West Nile Virus in the Thunder Bay District, 2008

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EXECUTIVE SUMMARY

No human case of West Nile Virus (WNV) was reported from the District of Thunder Bay during 2008.

West Nile virus was recovered from 1 dead crow. The general public reported 68 dead birds, 15 of which were submitted for viral testing. The only positive bird was found on 1 August, 2008. A “spike”, a sudden increase of mortality, occurred in late May and again in late June during the summer, but the mortality was thought to be related to natural causes. 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.

Twenty catch basins at ten sites were inspected throughout the City of Thunder Bay on 21 August near areas where dead birds had tested positive for WNV. Six catch basins were dry because of a persistent drought. Only one of the remaining 14 catch basins had water which after extensive examination contained two *Cx. pipiens/ restuans* larvae. Efforts should be continued to determine the prevalence of *Cx. restuans* in the catch basins, but the survey should occur earlier during the summer when water is more likely to be present.

Five complaints about standing water as potential breeding sites were received during 2008. The only site that contained vector species mosquito larvae was drained during the summer.

No new larval habitat had been identified for examination during 2008; however, an extensive area in a light industrial area located near the centre of the city was found at the end of the 2008 WNV season. This site should be investigated during 2009.

Nineteen 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 2 July to 26 August for a total of 168 trap-nights. Two light traps were permanently removed from the mosquito surveillance programme because of travel difficulties associated with their maintenance. Seven vector species (one enzootic and six epizootic) were found in the light traps. The traps collected a grand total of 13046 specimens. A total of 7101 individuals were identified from these specimens. The identified specimens contained 2219 vectors. The vectors were pooled by species and then 64 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 80 individuals or approximately 0.6% of the 13046 mosquitoes. *Culex tarsalis* and *Culex salinarius,* competent vectors capable of transmitting WNV to both birds and mammals, were not recovered during 2008. Epizootic vectors included *Aedes vexans* (n= 1527) (11.5%) and five other species. *Cx. pipiens* was not collected.

Only 77.3 accumulated degree-days (AccDD) were recorded in Thunder Bay during 2008. A value of 380 AccDDs is required before an outbreak occurs. The low incidence (0.6%) of the enzootic vector *Cx. restuans,* the absence of *Cx pipiens, Cx. tarsalis,* and *Cx. salinarius,* as well as the low AccDD value made the amplification of WNV within the bird community to the point of “spill-over” an extremely unlikely event during the summer of 2008. The risk to humans of acquiring WNV was considered minimal. Neither larviciding nor adulticiding was considered necessary during 2008.

If the climate of Thunder Bay changes to one which is similar to the prairies (hot and dry) or to that of southern Ontario (hot and humid), then there will be increased risk from WNV because of increases of *Cx. restuans, Cx. tarsalis, Cx. salinarius*, and perhaps the establishment of *Cx pipiens.* Any increase in these extremely competent vectors would result in the increased risk of an outbreak of WNV in the District of Thunder Bay.

History of West Nile Virus in North America

West Nile virus (WNV) first appeared in North America in New York City during August 1999. This mosquito-vectored disease subsequently spread across North America. By the end of the summer of 2008, only Alaska remained free of WNV in humans, birds, animals, or mosquitoes in the continental United States (Centres for Disease Control 2008a). A total of 1370 cases of WNV infections occurred in humans in the United States during 2008, resulting in 37 deaths (Centres for Disease Control 2008b).

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. In 2003 a total of 1495 cases occurred, then 26 cases during 2004, 238 cases during 2005, 151 cases during 2006, and 2353 cases during 2007 (Deacon 2008), which decreased to 36 cases during 2008 (Public Health Agency of Canada 2008). 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, 2 during 2006, 8 during 2007 (Deacon 2008), and 0 during 2008 (Public Health Agency of Canada 2008). WNV was active only in Ontario, Manitoba, and Saskatchewan with travel-related cases reported from Alberta and British Columbia during 2008 (Public Health Agency of Canada 2008).

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 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 life threatening 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. The virus replicates in only some species of mosquitoes which act as the vectors of this disease. 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. 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. Replication of the virus occurs in the mosquito at a temperature above 14.3˚C (Reisen *et al.* 2006). Infected enzootic vector mosquitoes bite other birds, thus transmitting the infection to the new birds (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 in an amplifying cycle. 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*. These mosquitoes prefer to feed on birds but may also bite humans or other mammals (Wood *et al.* 1979). *Cx pipiens* is now known to be attracted to humans at certain times during its lifecycle which means that this species also acts as an epizootic vector of WNV to humans (Russell 2008). 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 now known from the Thunder Bay District as well as the prairies (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, as well as temporary pools or artificial containers (Wood *et al.* 1979).

