Vector-Borne Disease Report

West Nile Virus, Lyme Disease and Eastern Equine Encephalitis Surveillance and Control Activities for 2012

December 2012

BUREAU DE SANTÉ DE MIDDLESEX-LONDON HEALTH UNIT

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Executive Summary

This season the Middlesex-London Health Unit (MLHU) focused on a comprehensive Vector-Borne Disease (VBD) Program to monitor local tick and mosquito populations closely for Lyme disease (LD), West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE). The MLHU also focused on an enhanced Lyme disease (LD) education campaign, encouraging the public to prevent tick bites, check for ticks, remove ticks properly and submit ticks to the Health Unit.

West Nile Virus is an arbovirus, transmitted to humans through the bite of an infected mosquito. The transmission cycle begins when mosquitoes bite an infected bird and then transmit WNV through a bird-mosquito-bird cycle, with mosquitoes playing the role of the "primary vector" and humans the incidental hosts for infection when bitten by an infected mosquito. Infected humans can develop symptoms three to 15 days after being bitten; however, most people (80%) do not acquire enough of the virus in their bloodstream to make them ill. Twenty percent (20%) of those bitten will develop mild symptoms known as West Nile Fever. Severe cases will develop West Nile Encephalitis, a serious neurological condition causing acute inflammation of the brain which may cause tremors, disorientation, loss of consciousness, muscle weakness and/or paralysis. Approximately three percent to 15% of people with encephalitic symptoms will die from the infection. This season WNV activity increased within Middlesex-London with seven human cases, 17 WNV-positive mosquito traps and 23 WNV-positive birds confirmed. Increased WNV activity was also observed throughout the province.

Lyme disease—caused by the *Borrelia burgdorferi* bacteria—is the most common tick-borne illness in North America, transmitted to humans through the bite of an infected *Ixodes scapularis*, commonly known as the blacklegged or deer tick. Middlesex-London is currently not an endemic region for this tick species; however, since blacklegged ticks often feed on migratory birds, they can easily be spread throughout the province. Once again, the MLHU observed an increase in tick submissions from the public. In total, 87 ticks were submitted this season. Ten ticks were identified as blacklegged, three of which were positive for *Borrelia burgdorferi* (Lyme disease). All of the blacklegged ticks submitted to Health Unit were forwarded to the National Microbiology Laboratory in Winnipeg to test for *Borrelia burgdorferi*. There was one travel-related human case of Lyme disease reported in Middlesex-London in 2012.

Eastern Equine Encephalitis is an alphavirus transmitted through the bite of an infected mosquito. EEE circulates through a bird-mosquito-bird transmission cycle, with different mosquito species playing the role of the "primary vector" within avian, animal and human populations. The incidence of EEE in Canada has historically been low, however the MLHU and Province of Ontario continue to monitor for the presence of EEE-vector species and test for EEE when those vectors are identified in adult mosquito traps. This season there were no EEE-positive mosquito traps and a significant decrease in the number of EEE vector mosquito species trapped within Middlesex-London.

Dead bird testing is an important surveillance tool signaling the early presence of West Nile Virus activity in the community. This season the Health Unit continued to receive reports of dead birds and performed testing for WNV in the Strathroy Laboratory. In total, 41 dead birds were suitable for testing in the Strathroy lab, 23 of which were WNV-positive. The maintenance of a dead bird surveillance program allows the MLHU to detect WNV in the community and provide advanced warning to residents, in addition to setting up added hotspot traps in areas of confirmed WNV activity. This season, several WNV-positive birds confirmed the presence of WNV in the community, prior to nearby adult mosquito traps being identified as WNV-positive.

Mosquito larval surveillance is an important aspect of the MLHU's Integrated Pest Management strategy, as the identification of vector mosquito larvae initiates the larvicide treatment of sites containing WNV and/or EEE-vector species. In 2012, 21,201 mosquito larvae were identified, of which approximately 70% were vector species. The most abundant vectors identified this season were *Culex pipiens* and *Aedes vexans*. This season the MLHU also identified very high numbers of the non-vector species, *Culex territans*.

Adult mosquito surveillance and viral testing offers crucial information to the MLHU, providing a greater understanding of disease transmission, population densities, species variation, and the distribution of WNV positive activity throughout Middlesex-London. Adult surveillance is performed with the use of terrestrial and canopy traps; the VBD Team collects, identifies and performs viral testing on adult mosquitoes with the assistance of its service provider, on a weekly basis. This season, adult mosquito trapping and viral testing identified 17 WNV-positive mosquito traps. All species that tested WNV-positive this season were identified as *Culex pipiens/restuans*, the species most capable of transmitting WNV to humans.

The objective of human surveillance is to understand the epidemiology of vector-borne diseases within human populations. West Nile Virus, LD, and the encephalitic symptoms caused by EEE are classified as both *Reportable Diseases* and *Communicable Diseases* under the *Health Protection and Promotion Act*. The number of reported cases of WNV-related illness increased this season to a total of seven human cases. There was also an increase at the provincial level, with 252 WNV clinical cases reported in Ontario in 2012. This season there was one positive Lyme disease human case reported, which was travel-related. No EEE positive human cases have ever been reported in Middlesex-London or in Ontario.

The MLHU's vector mosquito control program aims to protect human health from vector-borne diseases, reducing vector mosquito populations which could potentially transmit WNV or EEE. This season, the MLHU and its service provider, The Canadian Centre for Mosquito Management Inc., (CCMM), used an Integrated Pest Management (IPM) approach, which is a decision-making process that includes identification of vector mosquito larvae, prior to treatment. This season 1047 treatments were performed at 229 sites monitored by the MLHU and its service provider. Municipal catch basins were also treated as part of the MLHU's control strategy. Approximately 88,000 catch basins were treated in three rounds throughout the course of the 2012 season. Sewage lagoons and standing water located in the City of London's pollution control plants were also treated this season when vector mosquito larvae were identified. The VBD Team also worked closely with stakeholders to continue remediation efforts in the town of Parkhill. In addition, the VBD Team maintained a comprehensive mosquito surveillance and control schedule in Parkhill, performing larvicide treatments when vector mosquito larvae were identified, and testing adult mosquitoes for WNV and EEE. Various remediation efforts by the Municipality of North Middlesex led to a reduction in adult and larval mosquito populations this year.

In 2012 the MLHU continued to receive public reports of vector-borne disease related complaints, comments and concerns. The most frequent public calls in the past two seasons have been dead bird reports and tick-related inquiries, followed by standing water concerns. Each season, as a result of the VBD Team's public education efforts, the MLHU has observed increased public involvement. The VBD Team encourages the public to report dead birds, standing water, ticks, and/or inquire about personal protection or prevention techniques.

Monitoring temperatures, rainfall and Accumulated Degree Days (ADD) has become an important aspect of the Vector-Borne Disease Program in order to better prepare for possible West Nile Virus activity and the emergence of increased mosquito or tick populations when favourable weather conditions exist. Through the monitoring of weather trends, the MLHU observed 235 consecutive degree days from June 27 to August 16, 2012. Prior to the confirmation of the first WNV-positive mosquito trap on July 18, 2012, 168 consecutive degree days were observed in Middlesex-London. The identification of consecutive degree days allowed the MLHU to heighten surveillance and prepare for possible WNV activity within the community. Areas where WNV-positive dead birds were found were monitored closely as those birds served as indicators for WNV-activity in addition to ADDs.

Public education remains an essential component of the Vector-Borne Disease Program. The MLHU distributed Lyme disease brochures, attended community events, developed print advertisements and engaged the public through social media. At community events, the VBD Team encouraged the public to reduce and repel mosquitoes and protect against tick bites. This season, the Vector-Borne Disease Team worked with Environmental Health's Epidemiologist and Program Evaluator to analyze data collected from the Rapid Risk Factor Surveillance System (RRFSS) on the topic of Lyme disease awareness and education in Middlesex-London. The survey was organized to provide baseline data for the evaluation of public education initiatives to increase the awareness and use of protective measures related to Lyme disease. Final survey data will be received in the spring and will assist with 2013 vector-borne disease program planning.

Vector-Borne Disease program objectives seek to prevent the transmission of WNV, LD and EEE to residents, in addition to reducing the amplification of these diseases within local mosquito, tick and avian populations. In an effort to maintain the goals of this program, the MLHU will continue to enhance its public education strategies, maintain partnerships with local stakeholders and ensure residents are aware of the Vector-Borne Disease Team's message and services. Each season, the VBD Team continues to evaluate program outcomes and seasonal surveillance data, in order to adjust monitoring, control and public education strategies based on the changing dynamics of local mosquito and tick populations. This season, following a summer with increased WNV- activity, and an increase in blacklegged tick submissions, the MLHU will focus efforts in 2013 on Lyme disease and tick submission awareness, in addition to monitoring adult mosquito populations within Middlesex-London.

Chapter 1: West Nile Virus

1.1 Introduction

West Nile Virus (WNV) originated in the Ugandan Province of West Nile in 1937. Since its introduction, outbreaks have occurred worldwide. The first WNV activity in North America was reported in New York City in 1999. West Nile activity in Canada was first reported in 2001. The first human cases in Ontario occurred in 2002, when 394 positive human infections were recorded across the province. Since the initial outbreak of WNV in Ontario, regional health units have established and maintained larval and adult mosquito surveillance and control programs in order to monitor vector mosquito populations and prevent the transmission of WNV to humans.

