West Nile Virus in the Thunder Bay District, 2007

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EXECUTIVE SUMMARY

Two asymptomatic human cases of West Nile Virus (WNV) were reported from the District of Thunder Bay during 2007. One case was travel-related; however, the other case was acquired locally.

West Nile virus was recovered from 11 dead crows. The general public reported 81 dead birds, 20 of which were submitted for viral testing. Viral testing was terminated in the District of Thunder Bay during week 29 (mid-July), similar to 2006. Bird reports remained constant throughout the summer. The first bird tested positive for WNV 11 June and the last bird 11 July. Two “spikes”, a sudden increase of mortality, occurred during the summer, but no “hot spot”, a clustering of several dead birds in one area was present. Risk to human health was considered minimal and no remedial actions were recommended.

Ten catch basins were inspected throughout the City of Thunder Bay on 9 August near areas where dead birds had tested positive for WNV. The catch basins were dry because of a persistent drought.

Two complaints about standing water as potential breeding sites were received during 2007. One site contained no mosquito larvae and the other site was in the process of being permanently drained.

Twenty-four potential breeding sites/larval habitats were examined during August-September 2007. Larvae or pupae of *Anopheles earlei, Anopheles punctipennis,* and *Culex restuans* were recovered from nine sites. No more than six larvae/pupae were found at any site after as many as 200 dips. None of the sites were considered major areas of mosquito production.

Twenty-one CDC adult mosquito light traps were operated almost consistently for one night per week in the City of Thunder Bay and the Region during the nine week period from 3 July to 27 August for a total of 185 trap-nights. Ten vector species (two enzootic and eight epizootic) were found in the light traps. The traps collected a grand total of 6799 specimens. A total of 5626 individuals were identified from these specimens. The identified specimens contained 3045 vectors. These vectors were pooled by species and then 77 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 205 individuals or approximately 3.0% of the 6799 mosquitoes while *Culex tarsalis,* the other enzootic vector, totaled only 8 individuals (0.1%). Epizootic vectors included *Aedes vexans* (n= 1441) (21.2%), *Coquillettidia perturbans* (n= 1672) (24.6%), and six other species, including Culex *salinarius* (n= 1) (0.01%). *Cx. pipiens* was not collected. The warm, very dry summer of 2007 produced the lowest total number of mosquitoes reported to date but an increase in the vector species *Cx. restuans* (3.0%) and the very competent vector *Cx. tarsalis. Culex salinarius* was again recovered in the District of Thunder Bay. *Cx. tarsalis* and *Cx. salinarius* are capable of transmission to both birds and mammals, increasing the risk of WNV to public health.

These observations lead to the conclusion that WNV posed a minimal risk to human health during 2007, but a risk that is increasing as the climate becomes more typical of the prairies which will favour an increase of *Cx. tarsalis.*

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 2007.

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 during biting) by infected mosquitoes spread across North America. By the end of the summer of 2007, only Alaska remained free of WNV in humans, birds, animals, or mosquitoes in the continental United States (Centres for Disease Control 2008b). A total of 3510 cases of WNV infections occurred in humans in the United States during 2007, resulting in 109 deaths (Centres for Disease Control 2008a).

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 rose to 1495, 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 down to 151 (Public Health Agency of Canada 2006a); however, the number of cases increased dramatically to 2353 during 2007 (Public Health Agency of Canada 2007). The majority of the 2007 WNV cases were from the prairie provinces of Manitoba, Saskatchewan, and Alberta (Public Health Agency of Canada 2007). The number of deaths attributed to WNV in Canada was 11 during 2002, 10 during 2003, 2 during 2004, 12 during 2005 (Deacon 2006), 2 during 2006 (Public Health Agency of Canada 2006c), and then 8 during 2007 (Public Health Agency of Canada 2007). WNV was found in Nova Scotia, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia during 2007. Newfoundland, Prince Edward Island, New Brunswick, Yukon, Northwest Territories, and Nunavit did not find WNV (Public Health Agency of Canada 2007).

The first two asymptomatic human cases of WNV (one of which was travel-related) were recorded from the District of Thunder Bay District during 2007.

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). Immunocompromised patients and the elderly are at the greatest risk for encephalitis and death (Groner 2005).

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 enzootic vector 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. Epizootic vectors, also called “bridge vectors” transmit WNV from birds to mammals.

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) and is an abundant species in the District of Thunder Bay. Another species, *Coquillettidia perturbans* is often the most abundant in the District of Thunder Bay, but this species is considered a poor epizootic vector of WNV (Turell *et al.* 2005).

Cx. pipiens, Cx. restuans, Cx. tarsalis, Ae. vexans, and *Cq. perturbans* are found in proximity to human populations, which potentially 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, 2007

1. A risk analysis of West Nile Virus activity in the Thunder Bay District was to be completed.

2. A toll-free “Crowline” was to be established by the Thunder Bay District Health Unit (TBDHU) to facilitate the reporting of dead birds by the general public from 23 May to 30 September.

