification. During the summer of 2006, the number of opportunities to examine catch-basins was adequate to complete an extensive survey; however, similar to 2005 understaffing again prevented a comprehensive examination of catch basins.

Twelve catch basins (Fig.4) were inspected on 20 July near areas where dead birds had tested positive for WNV. Three of these catch basins (25%) contained mosquitoes. As in 2003 and 2005 the only species present in these catch basins was *Cx. restuans,* an enzootic vector of WNV. The catch basin sample size of n=12 (2006), n=12 (2005), and n=25 (2003) is too small to allow meaningful comment about the incidence of mosquitoes in catch basins in Thunder Bay; however, the presence of *Cx. restuans* as the only species in the catch basins is significant. Catch basins are an important habitat for *Cx. restuans* in the urban environment, creating an opportunity for this species to breed in close proximity to humans, increasing the risk of transmission of WNV.

After an extensive survey of two potential breeding sites related to complaints (Fig 4), one mosquito larvae of *Cx. restuans* was recovered. The presence of numerous *Cx. restuans* in the catch basins and one individual in the potential breeding sites indicate that *Cx. restuans* is well established within the urban environment. Catch basins

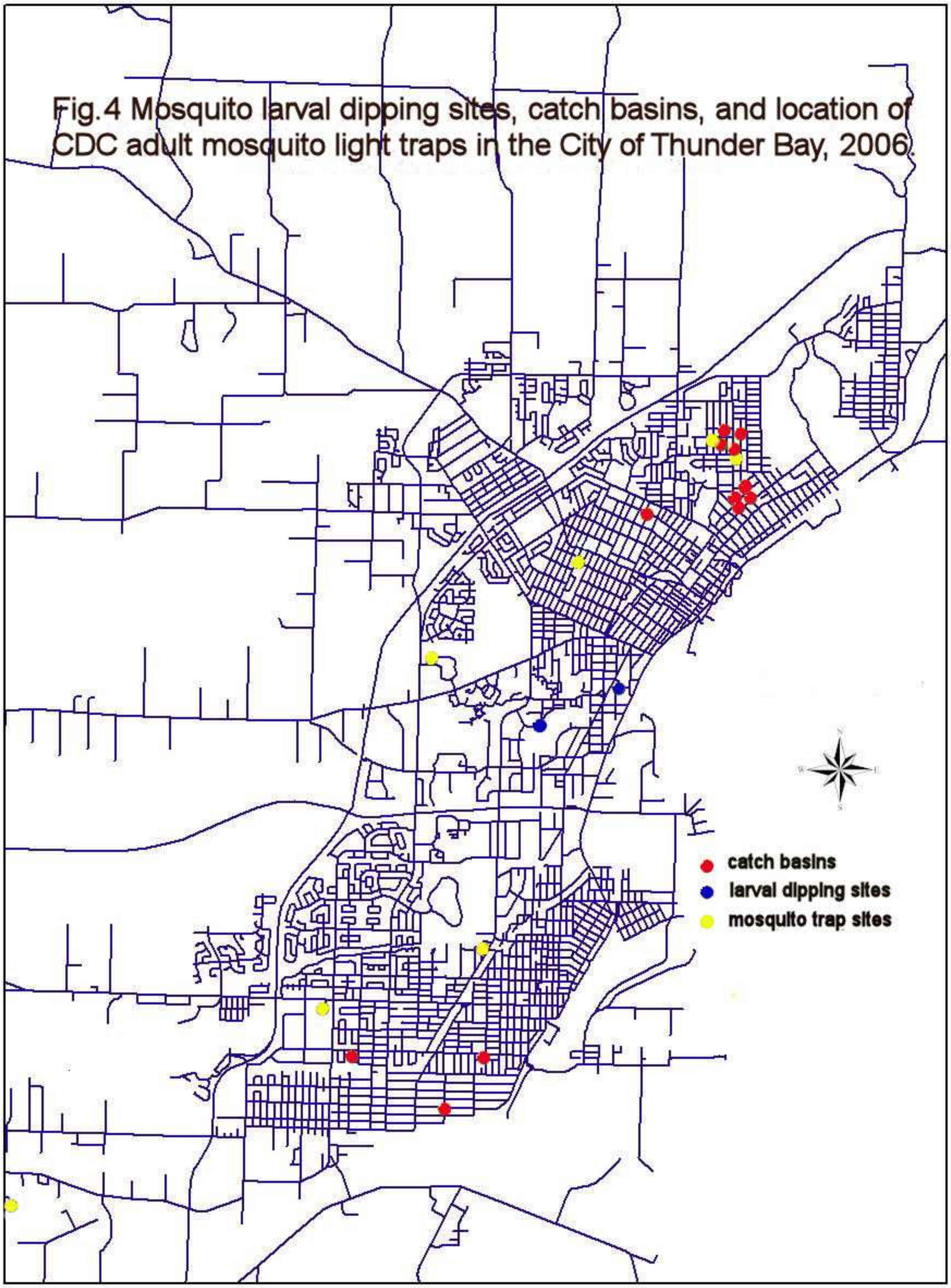


Fig.4 Mosquito larval dipping sites, catch basins, and location of CDC adult mosquito light traps in the City of Thunder Bay, 2006.
catch basins
larval dipping sites
mosquito trap sites

probably represent the major source of the mosquitoes for enzootic transmission of WNV to birds within the City of Thunder Bay. A more comprehensive survey of both catch basins and potential breeding sites must be completed before a definitive statement can be made about the importance of *Cx. restuans* and their possible risk to public health in Thunder Bay.

GIS mapping has greatly increased our ability to note areas of concern within the city; therefore, facilitating precise larviciding 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. Additional staffing is essential to complete this survey during 2007.

Adult Mosquito Surveillance

Twenty-one 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 (Figs 3 & 4). Light traps were consistently set from 5 July to 29 August during 2006 for a total of 189 trap-nights. No data were missing.

Based on the analysis of data collected during 2003, 2004, and 2005, the period of sampling was reduced to end the last week of August. This reduced period of 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 exceeding 10% of the number collected per night during July. The enzootic vector (*Cx. restuans)* consistently reaches peak abundance by mid-July (Deacon2006) and is greatly reduced in the traps in Thunder Bay by late August.

The contents of the light traps were analysed by Entomogen Inc. The species of mosquitoes were identified and all were counted unless the trap contained more than