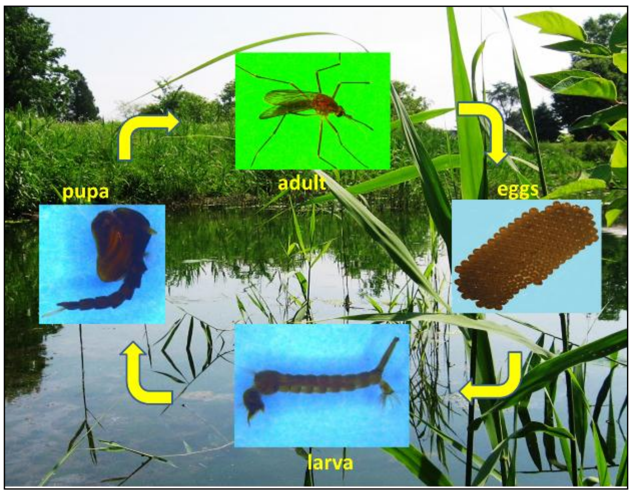

Figure 1-1: Mosquito life cycle.

1.2 Mosquito Life Cycle

There are four stages in a mosquito's life cycle: egg, larva, pupa and adult [**Figure 1-1**]. Females are the only mosquitoes that bite, as they require a blood meal to nourish their eggs. Most female mosquitoes do not live long after laying eggs; however, in some species, ovulation may be repeated several times before death. Female mosquitoes can lay as few as one or as many as several hundred eggs at a time. Some species lay eggs individually, and others lay multiple eggs that group together as a "raft". It can take as little as two days for the eggs to hatch and for larval and pupal stages to ensue, provided an ideal habitat is maintained (warm, still water). Combined, larval and pupal stages can last anywhere from four to 14 days; increased temperatures accelerate the progression from first instar larva to pupa. When adult mosquitoes emerge, they immediately seek refuge in dense vegetation. Mating usually occurs within the first few days of this adult stage. The length of a mosquito's life generally depends on temperature and the species' biological characteristics. Many species differ in their preferred blood source, habitat, ability to carry disease, and over-wintering strategies.

1.3 Transmission of West Nile Virus

West Nile Virus is a flavivirus that can cause head and body aches, fever, skin rash and swollen lymph nodes in infected human cases (Sporometrics, 2012). The transmission cycle of WNV begins when mosquitoes bite an infected bird and then transmit the virus to humans through a bite. West Nile Virus often circulates through a bird-mosquito-bird cycle, with mosquitoes playing the role of the "primary vector" for infection. This cycle of transmission is called "amplification". Transmission begins in early spring and by mid-summer an influx of infected birds and mosquitoes can result from this cycle of amplification.

Figure 1-2: WNV transmission cycle (PHAC, 2006).

The over-wintering of certain mosquito species plays a large role in the amplification of WNV, as these species can jump-start a cycle of WNV transmission. The "jump-starting" of WNV transmission begins when mosquitoes overwinter as adults infected with the virus, and/or emerge in early spring and begin to feed on birds infected with WNV. Mosquito species that feed on both birds and mammals have the ability to transmit the virus to humans [**Figure 1-2**]. Birds are considered to be the "reservoir" hosts for WNV, while humans (and other mammals) can become incidental end hosts for infection within the viral transmission cycle. (Public Health Agency of Canada, 2006).

1.4 Signs and Symptoms

Analysis of WNV has shown that humans will develop symptoms of the illness two to 15 days after being bitten by an infected mosquito. In North America, studies have shown that when bitten, most people (80%) do not acquire enough of the virus in their bloodstream to make them ill. Twenty percent (20%) of those bitten will develop mild symptoms known as West Nile Fever, consisting of general symptoms of fever, headache, muscle aches, nausea, fatigue, skin rash and/or swollen glands. In some instances, those infected with WNV will develop encephalitis, a serious neurological condition causing acute inflammation of the brain. Severe encephalitis can cause tremors, disorientation, loss of consciousness, muscle weakness and/or paralysis. Severe symptoms of encephalitis caused by WNV have been found to occur most frequently in adults over 50 and in those with chronic health issues due to weakened immune systems. Three percent to 15% of people with encephalitic symptoms will die from the infection. Studies indicate that those who survive often experience long-term side effects which include; fatigue, memory problems, muscle weakness, difficultly walking and/or depression. (MLHU, 2002)

1.5 West Nile Virus Related Activities in Middlesex- London

The Middlesex-London Health Unit's (MLHU) Vector-Borne Disease (VBD) Program uses an Integrated Pest Management (IPM) approach to monitor and control vector mosquito larvae and perform viral testing on adult mosquitoes, to decrease the threat of vector-borne illness to humans.

In order to reduce and repel vector mosquito populations, the VBD Program emphasizes:

- Public education
- Adult mosquito trapping and viral testing
- Dead bird surveillance and WNV testing
- Weekly monitoring of standing water and identification of mosquito larvae
- Control of vector mosquito larvae in standing water located on public property
- Mapping of adult mosquito trap locations and larval dipping sites

Although WNV is the main vector-borne disease of concern in Middlesex-London, the MLHU continues to monitor for other vector-borne diseases that could affect local populations in future seasons.

1.6 Vector-Borne Disease Program

The VBD Team has actively monitored sites throughout Middlesex-London since 2002. This season, the Canadian Centre for Mosquito Management (CCMM) was once again contracted as the MLHU's licensed mosquito control service provider. The Canadian Centre for Mosquito Management treated roadside and other municipal catch basins this season, in addition to assisting with standing water surveillance within the City of London.

Both CCMM staff and members of the MLHU's VBD Team obtained a Mosquito/Biting Fly Exterminator licence prior to applying larvicide products located on public property. In preparation for the 2012 season, both teams participated in a series of training sessions, in addition to focused in-class training provided by an Ontario Pesticide Specialist. Staff orientation consisted of a field component where larval dipping and treatment demonstrations were conducted. In addition, practical examinations to test the team's ability to understand the safe handling and application of pesticides were administered.

Chapter 2: Lyme Disease

2.1 Introduction

Lyme disease (LD) is caused by bacteria known as *Borrelia burgdorferi*. This bacterium is carried by the blacklegged tick (*Ixodes scapularis*), also known as the deer tick and can be spread to a host through a bite. The bacterium is found in small animals such as mice, squirrels, chipmunks and shrews. Lyme disease in humans can have a range of effects from rashes and flu-like symptoms to more serious symptoms which include arthritic, cardiac and neurological effects. It can often be effectively treated, especially if detected in the early stages. Lyme disease is an occupational concern for people who work outdoors. Any person who spends time outdoors is also at risk. (Canadian Centre for Occupational Health and Safety, 2008)

In Canada, the blacklegged tick is the main vector species that carries and transmits Lyme disease. The greatest risk of Lyme disease in Canada occurs where populations of these ticks are established or endemic, and where there is evidence that these established ticks are transmitting the agent of Lyme disease to local mammal and incidentally, human, populations. These locations are termed 'Lyme endemic or established areas' as defined by Public Health Ontario (PHO). (PHO, 2011)

Within Ontario, blacklegged tick populations are most often found along the shores of Lake Erie, Lake Ontario and the St. Lawrence River, coinciding with migratory bird flight routes. Endemic locations with blacklegged ticks include Long Point, Turkey Point, Wainfleet Bog, Rondeau Provincial Park, Point Pelee National Park, Prince Edward Point National Wildlife Area and the St. Lawrence Islands National Park in the Thousand Islands region of eastern Ontario. It is difficult to establish precise boundaries of tick populations since the species continues to expand into neighbouring regions.

Current research suggests that tick populations and Lyme disease endemic areas only occur in a limited number of areas in Canada; however surveillance indicates that established tick populations are beginning to expand their territory. Since blacklegged ticks feed on migratory birds, deer and other animals, they can easily be transported throughout the province. Due to the potential for expansion of tick populations, it is difficult to define the geographic limits of this species. (PHAC, 2012)

Figure 2-1: Blacklegged tick, *Ixodes scapularis*, identified in the Strathroy laboratory.

British Columbia, Manitoba, Quebec and Nova Scotia have also reported LD activity in local tick populations. In the United States, LD-carrying ticks have been identified in states along the Atlantic seaboard and in Ohio, Minnesota and Washington. (Public Health Ontario, 2011)

Figure 2-2: Dog tick, *Dermacentor spp.*, the most common tick submitted to the MLHU, identified in the Strathroy laboratory.

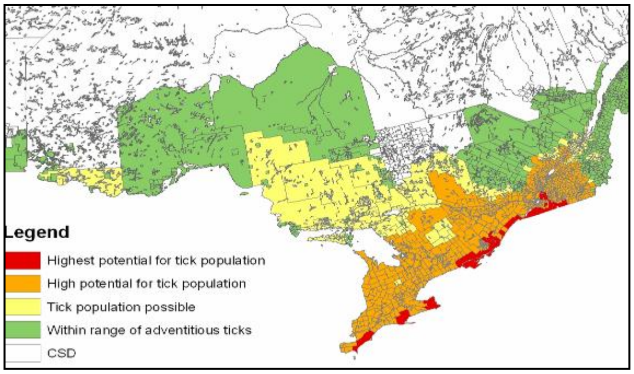

Figure 2-3: Areas in Ontario where blacklegged tick populations have become established or endemic. (PHO, 2011)

It is important in the surveillance of Lyme disease to understand the definition of an 'adventitious' and 'established' versus 'endemic' blacklegged tick population. These three terms are used to describe the level of risk within certain geographic regions of Ontario, depending on the number of blacklegged ticks and LD cases reported from within that region. Throughout this Vector-Borne Disease (VBD) report, the MLHU will discuss established and endemic areas for blacklegged tick populations, advising residents through public education campaigns on how to protect themselves when travelling to these regions. In order to understand why it is important to employ personal protection in these regions, it is important to know the difference between these terms.