“Bridge vectors” are generalist feeders, biting both birds and mammals. “Bridge vectors” are responsible for transmitting WNV from birds 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. *Aedes vexans* is the principal “bridge vector” in Ontario; however, this species is only moderately effective as a 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. *Ochlerotatus canadensis* is another species often abundant in the District of Thunder Bay, with larvae found in small open ponds, temporary woodland pools, roadside ditches, cattail and sedge marshes, and muskeg pools (Wood *et al.* 1979). *Oc. canadensis* is also considered a moderately effective “bridge vector” of WNV (Belton 2007).

Cx. pipiens, Cx. restuans, Cx. tarsalis, Ae. vexans, and *Oc. canadensis* are found in close proximity to human populations, which makes these mosquitoes important 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, 2008

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 to facilitate the reporting of dead birds by the general public from 26 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 District of Thunder Bay 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 habitat used by *Culex tarsalis* in the District of Thunder Bay was to be studied, if possible.

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

8. Human cases of WNV 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 2008 report on West Nile Virus activity in the District of Thunder Bay was to be completed.

Dead Bird Monitoring

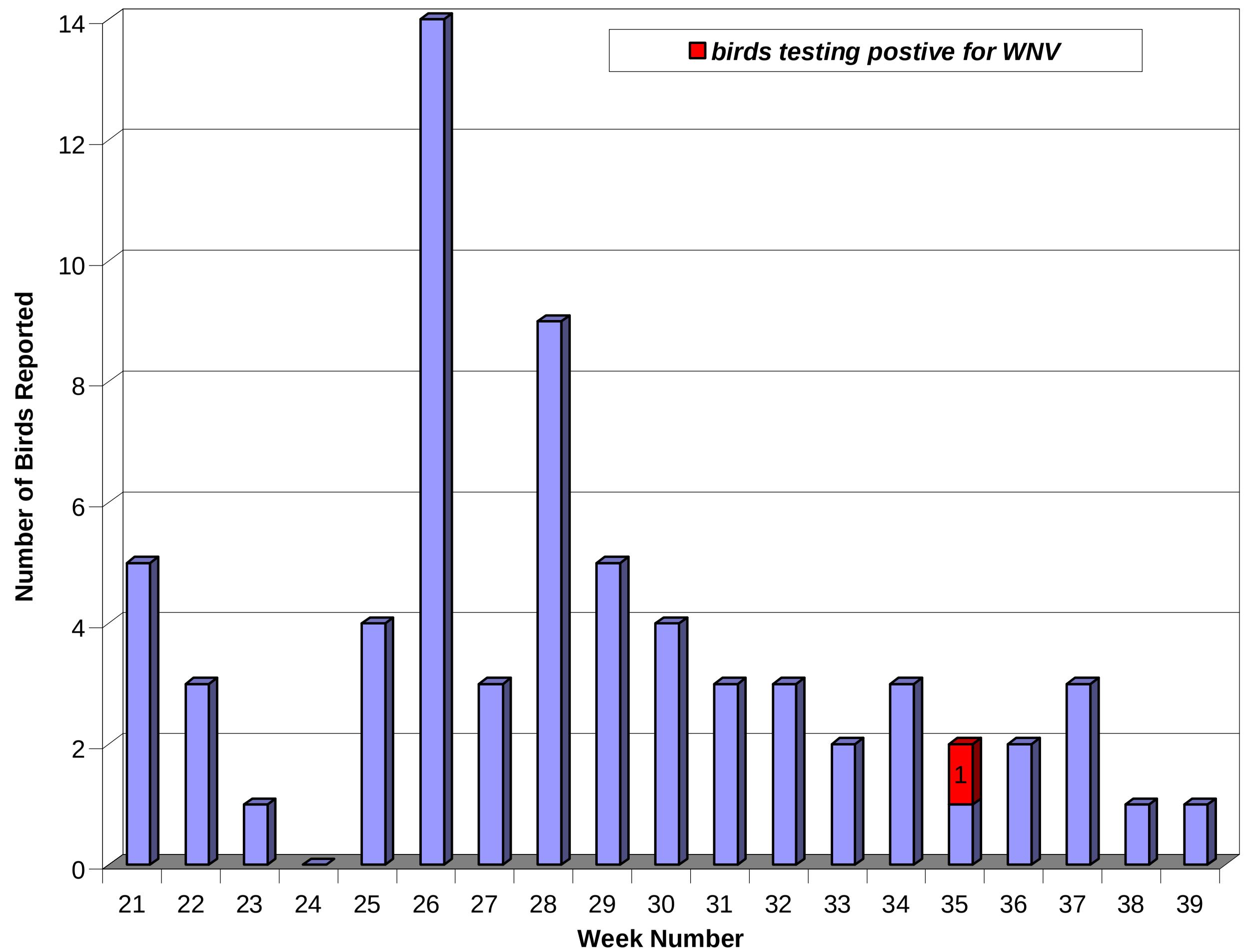
Dead crows are a good indicator of WNV activity. Dead bird sightings often “spike” (bird deaths increase suddenly) just before human cases begin to appear. Clusters of dead birds, known as a “hot spots”, indicate increased WNV activity in an area with increased risk to human health (Elliott *et al*.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