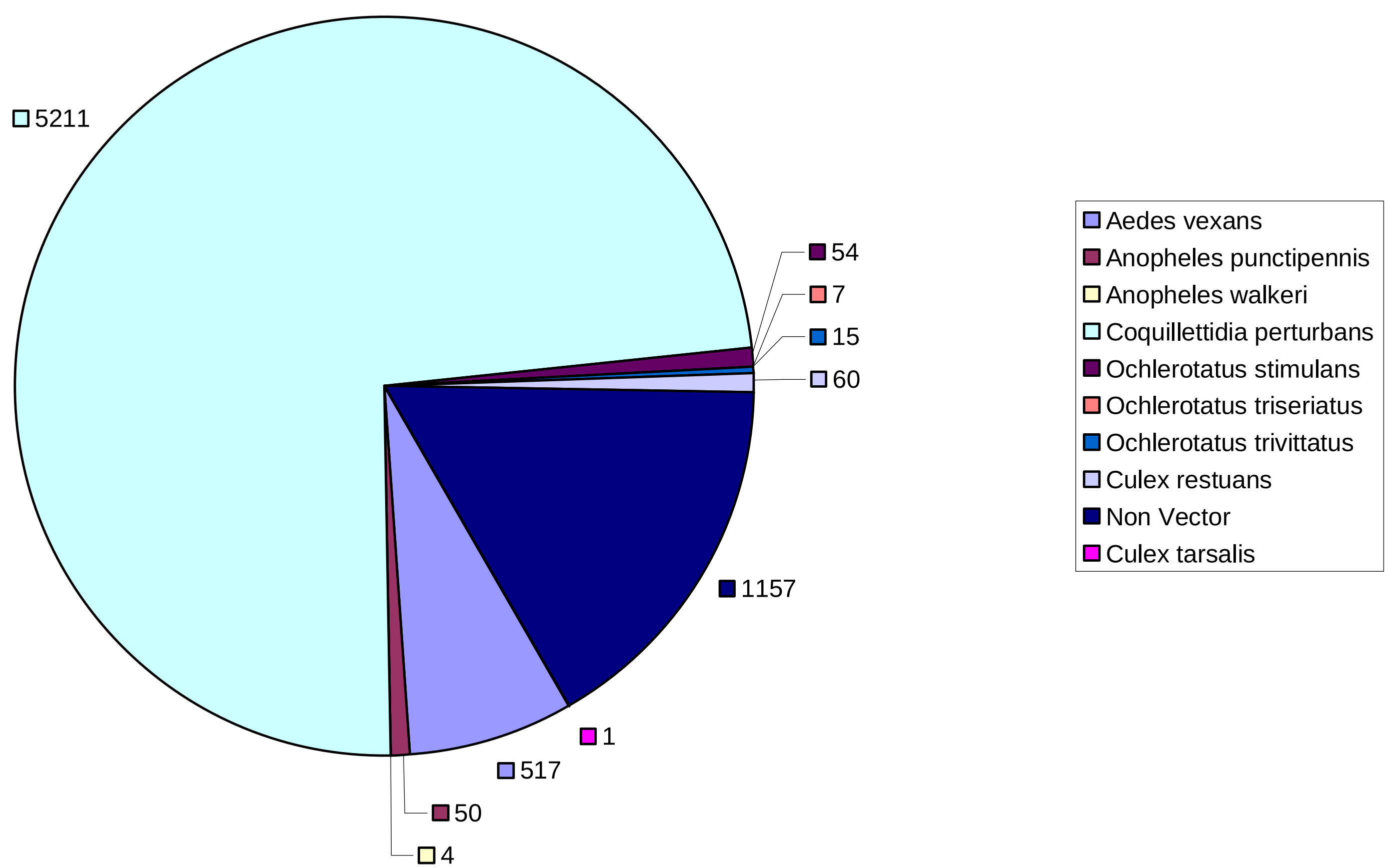
100 individuals. These larger samples were counted and subsampled with at least 100 individuals identified randomly. The remaining mosquitoes were referred to as "extras". The light traps collected "extras" on five occasions during the summer.

Nine vector species (one enzootic and eight epizootic) were found in the light traps. The light traps collected a grand total of 7076 specimens. Of this grand total, 171 individuals were unidentifiable or were unidentified males (males do not blood feed; therefore, they do not transmit WNV) leaving 6905 specimens for species determination. A total of 4376 individuals were identified from these specimens, of which 3078 were vectors. These vectors were pooled by species and 36 pools (33 *Culex* spp. pools plus one pool each of *Ae. vexans*, *Coquillettidia perturbans*, and one non-vector species) were tested for WNV using Reverse Transcription-Polymerase Chain Reaction (RT-PCR). No mosquito pool tested positive for WNV.

The total number of each species of the unidentified specimens was estimated based on the ratio of the individuals identified to the individuals remaining 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 5919 individuals, whereas non-vector species numbered 957 individuals and unidentifiable specimens/males numbered 200 individuals. These proportions are a more accurate reflection of the vectors within the mosquito community throughout the entire summer.