Regions with an 'established' blacklegged tick population have identified a number of blacklegged ticks in the same area over multiple years, however these ticks have **not** tested positive for *Borrelia burgdorferi.* Regions with an 'endemic' blacklegged tick population have identified blacklegged ticks in all life cycle stages in the same area over multiple years and both ticks and small mammals in the area **have tested positive** for *Borrelia burgdorferi.* Active tick surveillance is conducted in regions classified as 'established' or 'endemic'. Adventitious tick populations are areas where blacklegged ticks are found only sporadically. Middlesex-London falls within this classification as tick dragging has not identified any established populations of blacklegged ticks however, on occasion blacklegged ticks are submitted from within Middlesex-London. An 'adventitious' tick population means that both passive and active surveillance are conducted within the region, depending on the total number and species of ticks that are reported and submitted to the Health Unit. The risk of acquiring LD within a region classified as having an 'adventitious' blacklegged tick population is low, however it is possible. The risk of acquiring LD increases anywhere that blacklegged ticks are established or "endemic".

Understanding the complex life cycle of the blacklegged tick can help in understanding how to prevent tick bites and Lyme disease transmission. The complete life cycle of blacklegged ticks requires two years. Tick eggs are laid in the spring, and hatch as larvae in the summer. Larvae feed on mice, birds, and other small animals in the summer and early fall. The larvae may become infected with Lyme disease bacteria when feeding on these animals. Once a tick becomes infected, it stays infected for the duration of its life and can transmit the bacteria to other hosts. After the initial feeding, the larvae usually become inactive until the following spring, when they develop into nymphs. Nymphs seek blood meals in order to fuel their growth into adults. Nymphs feed on small rodents, birds, and other small mammals in late spring and early summer. Nymphs will also feed on humans, and if infected with the Lyme disease bacterium, they can transmit the disease to humans. Nymphs molt into adult ticks in the fall. In the fall and early spring, adult ticks feed on large animals, such as deer; mating also occurs at this time of the year. Adult female ticks may also feed on humans at this time. In spring, adult female ticks lay their eggs on the ground, completing the two-year life cycle [**Figure 2-4**].

2.2 Lyme Disease in Humans

Lyme disease is transmitted to humans after an infected tick feeds on a host for at least 24 hours. It takes this length of time for the bacteria to transfer from the tick's salivary glands to the host's bloodstream. Because of this, rapid detection and removal of ticks is essential in preventing LD.

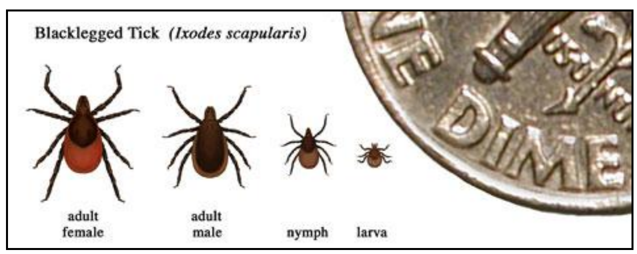

Figure 2-4: Life stages of the blacklegged tick. (Ontario, Ministry of Health and Long-Term Care, 2012)

Humans infected with LD may have a number of different symptoms. These symptoms often occur in three stages and not all patients will show every symptom. Many symptoms also occur with other diseases, which can make diagnosing LD challenging.

Symptoms usually begin within three days to one month after being bitten by an infected tick. The first sign of infection is usually a circular rash called erythema migrans (EM), commonly known as the “bull’s-eye” rash [**Figure 2-5**]. This rash varies in size and typically occurs in 70% to 80% of those infected. During the initial stage of infection, symptoms may include; fatigue, chills, fever, headache, muscle and joint pain, and swollen lymph nodes. If left untreated, the symptoms may progress to the second stage of infection, which can last several months. Second stage symptoms may include; multiple skin rashes, heart palpitations, arthritis and/or arthritic symptoms, extreme fatigue, general weakness, and central or peripheral nervous system disorders. The third stage may last for a few months or years with recurring neurological problems and arthritis. Most cases of LD can be successfully treated with antibiotics; however, if left untreated, LD can seriously affect the joints, heart and nervous system, resulting in chronic health problems. (Public Health Ontario, 2011)

2.3 Incidence of Lyme Disease

The most common tick-borne infection in the Northern hemisphere, LD was first recorded in Canada in 1979, by a biologist who had been working in Long Point, Ontario, a known endemic region. Although 1979 may be the first documented case of LD in Ontario, it is difficult to establish an early history of the disease since many cases of LD in Canada have not been well documented in the past. Lyme disease has become important in recent years as provinces are seeing blacklegged ticks in higher numbers. (Artsob, 2010)

Due to the incidence of human LD cases along America's Atlantic seaboard, and an increasing number of blacklegged ticks being observed across Canada, Lyme disease is becoming an illness of increasing importance to local health units (Artsob, 2010). In response to these trends Lyme disease became a nationally reportable disease in Canada in 2010. This means that all medical professionals must report cases of LD to the Public Health Agency of Canada (PHAC). Considering the number of endemic regions in Ontario and the identification of increased blacklegged tick populations in bordering U.S. states, scientists believe that human LD cases may also increase in coming years due to the influence of climate change and the changing migration patterns of birds. So far, the monitoring of LD cases and blacklegged ticks in Ontario has been effective in detecting the prevalence and reducing the transmission of LD. (PHAC, 2010)

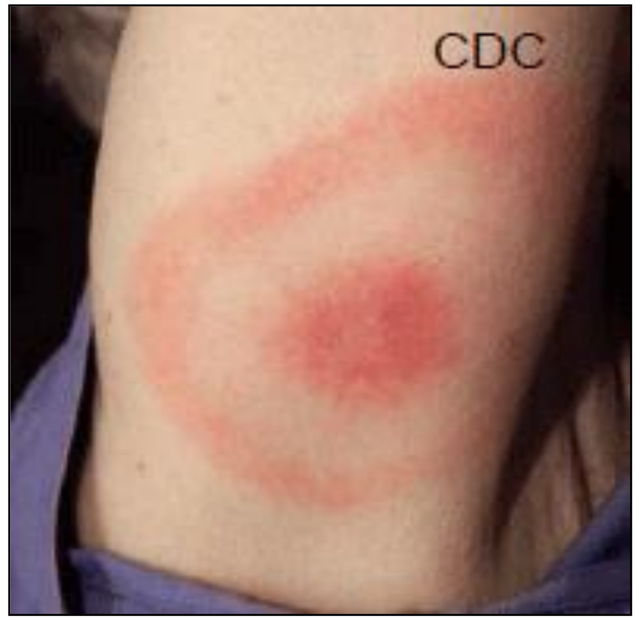

Figure 2-5: “Bull’s-eye” rash circulating from tick bite. (PHIL, 2012)

2.4 Lyme Disease in Middlesex-London

With the addition of LD to the Vector-Borne Disease Program in 2009, it was determined that Middlesex-London does not have endemic or established blacklegged tick populations, therefore a passive tick surveillance approach has been utilized. Passive surveillance relies on tick submissions from physicians, veterinarians and the public to determine the presence of LD vectors within the community. All submissions are identified in the MLHU's Strathroy laboratory, and if a blacklegged tick is identified it is sent to the London Public Health Laboratory for species confirmation and then to the National Microbiology Laboratory to determine if *Borrelia burgdorferi* is present in the tick sample. If a blacklegged tick is submitted and/or identified from within Middlesex-London, follow-up tick dragging is performed in the area of concern. Multiple tick submissions from the same geographic area will also prompt the MLHU to monitor tick populations closely.

This season, the VBD Team performed tick dragging at various habitats across Middlesex-London. The MLHU also attended a Lyme disease and tick dragging workshop hosted by Public Health Ontario, on May 30, 2012. Members of the VBD Team attended the workshop and received training on active tick surveillance and identification. The workshop was held in Turkey Point, an endemic region for blacklegged ticks. Tick dragging at the workshop identified several blacklegged ticks, which were collected for public education purposes.

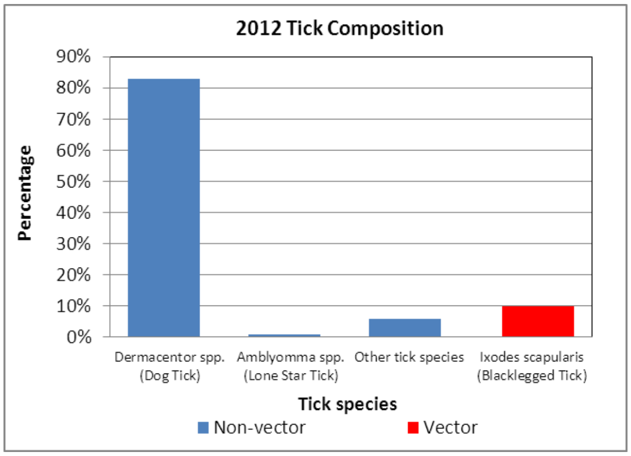

Figure 2-6: Total number of ticks identified in 2012.