Bird monitoring occurred from 26 May to 30 September 2008, during which time 68 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). The total number of birds reported (n=68) was lower than during 2007 (n=81), 2006 (n=152), 2005 (n=159), or 2004 (n=265) (Deacon 2008). 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 (Hahn *et al.* 2006), which could account for decreased mortality of birds and therefore decreased reporting by the public.

Fifteen birds were selected for viral testing during 2008. One bird collected on 1 August in Thunder Bay tested positive for WNV (Fig 1). The purpose of the viral testing programme was to establish that WNV is present in the bird community of a given area.

The rate of mortality”spiked” during late May in week 21 with five dead birds reported. A second spike occurred during late June in week 26 with 14 dead birds reported (Fig. 1). A “spike” in mortality is thought to indicate increased WNV activity and increased human health risk. The “spike” in mortality for week 21 consisted of only 5 birds and was probably an artifact caused by abnormally cool weather which occurred from late May until mid-June (Environment Canada 2008). Cool weather reduces the rate of

Fig. 1 Birds reported to the Crow Line, Thunder Bay District Health Unit, 2008. Number of West Nile Virus positive birds indicated.



replication of the virus in the mosquitoes and the activity of the mosquitoes which in turn reduces the number of infected and dead birds. The second “spike” occurred during week 26 when the young crows are fledging and natural mortality is high.

Consideration was given to the spatial distribution of dead birds to determine whether there were 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).

Sixteen of the 68 dead birds (23.5%) were located in the Region, ranging in distribution from Geraldton in the north, Manitouwadge in the east, Neebing in the south, and Murillo in the west (Fig. 3). No bird from the Region tested positive for WNV.

The presence of WNV was again confirmed in the bird community indicating that WNV was once again present within the District of Thunder Bay during 2008. WNV had not amplified extensively within the bird community, possibly because of cool conditions or because of the development of immunity to the disease by the birds. 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.