Cx. restuans, the only enzootic vector recovered from the light traps, totaled 60 individuals which was about 0.8% of all the individuals collected (Fig. 5). The epizootic vectors were *Ae. vexans* (n= 517) (7.3%), *Anopheles punctipennis* (n= 50) (0.7%), *Anopheles walkeri* (n= 4) (0.1%), *Coquillettidia perturbans* (n= 5211) (73.6%), *Ochlerotatus stimulans* (n= 54) (0.8%), *Ochlerotatus triseriatus* (n= 7) (0.1%), *Ochlerotatus trivittatus* (n= 15) (0.2%), and *Culex tarsalis* (n= 1) (0.01%)(Fig. 5). *Culex pipiens,* one of the main enzootic vectors of WNV in southern Ontario, has not been

Fig. 5 Number of individuals of vector mosquito species and non-vector mosquitoes collected in the District of Thunder Bay, 2006



recovered from the light traps after four years of monitoring. During our four years of mosquito surveillance, *Cx. restuans* exceeded 1% of the mosquito community during 2004 when it reached only 2% of the mosquitoes collected (Deacon 2005).The continuing low incidence (0.8%) 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 2006.

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 in 2003 (Deacon 2004) and again in 2005 (Deacon 2006) but not during 2006 *Cx. salinarius* is a competent vector of WNV (Andreadis *et al.* 2004) ; however, the numbers of this species in the District of Thunder Bay appear extremely low at present. Only two individuals have been recovered from 23028 specimens during monitoring from 2003 to 2006. 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 *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). The collection of 21 specimens from Kakabeka to Geraldton during 2005 (Deacon 2006) and the collection of one specimen from Red Rock during 2006 indicates that this species is established and widespread within the Boreal forest. More information is needed about the biology of *Cx. tarsalis* to explain the occurrence of this species in the Boreal forest and to examine the effect that weather has on abundance. Unfortunately the recovery of only one specimen during the 2006 season did not provide the opportunity for further study. Additional information will help us predict the nature of the threat to public health posed by *Cx. tarsalis.*

The probable cycle of WNV in the District of Thunder Bay remains as suggested for 2005 (Deacon 2006). 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.

The 19 to 21 light traps were situated in almost the same locations from 2004 to 2006. Habitat and man-made structures around the light traps remained similar in the City (Fig.4) and the Region (Fig. 3) during this study; however, the abundance and species composition of the mosquitoes changed dramatically. Weather plays a critical role in determining the distribution and abundance of organisms (Smith and Smith 2006). The weather during 2004 was cool and wet; whereas, the weather during 2005 was warm and dry, and during 2006 was slightly warmer than 2005, but almost as wet as 2004. The number of degree days (the number of days when the maximum temperature exceeded 20°C) was 48 during the 10-week period from 1 July to 8 September 2004, whereas the number of degree days was 60 during this period in 2005, and 63 from 1 July to 8 September during 2006 (Environment Canada 2007). Precipitation during this 10-week period was 162.5 mm during 2004, 99.0 mm during 2005, and 156.5 mm during 2006 (Environment Canada 2007). The average number of mosquitoes collected per trap night during the warm, wet summer of 2006 was substantially lower (37.4) than collected during the warm, dry summer of 2005 (60.6) or the cool, wet summer of 2004 (109.8).

The cool, wet summer of 2004 produced the greatest number of C*x. restuans* (n= 346) (Deacon 2005). The warm, dry summer of 2005 produced far fewer individuals of C*x. restuans* (n= 52) (Deacon 2006), and finally C*x. restuans* increased slightly (n= 60) (Fig. 5) during the warm, wet summer of 2006. During this three year period there were still no *Cx. pipiens* present in the mosquito community of northwestern Ontario. The warmer summers 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). However, C*x. restuans* was more abundant in Thunder Bay during the cool, wet summer of 2004. Possibly vegetation/habitat/water chemistry/ timing of precipitation play more important roles in determining the distribution and abundance of these two species. If so, then *Cx. restuans* and *Cx. pipiens* will probably remain a small component of the mosquito community of northwestern Ontario, reducing the risk of human cases of WNV in the District of Thunder Bay. However, the summer of 2005 saw the first appearance of *Cx. tarsalis* with a reoccurrence during 2006. If the climate changes to one which is hot and dry, then there may be increased risk from WNV because of an increase in *Cx. tarsalis,* a competent vector of WNV 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. Mosquitoes tested positive for WNV in the Algoma Health District (Entomogen 2005) to the east of the TBDHU and one human case of WNV was reported from the Norhtwestern Health Unit during 2006 (Northwestern Health Unit 2006) to the west of the TBDHU. Although the risk of an individual acquiring WNV in the TBDHU remains low, the probability of a human case is increasing. Continued monitoring of the adult mosquito community is necessary.