Figure 2-7: VBD staff tick dragging in 2012.

In 2012, a total of 87 ticks were submitted to the MLHU. This is an increase from 73 ticks submitted in 2011 and 46 submitted in 2010. Submissions were made between January 16, 2012 and October 16, 2012. Dog ticks (*Dermacentor* spp.), a non-vector species, were the most common type of tick submitted representing 83% of all ticks identified. Blacklegged ticks (*Ixodes scapularis*) were the second most abundant species representing 10% of all ticks identified. The remaining species identified were other tick species of the *Ixodes* genus (6%) and a Lone Star tick of the *Amblyoma* genus (1%) [**Figure 2-6**].

In 2012, ten blacklegged ticks were identified in the Strathroy lab. One of the blacklegged ticks was found on a dog and acquired within Middlesex-London. The remaining nine blacklegged ticks were found on humans and acquired outside of Middlesex-London. Three of the blacklegged ticks (found on humans) tested positive for Lyme disease (*Borrelia burgdorferi*). The three ticks testing positive for Lyme disease were acquired in Christie Lake, Ontario, Wolfeville, Nova Scotia, and Rondeau Provincial Park.

In 2012, there was one human case of Lyme disease, which was travel-related. There were no laboratory-confirmed human cases of Lyme disease contracted from within Middlesex-London.

2.5 Conclusions and Recommendations

The VBD Team continued passive surveillance based on public tick submissions and by dragging in areas where a high number of ticks were observed. The MLHU should continue to monitor for blacklegged ticks in order to inform residents about the regional incidence of tick populations in Middlesex-London.

Based on tick surveillance in 2012, the following recommendations have been made:

Although the incidence of LD-carrying ticks in Middlesex-London remains low, neighbouring regions of the province have been identified as endemic. Ticks are parasites that can migrate by way of host movement; therefore, potential hosts may carry ticks from these neighbouring communities into Middlesex-London. If blacklegged ticks were to become endemic to Middlesex-London, the MLHU would heighten monitoring efforts and initiate active surveillance.

A Lyme disease television commercial once again aired on Rogers TV throughout the 2012 season. The VBD Team also featured an ad in the City of London's Waste Reduction and Conservation calendar, reminding residents to protect themselves against tick bites. The MLHU will continue to educate the public encouraging more residents to use insect repellents when in grassy or wooded areas, and to submit ticks when found on humans. The MLHU will continue to develop and implement educational messages to reduce the risk of LD infection in humans.

Chapter 3: Eastern Equine Encephalitis

3.1 Introduction

Isolated in Canada for the first time in 1938, Eastern Equine Encephalitis (EEE) activity has been detected in Ontario, Quebec and Nova Scotia. Eastern Equine Encephalitis is classified as an *alphavirus* from the family *Togaviridae*. Eastern Equine Encephalitis most often circulates through a bird-mosquito-bird cycle of transmission, with the mosquito species *Culiseta melanura* acting as the primary vector for amplification within avian populations [**Figure 3-1**]. *Coquillettidia perturbans* and some *Aedes* species have been identified as the primary mosquito vectors for the transmission of EEE to animals and humans. In past seasons, all of these species have been identified in Middlesex-London, however in 2012; no *Culiseta melanura* specimens were identified. It is currently unknown how EEE over-winters in host species; it may endure in birds, mosquitoes or other mammals until it can once again emerge during the more temperate spring seasons. (MOHLTC, 2011; CCWHC, 2000; Goddard, 2007)

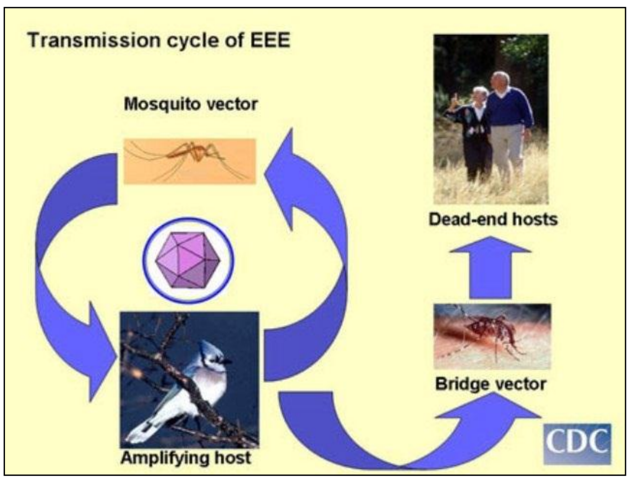

Figure 3-1: Transmission cycle of EEE (CDC, 2010)

3.2 Eastern Equine Encephalitis in Humans

In the past, EEE has predominantly affected equine populations; however the presence of EEE-positive mosquitoes in Ontario in recent years has increased the possibility of human infection. Human infection often involves severe symptoms of encephalitis including fever, headache and myalgia. Encephalitis occurs two to 10 days from the onset of initial symptoms. Approximately five percent (5%) of humans who acquire EEE will develop severe symptoms of encephalitis, characterized by the abrupt onset of systemic illness.

Signs and symptoms in encephalitic patients include fever, headache, irritability, restlessness, drowsiness, anorexia, vomiting, diarrhea, cyanosis, convulsions, and coma. (Centers for Disease Control, 2011)

Approximately one third (33%) of all people who develop the severe encephalitic symptoms of EEE will die from the disease. Of those who recover from the illness, many are left with disabling and progressive mental and physical side effects, which can include minimal brain dysfunction to severe intellectual impairment, personality disorders, seizures, paralysis, and cranial nerve dysfunction. (MOHLTC, 2011; CDC, 2011)

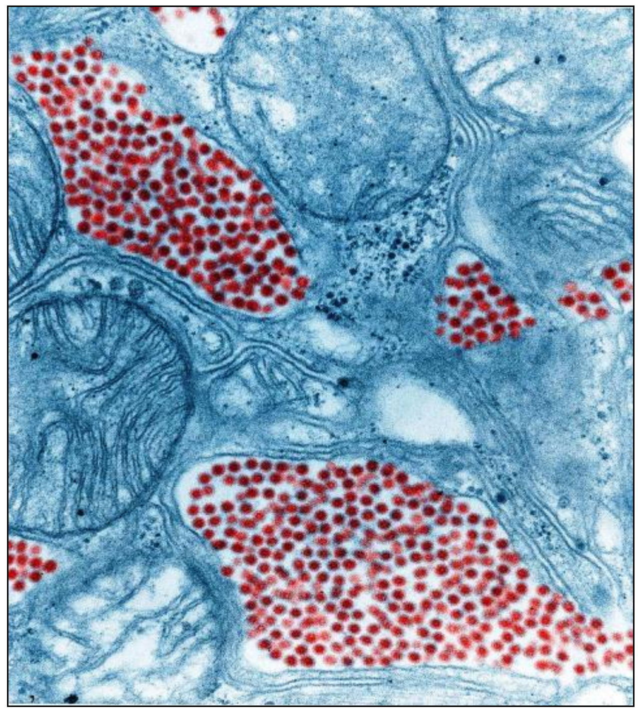

Figure 3-2: Colourized transmission micrograph of a salivary gland extracted from a mosquito infected with EEE virus (virus coloured in red). (PHIL, 2010)

There are currently no anti-viral medications available for humans who become infected with EEE; however a seasonal vaccination for horses is available. (AMCA, 2010) There have been no known EEE human cases reported to date in Canada; however in the past EEE activity has been confirmed in horses, emus, and some EEE-positive mosquitoes have been found in Ontario, Quebec and Nova Scotia. Several bordering American States have also experienced EEE outbreaks in recent years.

3.3 Incidence of EEE

Within Middlesex-London there were no EEE-positive mosquito traps and no specimens of the main vector, *Culiseta melanura,* collected in adult traps this season. In past seasons, adult mosquito trapping has identified the presence of several EEE-vector species. Of the 10,057 adult mosquitoes identified in 2012, only 31% were vector species for EEE, compared to 51% in 2011 and 48% in 2010. The EEE-vectors identified in 2012 in Middlesex-London were: *Aedes vexans, Cq. perturbans* and *Oc. canadensis*.

Public Health Ontario (PHO) guidelines outlined EEE surveillance protocols once again this season. These guidelines outlined the EEE Adult Mosquito Testing Order of Preference, which recommended priority species for EEE testing, which included *Cs. melanura*, *Oc. Canadensis*, *Cq. perturbans* and *Ae. vexans vexans* (**Appendix A**). The MLHU's service provider, Sporometrics, performed 334 EEE viral tests throughout the mosquito trapping season. All viral tests were negative. There were also no human or equine cases of EEE reported from Middlesex-London. (Sporometrics, 2012) Province-wide, no EEE-positive mosquitoes were identified.

In the past several years, the United States (U.S) has reported an increase in EEE cases. In 2010, the U.S saw some of its highest numbers of EEE in 30 years. In 2012, the U.S. still saw a high number of EEE-positive mosquitoes, birds, human and veterinary cases. The U.S. reported a total of 12 human cases; seven in Massachusetts, two in Vermont and one each in North Carolina, Virginia, and Florida.

This season there were 477 EEE-positive mosquito traps detected in the U.S. (CDC, 2012). Michigan reported one veterinary case in Van Buren County. (United States Geological Survey, 2012)

3.4 Conclusions and Recommendations

Since many mosquito vectors which have the potential to carry and transmit WNV also have the potential to transmit EEE, the MLHU's vector control program will continue to identify and manage species of concern. Regular mosquito identification and viral testing remains an important part of controlling the number of EEE vectors within Middlesex-London.