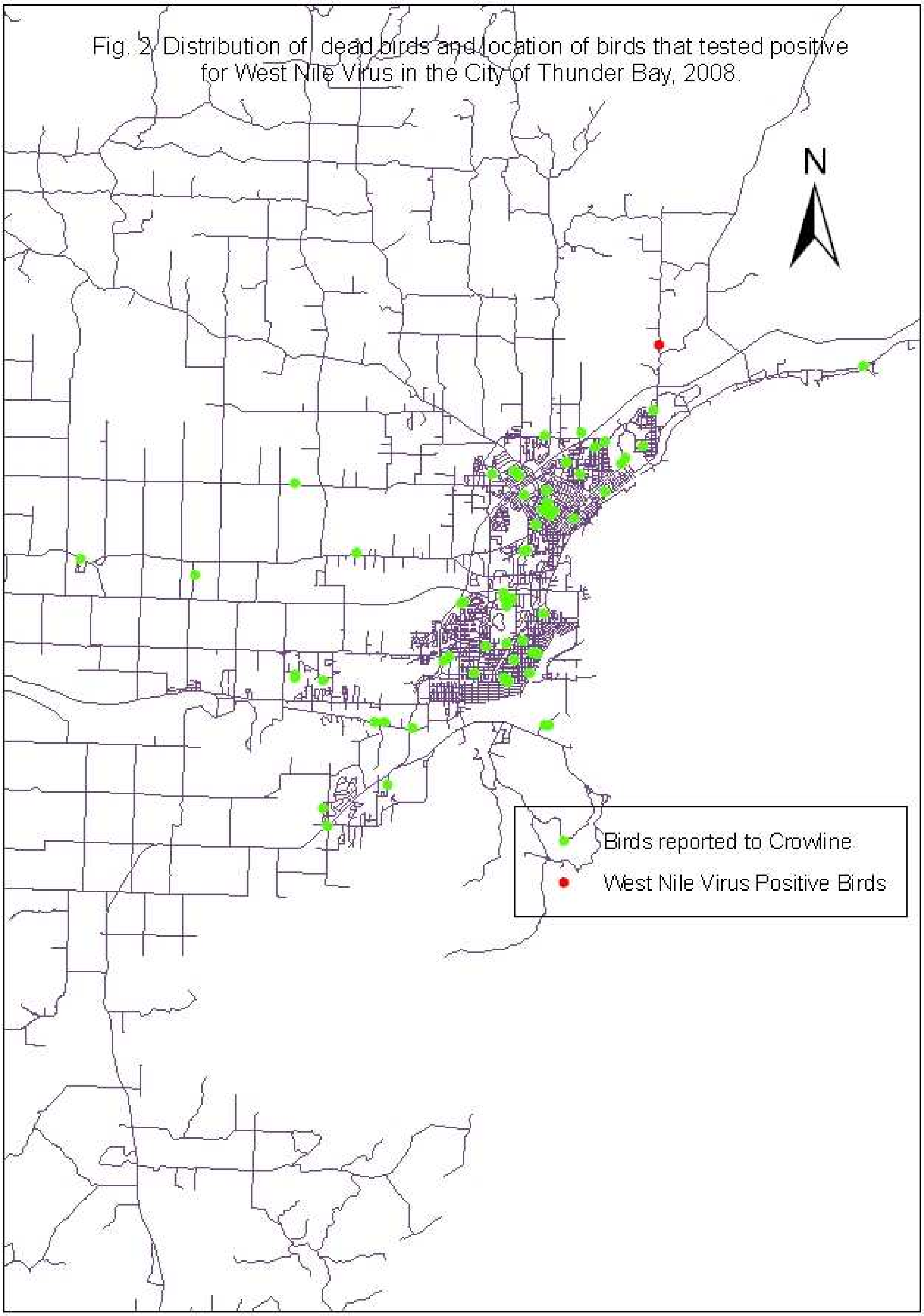
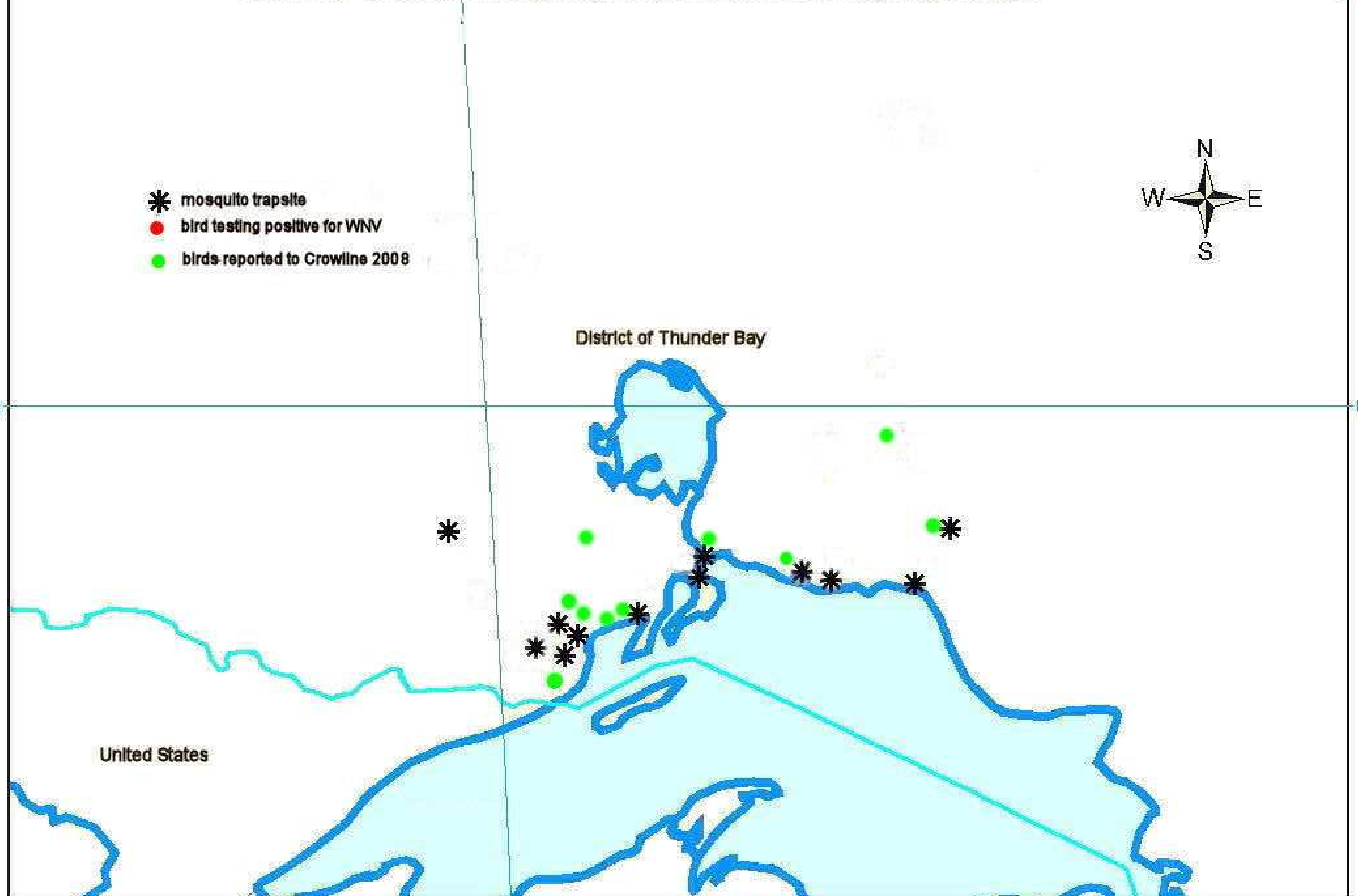