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 2007 report on West Nile Virus activity in the Thunder Bay District was to be completed.

Dead Bird Monitoring

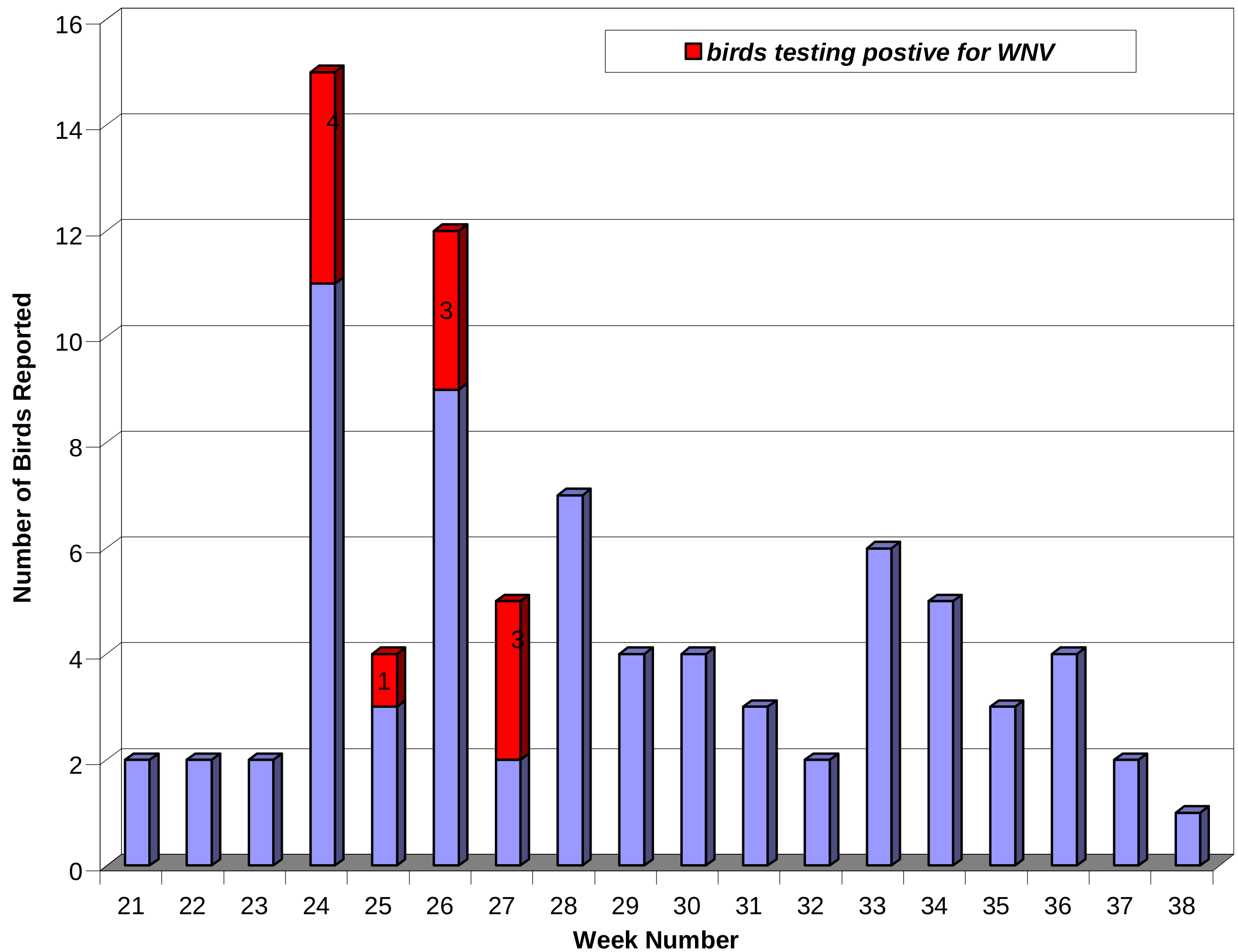
Dead crows are a good indicator of WNV activity. Dead bird sightings often peak just before human cases begin to appear. Clusters of dead birds, known as a “hot spots”, indicate increased WNV activity in an area (Elliott *et al*. 2003), with increased risk to human health.

Monitoring occurred from 23 May to 30 September 2007, during which time 81 dead birds (primarily crows) were reported by the public using the Crowline, a toll-free number initiated and maintained by the Thunder Bay District Health Unit (TBDHU). Callers were interviewed for details about the birds and 20 birds were selected for viral testing. Eleven birds tested positive for WNV in Thunder Bay during 2007. The first bird to test positive was picked up on 11 June (week 24) (Fig 1) and the last bird to test positive was picked up on 11July (week 28) (Fig 1). Both of these dates were similar to the first and last positive birds picked up during 2006.