In 2012, there were no confirmed cases of EEE in humans, mosquitoes or horses within Middlesex-London. Although EEE activity has not yet been identified within Middlesex-London the MLHU will continue to follow the directive of PHO and its partners in order to monitor the potential emergence of this disease.

It is important that the MLHU maintain partnerships with health units across the province as well as with local mosquito control organizations in the U.S in order to share information regarding emerging trends, to effectively monitor adult and larval mosquito populations and to track the distribution of EEE activity in North America. Forging partnerships with other organizations is necessary in order to develop uniform protocol and integrated prevention strategies against the transmission of EEE.

Chapter 4: Dead Bird Surveillance

4.1 Introduction

The objective of dead bird surveillance is to identify WNV activity in an area and to use that information to inform the public and reduce the potential risk of WNV transmission to humans. Information concerning dead birds was received online or by phone, and then recorded and triaged to staff. The Vector-Borne Disease (VBD) reporting line was accessed by Health Unit staff on a daily basis to record dead bird sightings from the public in Middlesex-London. Staff determined whether the birds were acceptable for preliminary WNV testing in the Strathroy Laboratory.

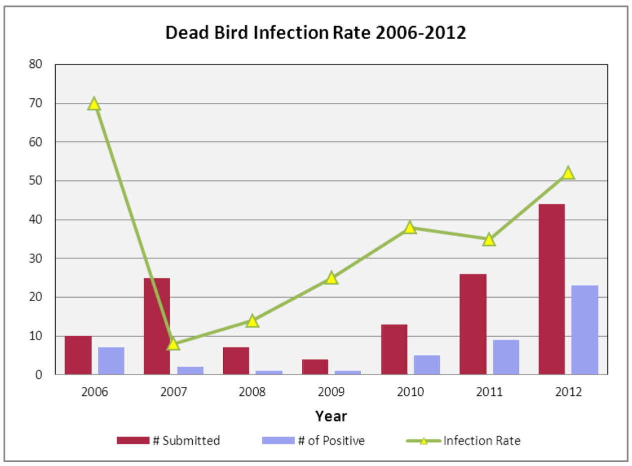

Figure 4-1: Dead bird infection rate, 2006 to 2012.

4.2 Results

The first dead bird report was received on March 20, 2012. By the end of the season, a total of 205 dead bird concerns had been reported. This is a 27% increase in the number of dead bird reports compared to 2011 [**Figure 4-1**]. Forty one (41) birds were suitable for testing by MLHU staff. A total of 23 birds tested positive for WNV in the Strathroy laboratory (**Appendix B**). The birds were then sent for confirmation, and the positive results were verified by the CCWHC.

4.3 Discussion

This season's trends indicate that WNV is still present within Middlesex-London and that public submissions are an important part of tracking and pin-pointing the geographic distribution of West Nile Virus. In several areas where WNV-positive birds were identified, the MLHU confirmed WNV-positive mosquito traps a short time after. These submissions served as an early warning sign that WNV was present in the community. Prior to the identification of the first WNV-positive mosquito trap located at Greenside Avenue and Springbank Drive, two WNV-positive crows were submitted from the same area. A WNV-positive crow was submitted from London's east end, prior to a trap at the Huron Conservation Area being confirmed as WNV-positive. In week 31, an additional three WNV-positive crows were confirmed prior to the identification of the Health Unit's fifth WNV-positive mosquito trap of the season. This is significant because the positive birds allowed the MLHU to focus its efforts in those areas and increase visits to standing water located in those regions. Heightened surveillance in areas identified by early-indicator WNV-positive birds prompted the MLHU to increase surveillance and control efforts, as well as educate residents though media releases to protect against mosquito bites and to avoid being outdoors at dawn and dusk, when mosquito activity is at its highest.

Figure 4-2: VBD staff testing a crow for WNV.

Public education strategies have assisted the MLHU in making residents aware of dead bird reporting and of efforts to test dead birds for WNV. The MLHU's comprehensive education program has provided the public with contact information for the VBD Team and the Vector-Borne Disease Reporting Line. This allows members of the public to play an active role in the program by reporting dead crows and blue jays that are observed in Middlesex-London.

4.4 Conclusions and Recommendations

Maintaining aspects of the dead bird surveillance program allows the MLHU to:

- Provide advanced warning and relevant information to residents regarding the presence of WNV in the community.
- Strengthen knowledge and understanding of WNV trends.
- Increase surveillance and control efforts in areas where WNV activity has been detected.

The increased viral activity observed in 2012 indicates that an avian surveillance program is still an important part of detecting WNV activity in the community.

Continuing to accept calls, analyzing submissions and performing WNV-testing on a discretionary basis can complement the MLHU's Vector-Borne Disease Program's multi-disciplinary approach.

It is also important that the MLHU maintain an effective education program to notify residents that dead bird submissions assist in monitoring the prevalence of WNV within the community. Promotional items highlighting dead bird submission protocols and the Dead Bird Reporting Line are helpful ways to keep the public involved in the MLHU's efforts to reduce the transmission of West Nile Virus.

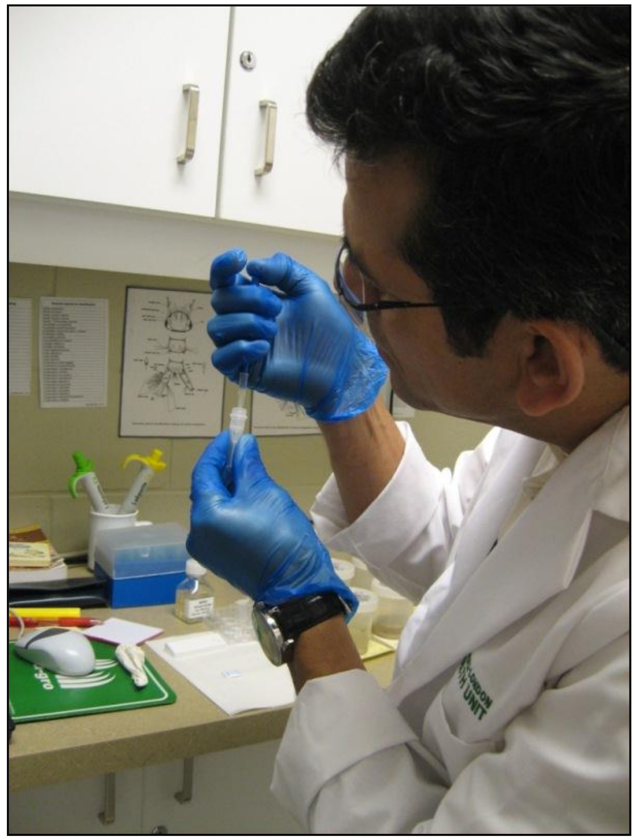

Figure 4-3: VBD staff completing a test for WNV.

Chapter 5: Larval Mosquito Surveillance

5.1 Introduction

In 2012, larval mosquito surveillance remained an important part of the Vector Borne Disease (VBD) Program. The Middlesex-London Health Unit (MLHU) uses the data collected from larval surveillance to initiate control measures as part of an Integrated Pest Management (IPM) approach to control vector mosquito species.

Figure 5-1: VBD staff collecting mosquito larvae.

5.2 Larval Identification Results

This season, larval surveillance began on March 12, 2012 (week 11). The first larvae collected were *Ochlerotatus stimulans*. During 2012, a total of 21,201 mosquito larvae were identified, of which 14,886 (70.2%) were vectors, and the remaining 6,315 (29.8%) were non-vectors. From 2005 to 2011, week 29 has bred the highest number of vector mosquito larvae, however this season, vector mosquito larvae populations peaked earlier in the season in week 23. This can be attributed to warmer than average temperatures.

5.3 Vector and Non-Vector Breakdown

The mosquito species, *Culex pipiens* was the most abundant vector species identified, representing 28.17% of all larvae collected. *Aedes vexans* was the second most abundant vector representing 13.03%, followed by *Culex restuans* at 11.55%, *Anopheles punctipennis* at 9.03% and *An. quadrimaculatus* at 4.02%. The species *Ochlerotatus japonicus* 2.37%, *Oc. stimulans* 1.17%, *Oc. canadensis* 0.85%, and *Oc. salinarius* 0.02% represented the remaining vector species identified this season.

Culex territans was once again the most prevalent non-vector species identified, comprising 29.32% of all larvae. Less than 1% of the remaining species identified were other non-vectors.

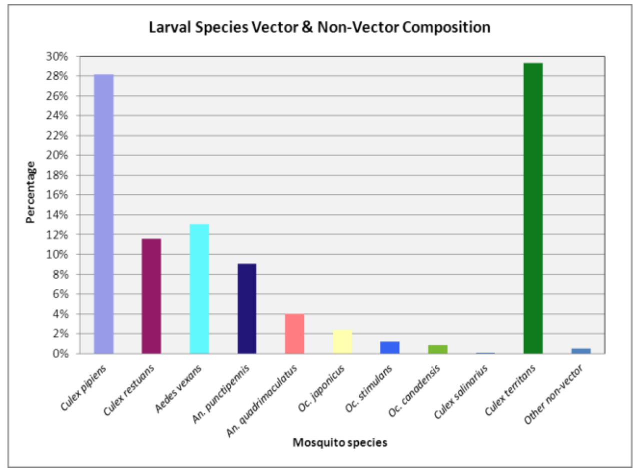

Figure 5-2: Vector and non-vector larval mosquito composition, 2012.