Fig. 2 Distribution of dead birds and location of birds that tested positive for West Nile Virus in the City of Thunder Bay, 2008.
N
Birds reported to Crowline
West Nile Virus Positive Birds

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, 2008.



Ten sites with 20 catch basins were examined during 2007 and were re-examined on 21 August during 2008 (Fig.4). The catch basins were located throughout the city near areas where dead birds had previously tested positive for WNV. A persistent drought left six of the 20 catch basins dry. Only one catch basin with water had 12 larvae and pupae which were identified as two *Cx. pipiens/ restuans* females and ten Chironomidae which are non-biting midges. Catch basins are an important habitat for *Cx. pipiens/ restuans* in the urban environment. The catch basins provide an opportunity for *Cx. pipiens/ restuans* to breed in close proximity to humans, increasing the risk of transmission of WNV. Efforts should be continued to determine the prevalence of *Cx. restuans* in the catch basins. A survey should occur earlier during the summer when water is more likely to be present in the catch basins.

Five complaints about standing water as potential breeding sites were received during 2008 (Fig 4). The first site visited on 22 May consisted of two areas. One area was dry, whereas the second area contained 15 larvae: four *Ae. vexans*; one *Anopheles punctipennis;* four *Cx. restuans* males; one *Cx. pipiens/ restuans* female; and five Chironomidae (non-biting midges). This second area was drained during the summer, so no longer remains a breeding site for mosquitoes. The second site visited on 17 June was spot checked extensively and four pupae were found after 110 dips. One *Anopheles earlei* (non-vector species) and three Chironomidae were reared from these pupae. The third site visited on 4 July yielded one *An. earlei* larva after 100 dips. The fourth site visited on 21 August was dry. The fifth site visited on 10 September was spot checked extensively, but no larva was found after 150 dips. Only the second, wet area in the first site which was subsequently drained produced a significant number of vector mosquitoes.

No new larval habitat had been identified for examination during 2008; however, a wet area in a light industrial sector located near the centre of the city was found after the end of the WNV season. This site should be examined during 2009.