The viral testing programme was terminated in the City of Thunder Bay by the Canadian Cooperative Wildlife Health Centre during week 29 (mid-July) which was approximately the same date as 2006 but several weeks earlier than during 2004 or 2005. Eleven birds had already tested positive for WNV by 11 July 2007. The purpose of the bird submission programme is simply to establish that WNV is present in the bird community of a given area. Consistent effort encouraging the public to report dead birds was maintained throughout the entire season which was reflected by the proportional number of reports received about dead birds for the period up to week 28 (n=41) compared to the period after week 28 (n=40) (Fig. 1). The total number of birds reported, however, was considerably lower (n=81) than during 2006 (n=152) (Deacon 2007), 2005 (n=159) (Deacon 2006), or 2004 (n=265) (Deacon 2005). Either the public is becoming indifferent to the request to report dead birds or fewer birds are dying. Birds are known to develop immunity to WNV and even pass this immunity on to their young through transovarial transmission of antibodies (Hahn *et al.* 2006).

The rate of mortality ”spiked” (a sudden increase in the number of bird deaths) dramatically during week 24 to a maximum of 15 calls then fell to seven calls during week 28 when the last bird to test positive for WNV was reported (Fig. 1). A second smaller “spike” of mortality occurred during week 33 (n=6) which tapered off to one dead bird during week 38 (Fig. 1). This was the first season with two “spikes” in bird mortality in Thunder Bay. A “spike” in mortality is thought to indicate increased WNV activity and increased human health risk. However, the “spike” in mortality for week 24 was only 15 birds which was significantly lower than the highest numbers recorded per week during previous years (n=29, 2006) (n=27, 2005) (n=32, 2004). The identification of the “spike” during 2007 was possible only in retrospect.

Fig. 1 Birds reported to the Crow Line, Thunder Bay District Health Unit, 2007. Number of West Nile Virus positive birds indicated.



Close consideration must also be given to the spatial distribution of dead birds to determine whether there are sustained “hot spots” (areas where clusters of dead birds occur). 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. No “spikes” with sustained “hot spots” occurred within the City (Fig 2) or the Region (Fig 3).

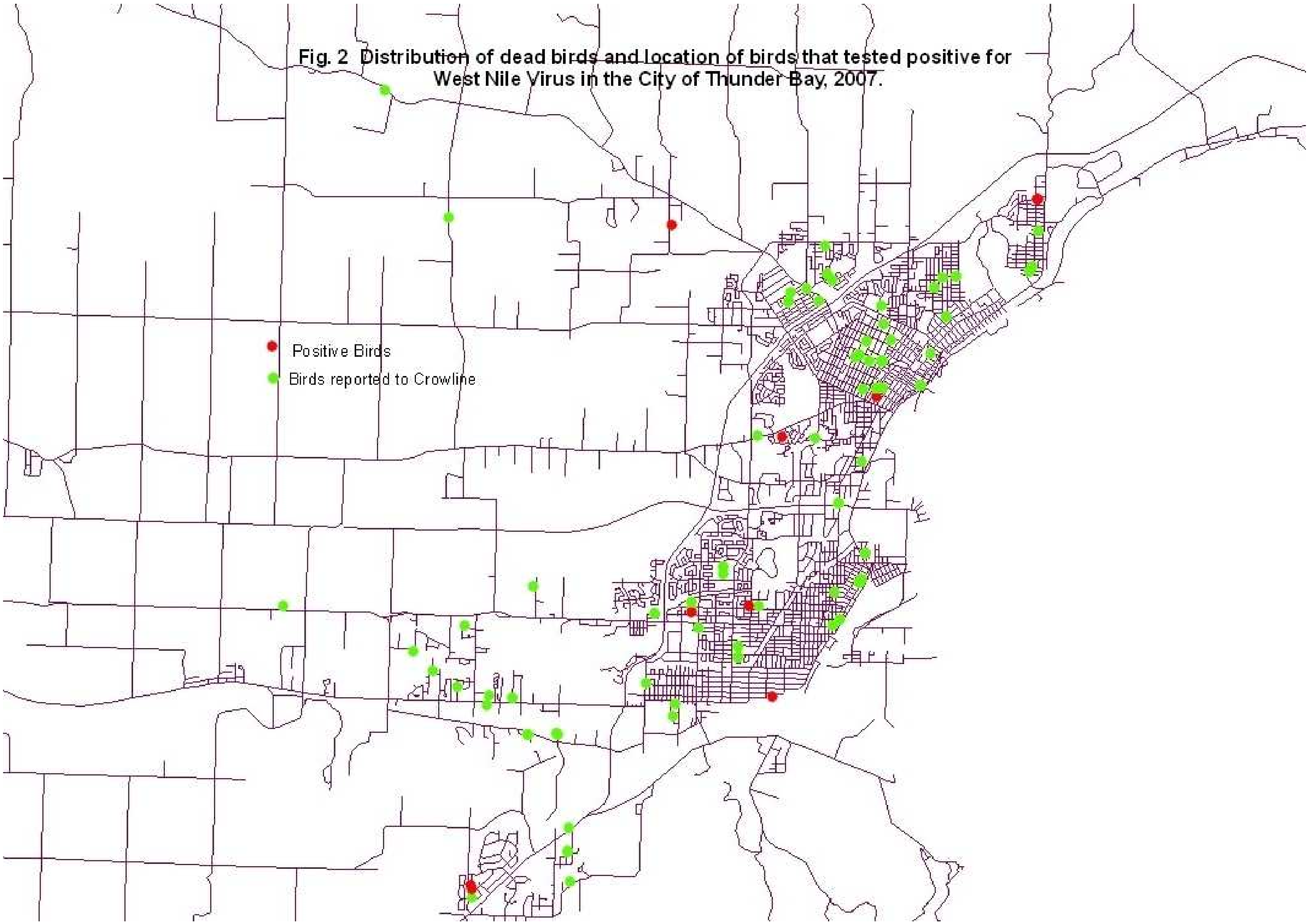
Ten of the 81 dead birds (12.3%) were located in the Region, ranging in distribution from Geraldton in the north, Manitouwadge in the east, South Gillies in the south, and Shebandowan in the west (Fig. 3). Participation by the Region using the “Crowline” was equivalent to that of 2006 (11.2%) even though the total number of calls (n= 81) was considerably lower during 2007. Two of the birds from the Region (one from Red Rock 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. Two “spikes” in mortality occurred without associated sustained “hot spots”. WNV had not amplified extensively within the bird community, possibly because of the development of immunity to the disease by the birds. Location and date of bird mortality, and the results of the 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.