Evidently cooler summers favoured *Cq. perturbans*, the most abundant epizootic vector. The cool, wet summer of 2004 produced the greatest number of *Cq. perturbans* (n= 8730) (Deacon 2005). The warm, dry summer of 2005 produced far fewer individuals of *Cq. perturbans* (n= 6969) (Deacon 2006), and finally *Cq. perturbans* decreased even further (n= 5211) (Fig. 5) during the warm, wet summer of 2006 (Fig. 5).

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. This separation was done to investigate possible habitat influences on the mosquito communities. The Region included all light traps located outside the city limits of Thunder Bay. During 2004, 2005, and 2006 the abundance of several vector species differed noticeably between these two environments, but no consistent trend was apparent. *Cx. restuans* was more abundant within the City (n= 311) than the Region (n= 30) during 2004 (Deacon 2005). *Cx. restuans* had approximately the same abundance within the City (n= 25) compared to the Region (n= 27) during 2005 (Deacon 2006), and was less than half as abundant within the City (n= 17) (Fig. 6) than the Region (n= 43) (Fig. 7) during 2006. *Cq. perturbans* was approximately half as abundant in the City (n= 2496) as the Region (n= 6235) during 2004 (Deacon 2005). During 2005 *Cq. perturbans* was more abundant in the City (5309) than the Region (1660) (Deacon 2006), and finally returned to the 2004 situation with *Cq. perturbans* approximately half as abundant in the City (1776) (Fig. 6) compared to the Region (3436) (Fig. 7) during 2006. These two important vectors are obviously responding to some as yet unidentified factor within the environment.

West Nile Virus Control Measures

Neither larviciding nor adulticiding was required within Thunder Bay District. 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 2006, 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 clubs, 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 interviews about WNV during the spring and summer of 2006. Personnel visited homes for seniors and attended community events in the City of Thunder Bay where they delivered presentations about the results from the 2005 WNV surveillance work. As well, on several occasions personnel staffed display booths, which were designed to convey essential information about the risk from WNV in Thunder Bay.

Fig. 6 Number of individuals of vector mosquito species and non-vector mosquitos collected in the City of Thunder Bay, 2006