5.4 Discussion

Since 2002, larval surveillance has shown a significant increase in the variety of mosquito species found in Middlesex-London. The variation of the larval species has increased from seven different species identified in 2002, to 32 different species identified to date. In 2012, over 21,000 mosquito larvae were identified representing 15 different species. More mosquito larvae were identified in 2012 than in any other season because of advances in the Strathroy lab, including advanced identification equipment and training of entomological and seasonal staff.

In 2011, the MLHU observed high numbers of both adult and larval mosquito populations in Parkhill. This followed a winter with significant snow accumulations and a very wet spring. On January 18, 2012, the Municipality of North Middlesex, the MLHU, the Ausauble Bayfield Conservation Authority, and members of the Parkhill community met to outline plans to continue efforts to reduce and manage mosquito populations in the Parkhill area. With the identification of mosquito larvae early in 2012, and in an effort to lower the density of mosquito larvae, the Municipality initiated aerial control measures in March and April as part of an IPM approach. In order to avoid another season with very high mosquito populations, the MLHU made its recommendations in order to help reduce the emergence of a high number of spring mosquito species in 2012. In early spring, the MLHU monitored local mosquito populations in wetlands adjacent to the Parkhill Creek, downstream of the dam. This assisted the Municipality of North Middlesex in trying to avoid a season similar to 2011. The area of concern, approximately 25 hectares of standing water, received two aerial applications of larvicide in April of 2012.

Vector Discussion

Ochlerotatus stimulans was identified in mid-March as the first vector species of the 2012 season. Although other spring vector species were identified in March 2012, total larval counts and cooler temperatures in the month of April did not warrant a larvicide treatment until May 14, 2012, when more capable WNV vectors, *Culex pipiens* and *Culex restuans* were identified in high numbers. *Culex pipiens* and *Culex restuans* were the most abundant vectors identified this year. There was a slight increase observed in their populations between 2011 and 2012 [**Figure 5-3**]. This can be attributed to weather conditions favourable for larval development, as warmer temperatures allowed these species develop from egg to larvae more quickly. As a result of their ability to transmit WNV and their abundance in larval form, the focal point for control has been on these specific species. Over the past ten seasons, the VBD program as detected some slight variations in populations of these vectors. It is important to note that there have been no significant population spikes since 2007. The gradual decrease of *Cx. pipiens* and *Cx. restuans* can be attributed to the VBD control program targeting these species.

Aedes vexans (13.03%) was the third most prevalent vector identified. This species has increased in number over the past six seasons and thrives in grassy pools that border wooded areas. In most cases, floodwater habitats tend to be dominated by this abundant mid-season mosquito. *Aedes vexans* are capable of carrying WNV and are also a secondary vector of Eastern Equine Encephalitis (EEE).

Anopheles punctipennis and *Anopheles quadrimaculatus* were identified in early May this year (week 18) and their population continued to increase for the remainder of the season. Similar to *Culex pipiens* and *Culex restuans, Anopheles* species continue to be a control target due to their increased presence within Middlesex-London and their ability to transmit both WNV and EEE.

Ochlerotatus japonicus, an invasive species, continues to increase in number across Middlesex-London. This species was once again observed in various habitats such as field pools, storm water management facilities, ditches, and different artificial containers such as tires and pollution control plants. Special consideration should be given to this species, as it is a highly effective WNV-vector and has been identified in Ontario in increasing numbers since 2001. It has been reported that *Oc. japonicus* has become established in southern Ontario and that the species is expanding its range throughout the province; it is also reported that *Oc. japonicus* larvae have been collected from a variety of natural and artificial habitats, which could pose problems in both urban and rural areas due to the species ability to breed in both natural and artificial environments. (Theilman and Hunter, 2006).

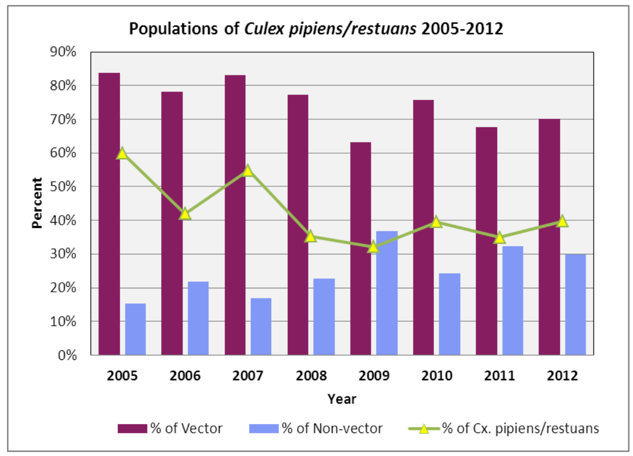

Figure 5-3: Results of vector and non-vector mosquito larvae identified compared to *Culex pipiens/restuans* identified from 2005 to 2012.

Culiseta melanura was not observed in larval or adult form this season. This is a significant finding since *Cs. melanura* is one of the main vectors for EEE. Although females prefer birds as host, they may also feed on small mammals and snakes. They have only rarely been observed biting humans in Canada. (Wood et al, 1979) Due to this species' ability to carry the virus and recommendations from Public Health Ontario, the MLHU will continue to monitor for this species and test for EEE when it is identified in adult mosquito traps.

Aedes albopictus (Asian tiger mosquito) has never been reported in Middlesex-London; however this species is an effective vector for many viruses. Since the discovery of *Ae. albopictus* in the United States, five arboviruses (Eastern Equine Encephalomyelitis, Keystone, Tensaw, Cache Valley, and Potosi virus) have been isolated from this mosquito. The Asian tiger mosquito is also a potential vector of dengue virus. The northernmost established populations of this species in the U.S. have been identified in Chicago, Illinois, and Minnesota. In the Northeast, it has been reported from Pennsylvania and, in 1995, from several counties in New Jersey. (CDC, 2011)

Two female Asian tiger mosquitoes were collected in the Niagara Region in 2001 during WNV larval surveillance. Despite continued surveillance efforts these remain the only specimens collected in Canada. (Theilman and Hunter, 2006) Because this species is a potential vector of several human diseases, it should be considered a public health concern if populations should someday begin to be identified in Ontario. The MLHU has begun to prepare for the possibility of the Asian tiger mosquito establishing itself in Middlesex-London. Planning for the possible identification and breeding of this species in Ontario is essential for early prevention and control strategies. Research indicates that *Ae. albopictus* are attracted to artificial containers. The surveillance of this species will allow the MLHU to possibly observe populations of this mosquito in suitable areas of future establishment. To monitor the presence of this mosquito species in Middlesex-London, the VBD Team has begun to use larval tire traps as a surveillance tool.

Beginning in June 2012 (week 25), weekly surveillance was conducted at four locations where tire traps containing standing water were set up (one in Strathroy and 3 within the City of London). Half a vehicle tire containing one and a half litres of water was hung on a tree branch at 80 centimeters above the ground [**Figure 5-4**]. The larval tire traps will assist the MLHU in obtaining information to understand the ideal time of year and habitat conditions necessary for this species to breed. Larval tire traps may also assist in early prevention, and control strategies, if *Ae. albopictus* are identified in these ideal structures.

Non-Vector Discussion

Culex territans, a non-vector in Ontario, was the most abundant mosquito species, representing 29.32% of all larvae identified this season. Like *Culex pipiens* and *Culex restuans*, *Culex territans* larvae can be found in artificial containers and other small bodies of water. The usual habitat for *Cx. territans* seems to be large permanent marshes, with high levels of vegetation, especially those covered with duckweed. The females of this species seek a blood meal from cold blooded animals which proliferate in marshes, such as amphibians or reptiles. (Wood et al, 1979) *Culex territans* have tested positive for WNV just south of Ontario, in New York State, in 2003. (CDC, 2009) Since this species represents a large proportion of all larvae identified each season, and although *Culex territans* are currently a non-vector species in Ontario, the MLHU should continue to monitor this species due to its increasing populations in Middlesex-London and known virus-carrying capabilities in nearby regions.

Figure 5-4: Larval tire-trap set up in Sifton Bog.

5.5 Storm Water Management Facilities

Storm Water Management Facilities (SWMFs) are temporary retention ponds that house water during the final stages of storm water management. The process of managing storm water aims to direct urban rainfall and surface water runoff into a receiving body of water. This process helps trap sediments, retain pollutants, and prevent erosion and downstream flooding when heavy precipitation overwhelms an urban area. Storm Water Management Facilities are ideal potential habitats for mosquito larvae, as they retain water for a long period of time to induce further settling before release into a sewer system or a receiving body of water. Emergent vegetation found along the banks of SWMFs provides shelter from wind and predators, further protecting larvae throughout the stages of a mosquito's life cycle. Each SWMF may be comprised of several components such as a forebay, cell, channel and/or plunge pool and therefore multiple sites can be present at each SWMF location. During the 2012 season, a total of 1,788 visits were made to SWMFs in Middlesex-London, accounting for 36% of all standing water visits (**Appendix C**).

This season, 7,152 larvae were identified from samples collected at SWMFs. *Culex pipiens* and *Culex restuans* accounted for 32.80% and 11.34%, respectively, of all larvae identified from SWMFs this season. Similar to 2011, larvae belonging to the *Anopheles* genus were the third most prevalent species in SWMFs, with *Anopheles punctipennis* representing 12.02% and *Anopheles quadrimaculatus* representing 4.80%. *Aedes vexans* (8.14%) and *Oc. japonicus* (2.00%) represented the remaining vector species identified. Non-vector species *Culex territans* accounted for 28.9% of larvae collected from SWMFs.