Fig. 2 Distribution of dead birds and location of birds that tested positive for West Nile Virus in the City of Thunder Bay, 2007.



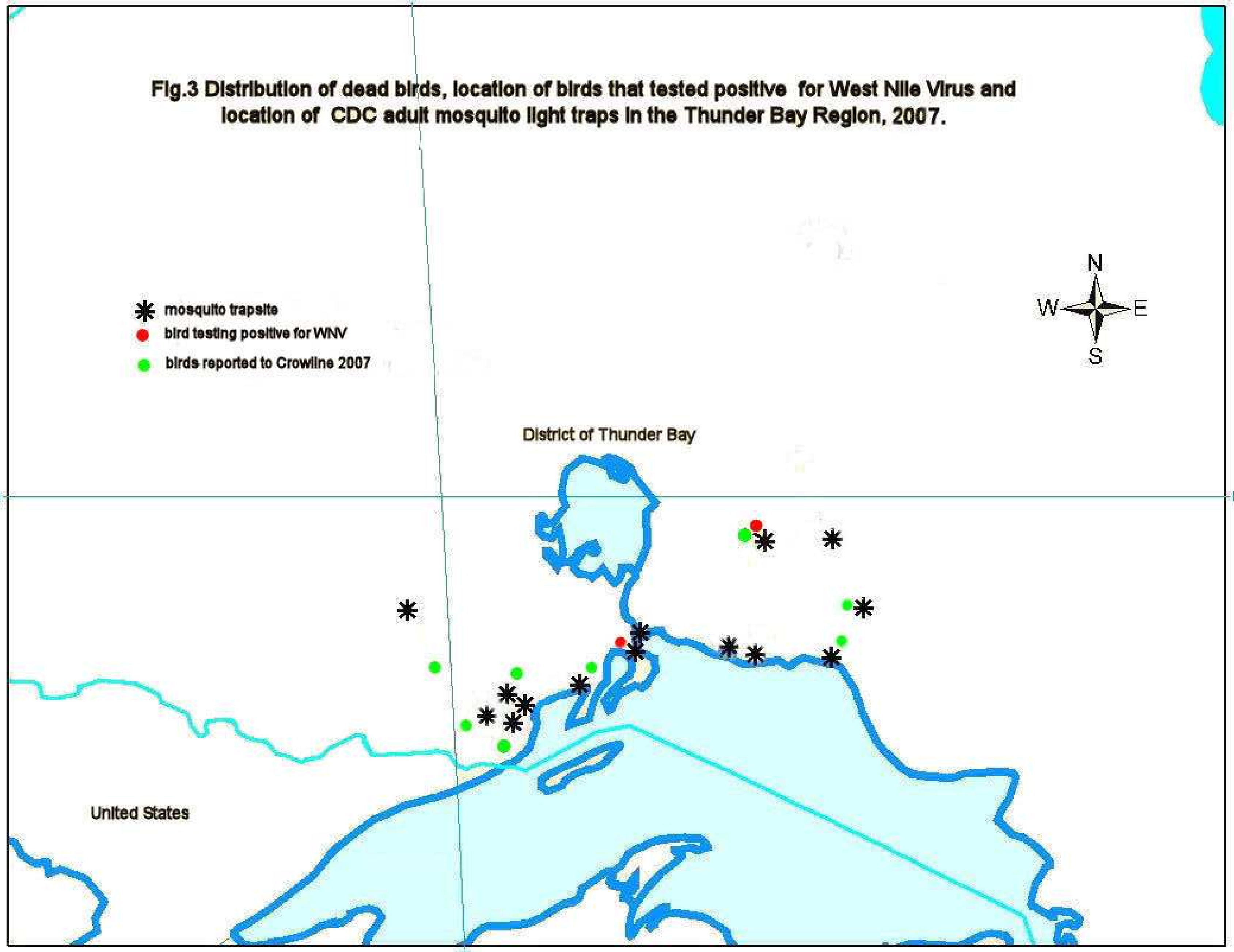


Fig.3 Distribution of dead birds, location of birds that tested positive for West Nile Virus and location of CDC adult mosquito light traps in the Thunder Bay Region, 2007.
mosquito trapsite
bird testing positive for WNV
birds reported to Crowline 2007
N
W
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S
District of Thunder Bay
United States

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 2007, the number of opportunities to examine catch basins was adequate to complete an extensive survey. Ten catch basins throughout the city (Fig.4) were inspected on 9 August near areas where dead birds had tested positive for WNV; however, because of a persistent drought the catch basins were dry. The presence of *Cx. restuans* as the only species in the catch basins was considered significant in previous years (Deacon 2003, 2005). 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. Efforts should be maintained if precipitation permits to determine the prevalence of *Cx. restuans* in the catch basins.

Two complaints about standing water as potential breeding sites were received (Fig 4) during 2007. One site contained no mosquito larvae when examined on 13 June and the other site was in the process of being permanently drained by the city on 13 July.

Twenty-four potential breeding sites/larval habitat were examined during August-September 2007 (Fig. 4). Larvae or pupae of *Anopheles earlei, Anopheles punctipennis,* and *Culex restuans* were recovered from nine sites. No more than six larvae/pupae were found at any site after as many as 200 dips. None of the sites were considered major areas of mosquito reproduction. 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.