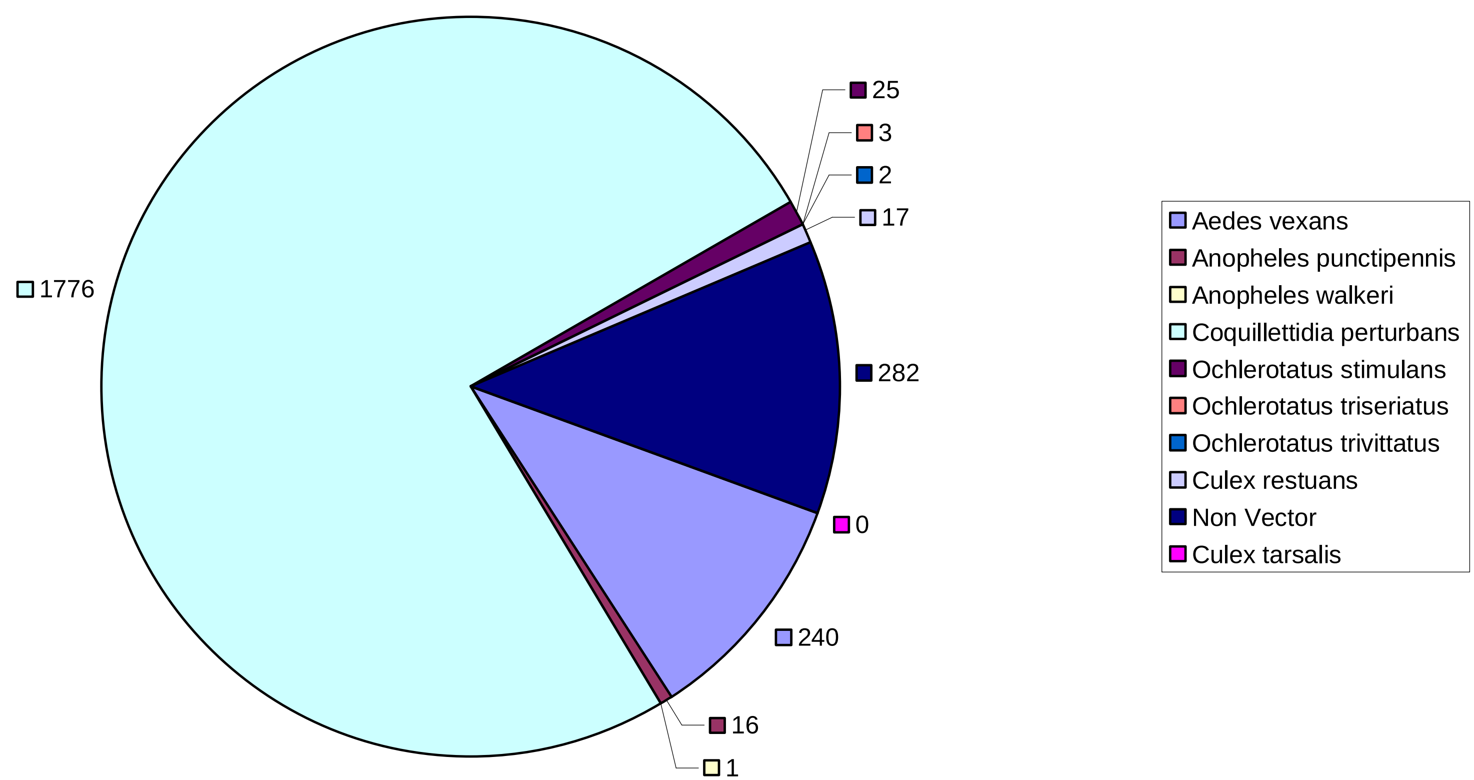
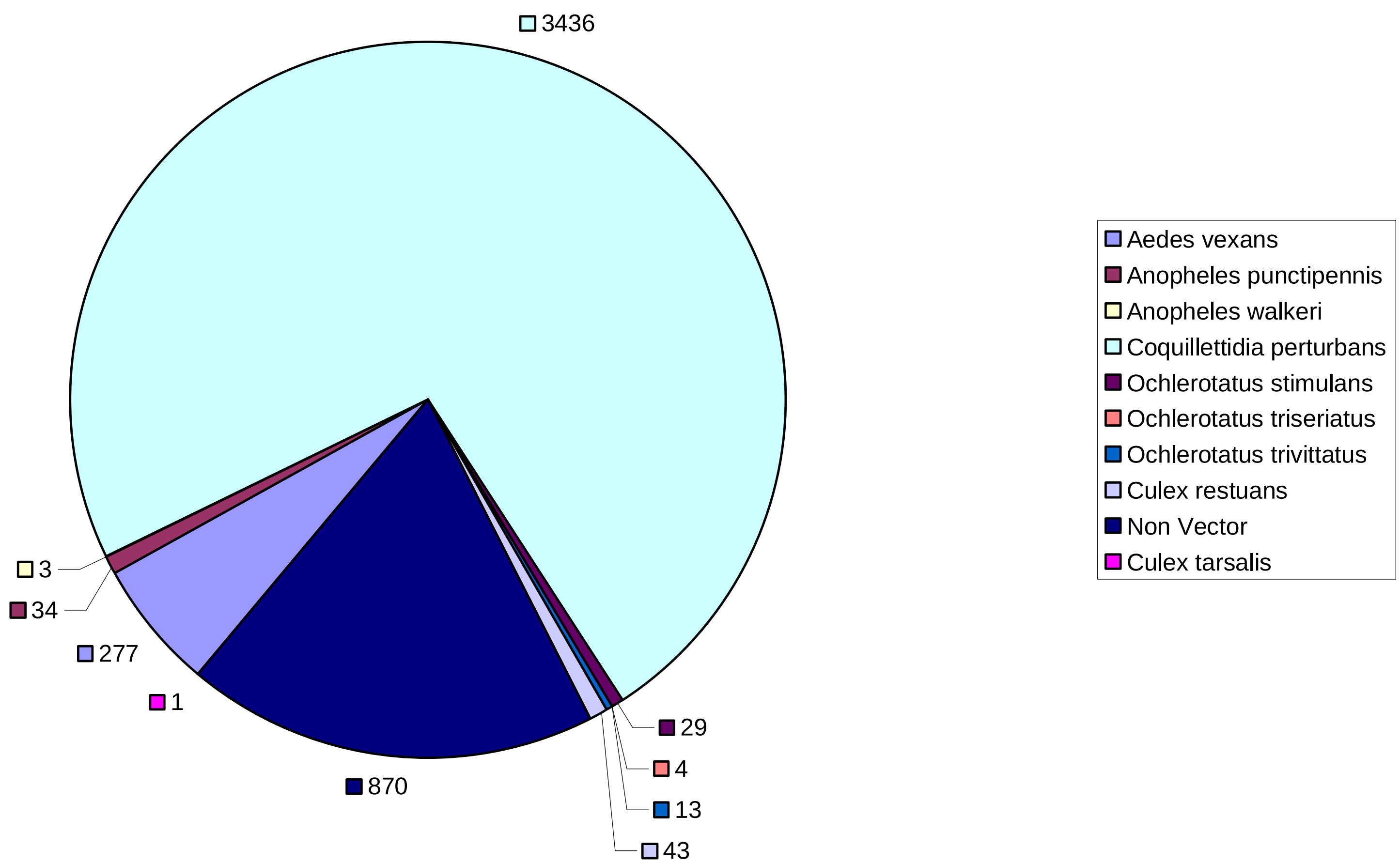


Fig. 7 Number of individuals of vector mosquito species and non-vector mosquitoes collected in the Thunder Bay Region, 2006



Conclusions

The data collected during 2006 have again demonstrated the potential for an outbreak of WNV if environmental conditions change. The warm, wet summer of 2006 lead to another decrease in the abundance of the mosquito communities, as well as substantial changes in the species composition of the mosquito communities in the City and in the Region.

Twelve dead crows tested positive for WNV in the District of Thunder Bay during 2006; however, no human cases were reported, no "spike" of bird mortality was seen, and no "hot spot" of dead birds was recorded. *Cx. pipiens* was not collected, and *Cx. restuans* continued to comprise a small component of the mosquito community. These observations lead to the conclusion that WNV posed a minimal risk to human health during 2006. However, two additional *Culex* species, *Culex salinarius* and *Culex tarsalis* are known to occur in the Thunder Bay District and are now of concern with regards to WNV. *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 is increased risk of human infection by WNV. Contingency plans for pesticide treatment should be developed now to prepare for the possibility that changing weather related to global climate change creates conditions ideal for the transmission of WNV in Thunder Bay.

Recommendations for 2007

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 City of Thunder Bay and in the Region using CDC 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 where this species occurs in the Boreal forest.

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