Storm Water Management Facilities will remain an area of focus for larval mosquito surveillance in future seasons. The monitoring of these sites is integral to the MLHU's effort to effectively control vector mosquito breeding grounds. Since many naturalized SWMFs breed high amounts of vector mosquito larvae, it is important that the MLHU continue to identify and treat these urban structures, especially since many are located within neighbourhoods and close to schools and/or vulnerable populations. Ongoing surveillance of Middlesex-London's SWMFs will try to ensure any vector mosquito breeding in these structures is effectively eliminated.

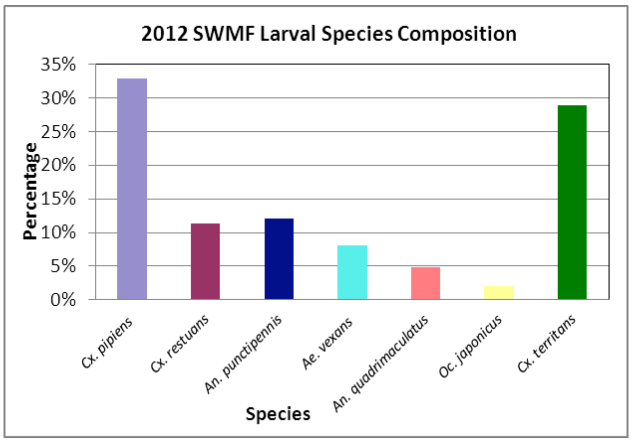

Figure 5-5: SWMF species composition.

5.6 Environmentally Sensitive Areas

Characterized by their unique ecology, Environmentally Sensitive Areas (ESAs) contain diverse natural landscapes which are home to endangered plants, significant wildlife species and also a variety of forests and wetlands. This season, the MLHU continued to monitor peripheral pools, woodland pools, tree holes and various other standing water habitats contained in ESAs for vector mosquito larvae. Environmentally Sensitive Areas located in Middlesex-London are predominantly found near urban, heavily populated areas that are frequently used for recreation during spring and summer seasons. As a result, continued surveillance and treatment of peripheral pools within the ESAs is essential in order to gather data, preserve vulnerable ecosystems, and reduce the risk of contracting mosquito-borne diseases.

A total of 2,937 mosquito larvae were identified during ESA surveillance this season. The non-vector species, *Culex territans* (50.70%) was the most abundant species identified in ESAs. The second most abundant species in ESAs was *Aedes vexans* (10.69%), followed by *Culex pipiens* (9.74%), *Culex restuans* (7.80%), *Anopheles punctipennis* (7.22%), *Ochlerotatus stimulans* (5.79%), *Anopheles quadrimaculatus* (3.34%), and *Ochlerotatus canadensis* (2.40%). Other non-vector species comprised 1.40% of the larvae identified [**Figure 5-5**].

Westminster Ponds Overview

At approximately 250 hectares, Westminster Ponds is the largest ESA in London and is also designated as a Provincially Significant Wetland. This site provides a great variety of natural habitats within the boundaries of a major urban centre. Because of its varied topography and drainage, this ESA supports an interesting combination of woodland, bog and meadow habitats. Wetland habitats are associated with the lowland areas and around the margins of the ponds and include deciduous swamp, peat bog, and cattail marsh. The ponds and the mixture of habitats make this site an excellent place for wildlife and mosquito development. **Figure 5-6** demonstrates the composition of mosquito larval species which were collected from Westminster zones in 2012. This season 44 treatments were performed in Westminster Ponds. On average, 41 treatments are performed within Westminster Ponds each season.

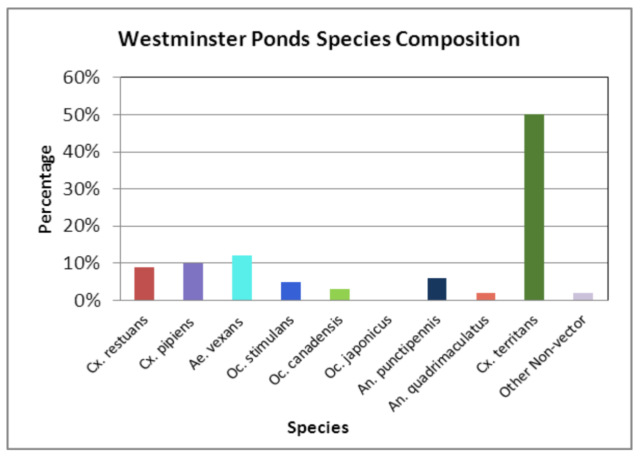

Figure 5-6: Westminster Ponds species composition.

Sifton Bog Overview

Sifton Bog is a Provincially Significant Wetland and Canada's most southerly large acidic bog. It consists of wetlands as well as the peripheral pools. The 40-hectare site is known to accumulate large amounts of standing water following rainfall and snow-melt since its original formation was the result of colonized glaciations. Permits issued by The Ministry of the Environment each season allow treatment of solely the peripheral pools, not the bog itself. Compared to the past six seasons, Sifton Bog experienced a considerable reduction in the amount of standing water contained within its periphery this season. This contributed to fewer vector mosquito larvae observed this year and fewer treatments in comparison to past seasons. Only two treatments were performed in Sifton Bog in 2012. Environmentally Sensitive Areas can play a critical role in the proliferation of vector mosquito species within Middlesex-London. Although some of the ESAs experienced a considerable decline in standing water this season, which resulted in decreased vector mosquito larvae and larvicide treatments, the MLHU will continue surveillance in these areas as they have the potential to house large areas of standing water, especially during seasons with increased precipitation. Continued surveillance and treatment within these areas is imperative in order to reduce vector mosquito breeding and possible increases in vector-borne diseases.

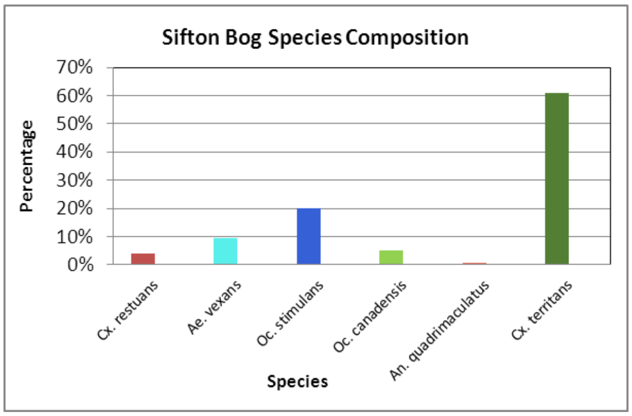

Figure 5-7: Sifton Bog species composition

5.7 Conclusions and Recommendations

Larval mosquito surveillance is an integral part of the MLHU's VBD Program. Vector species continue to dominate standing water sites across Middlesex-London. The variation of larval species has increased from only seven species identified in 2002, to 32 species identified to date. Overall, *Culex pipiens, Aedes vexans* and *Culex restuans,* were the most abundant species identified.

Based on 2012 larval mosquito surveillance, the following recommendations have been made:

Continue with earlier larval monitoring. With the increasing number of vector mosquito larvae identified in early spring months, earlier monitoring of surface water should be continued, as this helps the MLHU to determine the presence of vector mosquito larvae, and inform decisions surrounding control strategies in order to mitigate the risk of WNV to local populations.

The MLHU should continue to monitor populations of *Cx. pipiens* and *Cx. restuans*, as they remain the most effective vector and were identified as WNV-positive within Middlesex-London this season. A comprehensive control program targeting these species will assist in decreasing WNV-transmission.

The MLHU should continue to use larval tire traps as a surveillance tool to monitor for potential future populations of Asian tiger mosquitoes (*Aedes albopictus*).

The VBD Program should maintain its early larval surveillance in Parkhill in order to work with the municipality to reduce populations of spring species.

Chapter 6: Adult Mosquito Surveillance

6.1 Introduction

In order to effectively monitor for vector-borne diseases, it is essential to monitor and trap adult mosquitoes. This also allows the Middlesex-London Health Unit (MLHU) to identify viral activity within the community. The information gathered from mosquito trapping, species identification and viral testing allows the MLHU to assess the status of vector-borne diseases within Middlesex-London. As a result of this work areas that require increased surveillance and control efforts can be identified.

6.2 Adult Mosquito Surveillance Activities in Middlesex-London

Adult mosquito trapping began on June 13, 2012 and was completed on October 4, 2012. A total of 23 traps were set up in London and Middlesex-County and monitored weekly. Of these, fifteen terrestrial traps were placed four to six feet off the ground while eight canopy traps were placed 13 to 20 feet off the ground. The canopy traps allowed the VBD Team to study the variation and biting preferences of adult mosquitoes that fly at heights favourable for biting birds that rest in trees. The locations of the mosquito traps were chosen based on geographic distribution, proximity to vulnerable populations and/or the previous year's viral activity trends. In 2012, 18,464 mosquitoes were collected in adult mosquito traps (**Appendix D**). Of these, 10,057 mosquitoes were identified by the MLHU's service provider, Sporometrics.