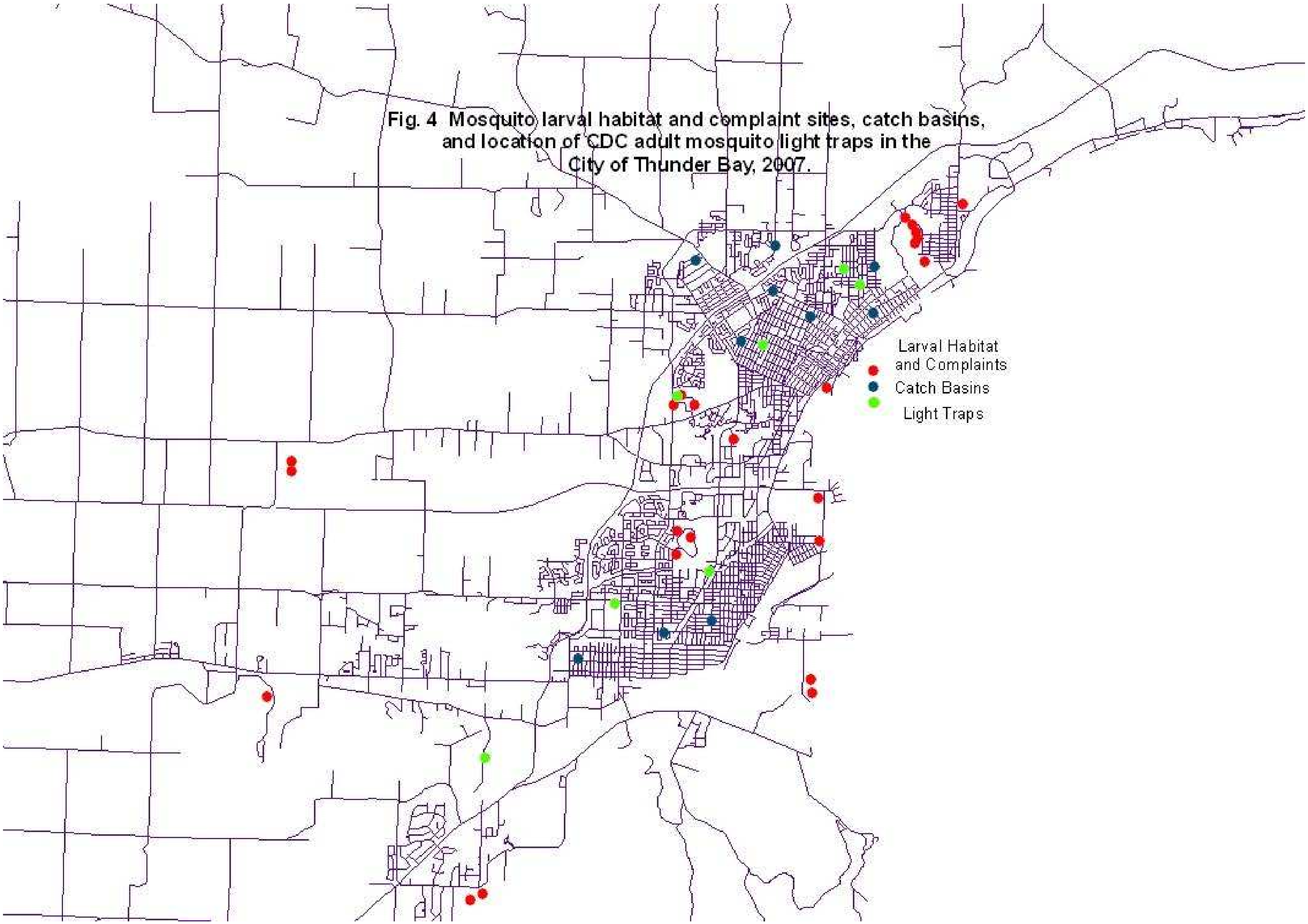


Fig. 4 Mosquito larval habitat and complaint sites, catch basins, and location of CDC adult mosquito light traps in the City of Thunder Bay, 2007.

GIS mapping has greatly increased our ability to note areas of concern within the city, thereby 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. Adequate staffing is essential to complete this survey during 2008.

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 set for nine weeks from 3 July to 27 August during 2007 for a total of 185 trap-nights. Traps were not set in Longlac and Geraldton on two occasions because of mechanical problems.

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 eight occasions during the summer. Entomogen Inc. also performed the viral analyses of the vector mosquitoes.