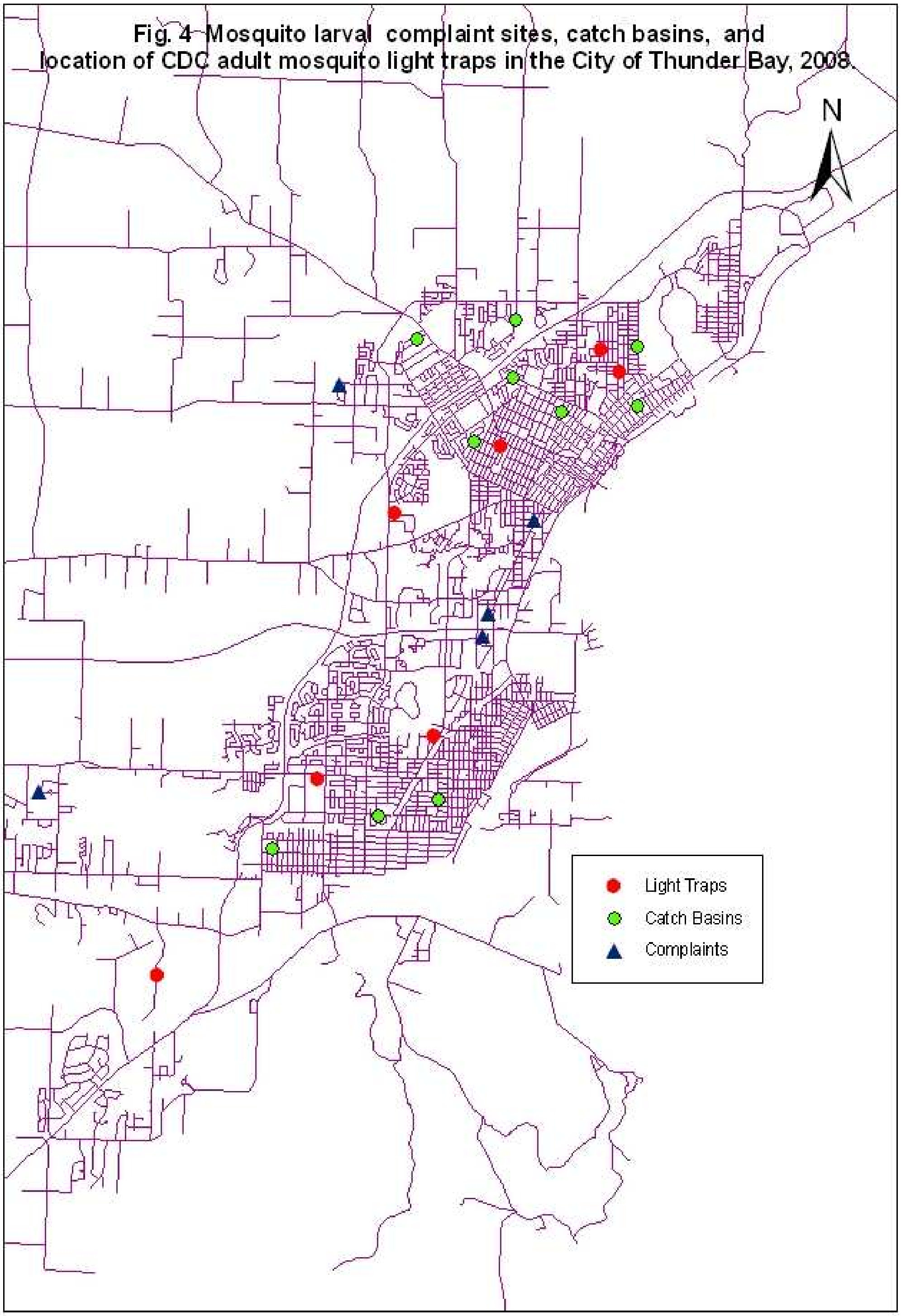


Fig. 4 Mosquito larval complaint sites, catch basins, and location of CDC adult mosquito light traps in the City of Thunder Bay, 2008.
N
Light Traps
Catch Basins
Complaints

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.

Adult Mosquito Surveillance

Nineteen 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 2 July to 26 August during 2008 for a total of 168 trap-nights. Two traps, one in Geraldton and one in Longlac were permanently removed from the mosquito surveillance programme during 2008 because of travel difficulties associated with trap maintenance and pick-up.

The contents of the light traps were analysed by Entomogen Inc. The species of mosquitoes were identified 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 15 occasions during the 2008 trapping season. Entomogen Inc. also performed the viral analyses of the vector mosquitoes.