Ten vector species (two enzootic and eight epizootic) were found in the light traps. The light traps collected a grand total of 6799 specimens. Of this grand total, 192 individuals were unidentifiable or were unidentified males (males do not blood feed; therefore, they do not transmit WNV) leaving 6607 specimens for species determination. A total of 5626 individuals were identified from these specimens, of which 3045 were vectors. These vectors were pooled by species and 77 pools (62 *Culex restuans* pools, 1 *Culex* spp. pool, 6 *Culex tarsalis* pools, 2 *Aedes vexans* pools, 1 *Coquillettidia perturbans* pool, 1 *Culex salinarius* pool, 1 *Ochlerotatus trivittatus* pool, and 3 non-vector

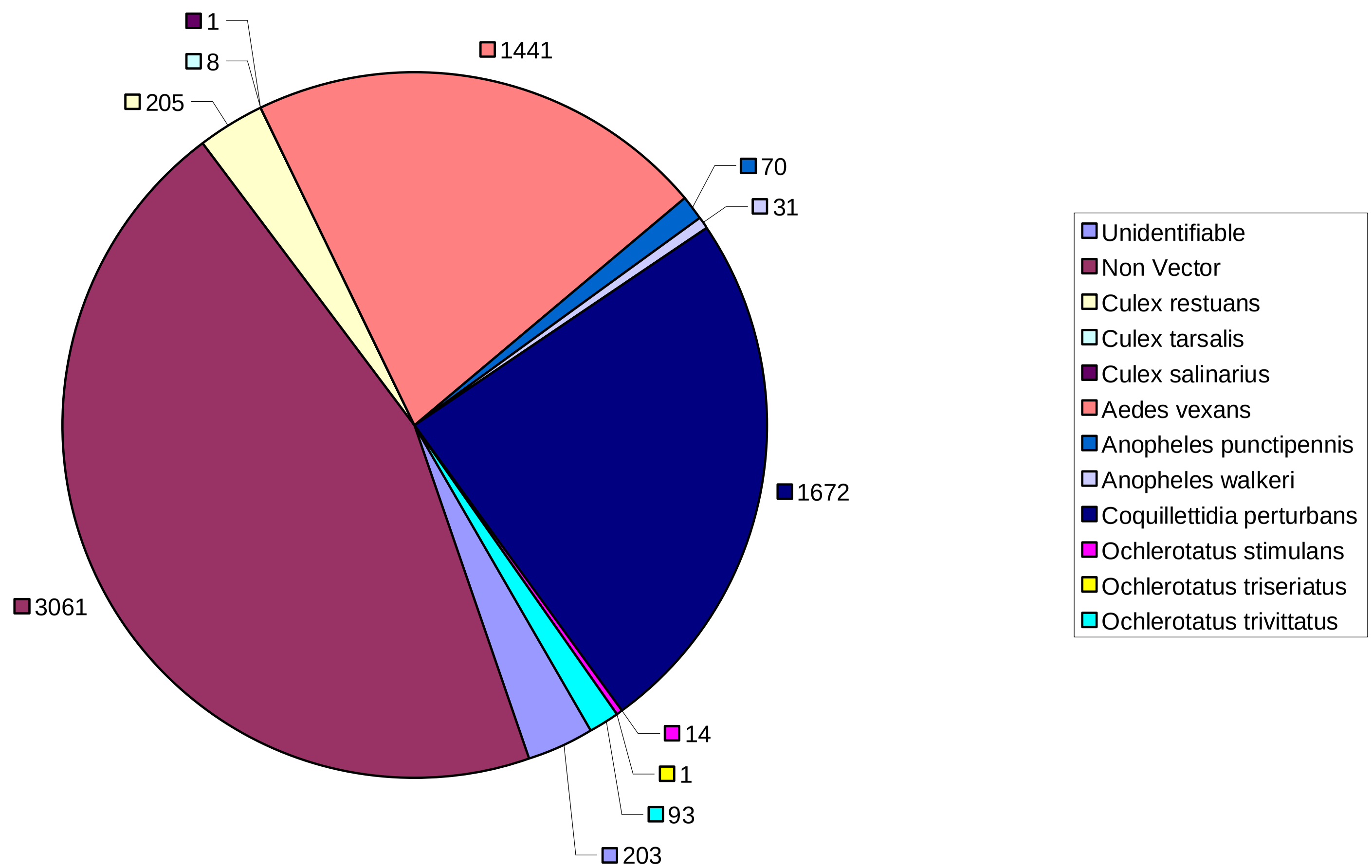
Ochlerotatus canadensis pools) were tested for WNV using Reverse Transcription-Polymerase Chain Reaction (RT-PCR). No mosquito pool tested positive for WNV.

The approximate 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 approximate total number of individuals of each species collected on that night. After this conversion, vector species numbered approximately 3535 individuals, whereas non-vector species numbered 3061 individuals and unidentifiable specimens/males numbered 203 individuals. These values are a more accurate reflection of the proportion of each species within the mosquito community throughout the entire summer.

Cx. restuans, an enzootic vector recovered from the light traps, totaled 205 individuals, about 3.0% of all the mosquitoes collected (Fig. 5). *Cx. tarsalis*, the other enzootic vector totaled 8 individuals (0.1%). The epizootic vectors were *Ae. vexans* (n= 1441) (21.2%), *Anopheles punctipennis* (n= 70) (1.0%), *Anopheles walkeri* (n= 31) (0.5%), *Coquillettidia perturbans* (n= 1672) (24.6%), *Ochlerotatus stimulans* (n= 14) (0.2%), *Ochlerotatus triseriatus* (n= 1) (0.01%), *Ochlerotatus trivittatus* (n= 93) (1.4%), and *Culex salinarius* (n= 1) (0.01%)(Fig. 5).

Culex pipiens, one of the main enzootic vectors of WNV in southern Ontario could possibly be present in the District of Thunder Bay, but still has not been positively identified after five years of monitoring. Hundreds of *Culex* larvae have been reared to the adult stage and all adult males have all been positively identified as *Cx. restuans* only. *Cx. restuans* amounted to 1.5% of the mosquitoes collected in the City of Thunder Bay during 2003, our first year of mosquito surveillance (Deacon 2004). After 2003 traps were located in both the City and the Region in consistent locations which facilitated comparisons amongst the different years. *Cx. restuans* reached 2.0% during 2004 (Deacon 2005), 0.5% during 2005 (Deacon 2006), 0.8% during 2006 (Deacon

Fig. 5 Number of individuals of vector mosquito species and non-vector mosquitoes collected in the District of Thunder Bay, 2007



2007), and 3.0% during 2007. Possibly *Cx. restuans* is increasing in the mosquito community of the District of Thunder Bay; however, no distinct trend is apparent.

Culex salinarius and *Culex tarsalis* are of continuing concern with regards to WNV in Thunder Bay. *Cx. salinarius* was previously reported in 2003 (Deacon 2004) and again in 2005 (Deacon 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. Monitoring must continue to determine changes in the abundance of *Cx. salinarius* and the potential threat this species may pose to public health.