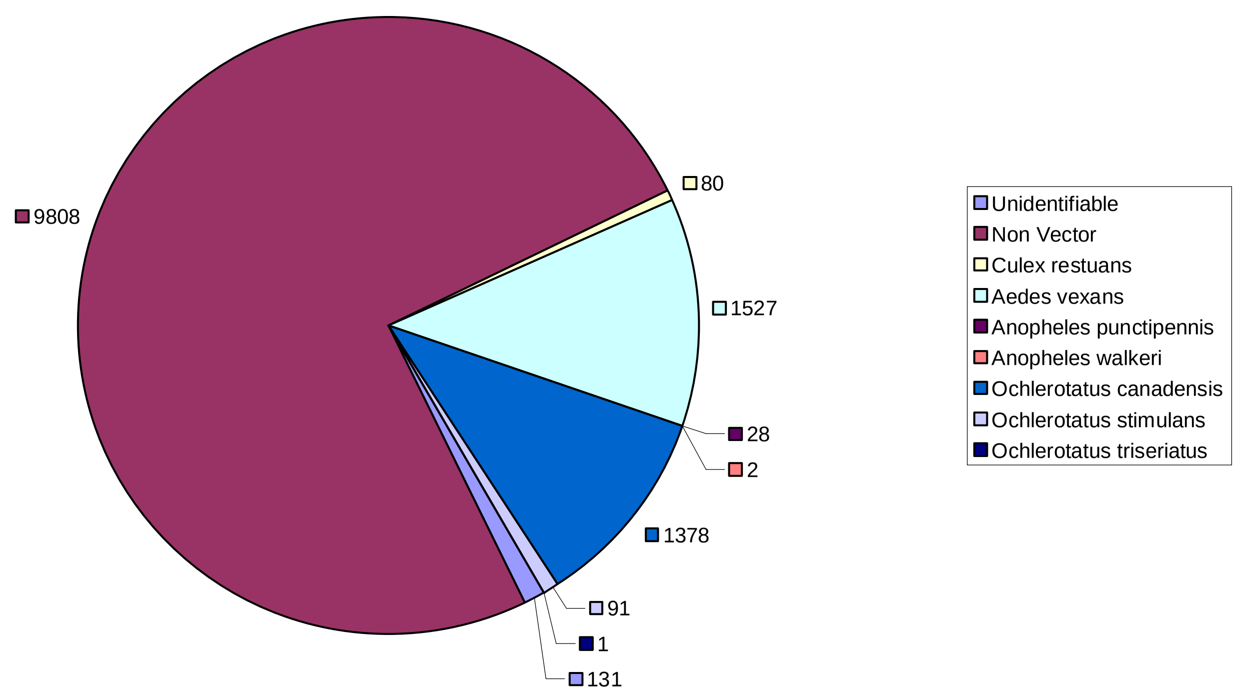
Seven vector species (one enzootic and six epizootic) were found in the light traps. The light traps collected a grand total of 13046 specimens. Of this grand total, 121 individuals were unidentifiable or were unidentified males (males do not blood feed; therefore, they do not transmit WNV) leaving 12915 specimens for species determination. A total of 7101 individuals were identified from these specimens, of which 2219 were vectors. These vectors were pooled by species and 64 pools (35 *Cx restuans* pools, 12 *Ae. vexans* pools, 13 *Oc. canadensis* pools, 3 *Ochlerotatus stimulans* pools, and 1 *Culiseta melanura* pool) 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 per sampling event. 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 were estimated at approximately 3107 individuals, whereas non-vector species were estimated at 9808 individuals and unidentifiable specimens/males were approximately 131 individuals. These values are a more accurate reflection of the number of each species within the mosquito community throughout the entire summer.

Cx. restuans, an enzootic vector recovered from the light traps, totaled 80 individuals (Fig. 5), about 0.6% of all the mosquitoes collected. The epizootic vectors were *Ae. vexans* (n= 1527) (11.8%), *An. punctipennis* (n= 28) (0.2%), *Anopheles walkeri* (n= 2) (0.02%), *Oc. canadensis* (n= 1378) (10.7%), *Oc. stimulans* (n= 91) (0.7%), and *Ochlerotatus triseriatus* (n= 1) (0.01%) (Fig. 5). *Coquillettidia perturbans* (n=3544) is no longer considered an epizootic vector; therefore, the total number of vectors was substantially reduced from previous years because *Cq. perturbans* was no longer counted as a vector.

Cx 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 six years of monitoring. Hundreds of *Culex* larvae have been reared to the adult stage each year of the study and all adult males have all been positively identified as *Cx. restuans* only. The population of *Cx. restuans* has varied from a low of 0.5% (2005) to a high of 3.0% (2007) of the mosquitoes collected. No indication of an apparent trend towards an increase or decrease in number is evident. The fluctuation is probably related to the extremely different weather experienced each summer since the start of mosquito surveillance in 2003.