The third *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 allow *Cx. tarsalis* to act as both an enzootic and epizootic vector. The distribution of *Cx. tarsalis* is described as western North America with some populations found in southeastern Ontario, and even Florida (Wood *et al.* 1979). The collection of specimens from Kakabeka to Geraldton during 2005 (Deacon 2006), one specimen from Red Rock during 2006 (Deacon 2007), and eight specimens from around the City of Thunder Bay during 2007 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 its abundance. The recovery of eight specimens during the 2007 season from five different locations around the City of Thunder Bay is encouraging for research opportunities, but must be considered an increased risk for human exposure to WNV. If *Cx. tarsalis* is found at these numbers around the City of Thunder Bay, then future studies should be possible. Additional information will help us predict the nature of the threat to public health posed by *Cx. tarsalis.*

The higher incidence (3.0%) of the enzootic vector *Cx. restuans* plus the presence of *Cx. tarsalis* and *Cx. salinarius* during 2007 still made the amplification of WNV within the bird community to the point of "spill-over" an extremely unlikely event during the summer of 2007. The risk to humans of acquiring WNV was considered greater than during previous years.

The 21 light traps were situated in almost the same locations from 2004 to 2007. Habitat and man-made structures around the light traps remained similar in the City (Fig.4) and the Region (Fig. 3) during this period; 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 moderately dry, and during 2006 was slightly warmer than 2005, but almost as wet as 2004. During 2007 the weather was warm and very dry. 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 when mosquitoes are of greatest concern regarding the transmission of WNV, whereas the number of degree days was 60 during this period in 2005, 63 from 1 July to 8 September during 2006, and 62 during 2007 (Environment Canada 2008). Precipitation during this 10-week period was 162.5 mm during 2004, 99.0 mm during 2005, 156.5 mm during 2006, (68.9 mm of precipitation occurred in one event on 31 July) and 74.5 during 2007 (Environment Canada 2008). The pattern of precipitation during 2006 actually resulted in drought-like conditions during most of the summer. The average number of mosquitoes collected per trap night during the warm, very dry summer of 2007 was 36.8 which was similar to the number collected during the warm, "wet" summer of 2006 (37.4). Both these numbers were substantially lower than numbers of mosquitoes collected during the warm, dry summer of 2005 (60.6) or the cool, wet summer of 2004 (109.8). Prolonged drought or single episode precipitation events greatly affect the presence of standing water throughout the summer. Standing water is necessary for the development of mosquito larvae. The abundance of the mosquitoes is reduced when habitat is reduced.

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). C*x. restuans* increased slightly (n= 60) during the warm, "wet" summer of 2006 (Deacon 2007). Finally, C*x. restuans* increased significantly (n= 205) during the warm, very dry summer of 2007 (Fig. 5). 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). *Cx. pipiens* is still not present in the District of Thunder Bay. C*x. restuans,* however, was more abundant in Thunder Bay during the cool, wet summer of 2004 and next most abundant during the warm, very dry summer of 2007. Evidently both temperature and timing of precipitation play important roles in determining the distribution and abundance of C*x. restuans*. While *Cx. restuans* remains a small component of the mosquito community of northwestern Ontario, the risk of human cases of WNV in the District of Thunder Bay remains low.

The summer of 2005 saw the first appearance of *Cx. tarsalis* with a reoccurrence during 2006 and again during 2007. If the climate changes to one which is similar to the prairies (hot and dry), 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.

Human Surveillance

Two asymptomatic human cases of WNV were noted mid-August in the District of Thunder Bay during 2007. One case was determined to be travel related. The second case was locally acquired.

Mosquitoes have 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 has increased with time. Continued monitoring of the adult mosquito community is necessary and the identification of larval habitat is essential if control measures are found to be necessary in the future.

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 2007, 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 2007. Personnel visited homes for seniors and attended community events in the City of Thunder Bay where they delivered presentations about the results from the 2006 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.

Conclusions

The data collected during 2007 have again demonstrated the potential for an outbreak of WNV if environmental conditions change. Two human cases of WNV were reported in the District of Thunder Bay, one of which was locally acquired. Eleven dead crows tested positive for WNV during 2007 and two “spikes” in bird mortality were noted, but no “hot spot” of dead birds was recorded. *Cx. pipiens* was not collected. The warm, very dry summer of 2007 produced a lower total number of mosquitoes but an increase in the vector species *Cx. restuans* (3.0%) and the very competent vector *Cx. tarsalis. Cx. salinarius* was again recovered in the District of Thunder Bay. *Cx. tarsalis* and *Cx. salinarius* are capable of transmission to both birds and mammals, increasing the risk of WNV to public health. These observations lead to the conclusion that WNV posed a minimal risk to human health during 2007, but a risk that is increasing as the climate changes to one more typical of the prairies which favours an increase of *Cx. tarsalis.*

More information is required about catch basins, larval breeding sites, 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 these proposed actions should be considered only if there is a significantly 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 2008

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, if weather permits, to identify the mosquito species that are present and the abundance of those mosquitoes within the City of Thunder Bay.

3. Continue the identification of larval mosquito habitat within the City of Thunder Bay.

4. Continue to 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. Investigate the biology of *Cx. tarsalis* to determine where this critical species occurs in the Boreal forest.

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