Fig. 5 Number of individuals of vector mosquito species and non-vector mosquitoes collected in the District of Thunder Bay, 2008



Culex salinarius and *Cx tarsalis* were not recovered during 2008; however, these species 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 are extremely low. Monitoring must continue to determine changes in the abundance of *Cx. salinarius* and the potential threat this species may pose to public health.

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 (Deacon 2008) indicates that this species is established and widespread within the Boreal forest in the District of Thunder Bay. 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. Additional information will help predict the nature of the threat posed by *Cx. tarsalis* to public health.

The Ontario Ministry of Health and Long-Term Care now uses accumulated degree-days (AccDD) (based on average daily temperatures above a threshold temperature of 18.3˚C) to evaluate the risk of a WNV outbreak. Mosquitoes are believed to require 380 AccDD before testing positive for WNV. Only 77.3 AccDD were recorded in Thunder Bay during 2008 (Environment Canada 2008), which is well below the required 380 AccDD. The AccDD value should have been slighlty higher for 2008 because temperatures from 11 t0 17 July were not recorded in the Environment Canada “Daily

Data Reports". Even with these records the estimated AccDD value would have barely exceeded 100, still well below the 380AccDDs required for an outbreak.

The low incidence (0.6%) of the enzootic vector *Cx. restuans,* the absence of *Cx pipiens, Cx. tarsalis,* and *Cx. salinarius,* as well as the low AccDD value made the amplification of WNV within the bird community to the point of "spill-over" an extremely unlikely event during the summer of 2008. The risk to humans of acquiring WNV was considered minimal. If the climate of Thunder Bay changes to one which is similar to the prairies (hot and dry) or to that of southern Ontario (hot and humid), then there will be increased risk from WNV because of increases of *Cx. restuans, Cx. tarsalis, Cx. salinarius*, and perhaps the establishment of *Cx pipiens.* Any increase in these extremely competent vectors would result in increased risk of an outbreak of WNV in the District of Thunder Bay.

Human Surveillance

No human cases of WNV were noted in the District of Thunder Bay during 2008, although two cases were reported during 2007 (Deacon 2008). 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. The risk of an individual acquiring WNV in the TBDHU remains low; however, 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 2008, this information was disseminated to the public through pamphlets and the media. Pamphlets and/or posters were distributed to health unit district offices, hospitals, children's daycare centres, seniors' centres, long-term care facilities, doctors' offices, pharmacies, golf clubs, municipal offices, community centres, resorts, sport shops, campuses, recreational camps, tree planting camps, garden centres, and parks. WNV information was also published on 19 occasions in Community and Seasonal newspapers.

The TBDHU conducted a number of media interviews about WNV during the spring and summer of 2008. Personnel also staffed display booths, which were designed to convey essential information about the risk from WNV in Thunder Bay.

Conclusions

The data collected during 2008 have again demonstrated the potential for an outbreak of WNV if environmental conditions change. One dead crow tested positive for WNV during 2008. Two "spikes" in bird mortality were noted, but not associated with WNV and no "hot spot" of dead birds was recorded. *Cx. pipiens* was not collected. The vector species *Cx. restuans* decreased to only 0.6% of the mosquitoes recovered in the District of Thunder Bay. These observations lead to the conclusion that WNV posed a minimal risk to human health during 2008, but a risk that will increase as the climate changes to one more typical of southern Ontario or western Canada. Any change which increases the numbers of the extremely competent vectors *Cx. restuans, Cx. tarsalis, Cx. salinarius*, and perhaps the establishment of *Cx pipiens* would result in the increased risk of an outbreak of WNV in the District of Thunder Bay.

More information is required about catch basins, larval breeding sites, and 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 more conducive for the transmission of WNV in Thunder Bay.

Recommendations for 2009

1. Discontinue the Crowline and dead bird pick-up, as recommended by the MOHLTC.

2. Continue the adult mosquito surveillance programme within the City of Thunder Bay and in the Region using CDC light traps.

3. Continue the catch basin monitoring program, if weather permits, to identify the mosquito species that are present and the abundance of those mosquitoes within the catch basins of the City of Thunder Bay.

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

5. Continue to monitor larval mosquito habitat that has been reported by, and is of concern to, the public.

6. Continue the use of GIS mapping to store all habitat, catch basin, and mosquito trap locations and data.

7. Investigate the biology of *Cx. tarsalis,* if weather permits, to determine where this critical species occurs in the Boreal forest.

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