Adult mosquito trapping followed the MLHU's standard procedures; collecting adult mosquitoes with battery-operated miniature light traps baited with carbon dioxide [**Figure 6-1**]. The traps operated for the duration of one night (15 to 20 hours in total) and samples were collected the following morning, packaged and sent by courier to Sporometrics Laboratories for species identification and viral testing. Sporometrics identified mosquitoes from an average of 21 traps per week, depending on the status of viral activity within Middlesex-London. Once Sporometrics received the traps, mosquitoes were counted, identified and tested for either West Nile Virus (WNV) or Eastern Equine Encephalitis (EEE). The MLHU was then informed of viral test results and the number of specific mosquito species. (Sporometrics, 2012)

Figure 6-1: VBD staff setting up an adult mosquito trap.

In 2012, Sporometrics performed 830 viral tests for WNV and EEE on 5,407 mosquitoes. Public Health Ontario's EEE guidelines were followed when testing species of preference for EEE, which focused on the primary enzootic vector *Culiseta melanura*, and three others, *Ochlerotatus canadensis*, *Coquillettidia perturbans*, and *Aedes vexans vexans*[1]. The EEE Testing Order of Preference tests species that are considered to be 'high-risk' vectors in Ontario by their ability to carry and transmit EEE infection. In total, 334 EEE viral tests were performed, all of which were negative. Overall, 496 WNV tests were conducted in 2012, of which, 17 mosquito traps were confirmed as positive (10 terrestrial traps and 7 canopy traps). The most frequently tested species were *Culex pipiens/restuans*[2]; this was also the only vector species to be confirmed WNV-positive. (Sporometrics, 2012). Viral testing and the vector status of each species are determined by Public Health Ontario (PHO). West Nile Virus and EEE-Testing Order of Preference protocols are designed by the Enteric, Zoonotic and Vector-Borne Diseases Branch of PHO. The mosquitoes recognized as primary vectors, as outlined by the WNV-Testing Order of Preference are *Cx. pipiens/restuans, Cx. salinarius, Oc. japonicus* and *Cx. tarsalis.*

(1) Sporometrics is able to identify mosquitoes to the sub-species level (e.g. *Aedes vexans vexans*); however, in subsequent chapters, species are identified by the MLHU to the species level (e.g. *Aedes vexans*). (2)Sporometrics combines *Culex pipiens* and *Culex restuans* when identifying adult mosquitoes as these species are very similar and both competent in transmitting WNV. These species will be reported as *Culex pipiens/restuans* when referring to their combined identification and for the purposes of reporting combined population increases or decreases.

6.3 Terrestrial Trap Surveillance

Of the 18,464 mosquitoes collected this season, 85% were from terrestrial traps (15,752). Of the mosquitoes collected, Sporometrics identified 7,586 from terrestrial traps, 94% (7,390) were vector species, and 6% (196) were non-vectors. This is a higher vector composition than 2011, where only 86% of mosquitoes in terrestrial traps were vector species. This season, the MLHU also trapped fewer mosquitoes overall than in 2011. The decrease can be attributed to fewer adult mosquitoes collected from Parkhill, which yielded significantly higher counts of non-vector species in 2011. The relative frequency of each vector species is determined by comparing the total number of vectors identified. The most abundant vectors this year were *Ae. vexans vexans* (28%) and *Oc. trivittatus* (24%). These are the same species that were the most abundant in 2009, 2010 and 2011. This season, there were also fewer EEE-vector species identified. In the past two seasons, approximately half of all mosquitoes were EEE vector species, however this season, only 31% were vectors for EEE.

Table 6-1: Vector species composition in terrestrial traps.

Vector	Number Identified	Percent
Culex pipiens/restuans	865	12%
Aedes vexans vexans	2058	28%
An. punctipennis	369	5%
Cq. perturbans	1555	21%
Culex salinarius	7	0.09%
Oc. stimulans	126	1.7%
Oc. triseriatus	180	2.2%
Oc. trivittatus	1783	24%
An. quadrimaculatus	161	2%
Oc. canadensis	50	1%
Oc. japonicus	235	3%
Culiseta melanura	0	-
Culex tarsalis	1	0.01%
Total	**7390**	**100%**

This season, ten terrestrial traps were found to be WNV-positive. The positive traps were located in several areas of Middlesex-London and all species that tested positive were *Cx. pipiens/restuans*, the most competent WNV-vector. The first positive mosquito trap was identified on July 18, 2012 (week 29), much earlier than in previous years. In 2011, WNV-positive mosquito traps were not confirmed until August, 24, 2011 (week 34). After confirming this WNV activity, the MLHU issued a press release to notify residents who live nearby. Hotspot traps were also set up to monitor additional mosquito populations. Heightened larval surveillance was conducted in areas identified as having WNV-positive activity.

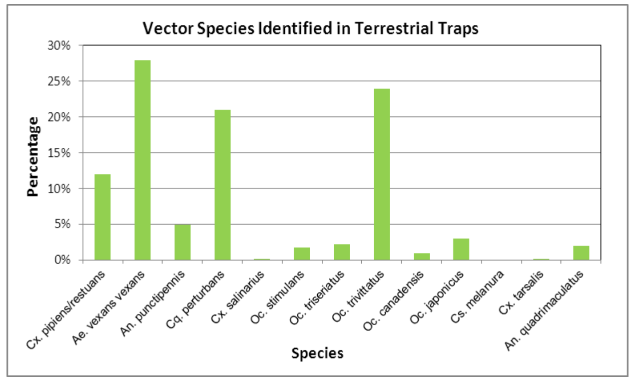

Figure 6-2: Terrestrial trap vector species composition.

Last season, the greatest number of adult mosquitoes was collected from Trap H, located in Parkhill. Trap H collected a total of 95,997 mosquitoes in 2011. This was a significant increase in the number of mosquitoes collected from Trap H compared to any other season, and it also significantly increased the overall number of mosquitoes collected in 2011. In 2011, traps located in North Middlesex collected the most adult mosquitoes, accounting for 71% of all mosquitoes collected. When comparing the total number of mosquitoes collected in 2011 to those collected in 2012, it may appear there was a significant decrease, however it is important to consider the large proportion of mosquitoes that were collected from traps located in North Middlesex. It is also important to note that although Trap H yielded the greatest number of adult mosquitoes in 2011, it did not in 2012 when compared to other trap locations. Trap H in Parkhill was composed of 26% vector species, 74% non-vectors and no WNV-positive mosquito traps. In addition, only 1,738 mosquitoes were collected from traps located in North Middlesex this year. This is a decrease of approximately 94,000 mosquitoes when compared to terrestrial traps located in Parkhill in 2011. In total, there was a decrease of 108,000 mosquitoes from all three traps located in Parkhill, which can account for the decrease in the number of mosquitoes collected overall this season.

Each week, the traps in Middlesex-London collected between 68% to 100% vector species. Hotspot traps collected fewer mosquitoes than permanent trap locations. Traps with a higher proportion of vector mosquito species posed a greater threat of viral transmission because those traps have greater potential to become WNV-positive more frequently than traps with lower vector mosquito counts. **Table 6-3** represents a summary of the vector species identified from terrestrial traps in 2010, 2011 and 2012. Of the 17 WNV-positive mosquito traps identified in 2012, the average proportion of vector mosquito species was 85%.

6.4 Canopy Trap Surveillance

Canopy trap surveillance is a unique part of the VBD Program where mosquitoes are collected at heights between 13 and 20 feet off the ground for the duration of one night. Canopy traps are used to analyze species composition, biting preferences and the viral capacity of mosquitoes that fly at those heights and prefer to bite birds. This is an important area of study because species that prefer to bite birds are often the cause of WNV amplification within the avian community. By identifying and testing mosquitoes collected in canopy traps, the MLHU is able to identify the rate of viral activity in mosquitoes that have the potential to increase the incidence of WNV within the avian community. This may potentially affect human health when a greater number of vector mosquitoes bite birds and become infected with WNV.

In 2012, eight canopy traps were set up, which resulted in the collection of 2,533 mosquitoes. Of these, Sporometrics identified 2,313 mosquitoes of which 91% were vector species and 9% were non-vectors [**Table 6-2**]. This is a significant increase over the proportion of vector species identified in canopy traps identified in 2011, which stood at 72%.

Culex pipiens/restuans (38%) were the most abundant vector species identified in canopy traps this season, followed by *Coquillettidia perturbans* (33.6%) and *Ochlerotatus trivittatus* (18%). The relative frequency of each vector species was determined by its comparison to the total number of vector species identified from canopy traps in 2012. (Sporometrics, 2012).

Table 6-2: Vector species identified in canopy traps.

Vector	Number Identified (Canopy)	Percent
Culex pipiens/restuans	811	38%
Aedes vexans vexans	100	5%
An. punctipennis	31	1.5%
Cq. perturbans	707	33.6%
Culex salinarius	9	0.4%
Oc. stimulans	5	0.2%
Oc. triseriatus	37	1.7%
Oc. trivittatus	382	18%
An. quadrimaculatus	11	0.5%
Oc. canadensis	3	0.1%
Oc. japonicus	3	1%
Culiseta melanura	-	-
Oc. cantator	-	-
Total	**2099**	**100%**

Seven canopy traps consisting of *Cx. pipiens/restuans* tested positive for WNV in 2012. Three of the seven positive canopy traps also had corresponding terrestrial traps that were found to be positive. When both ground and canopy traps are positive, it's an indication that certain vector mosquito species can be found at both ground and canopy heights; this increases the likelihood of transmitting WNV to humans. With the collection of 2,533 mosquitoes from canopy traps this season, the MLHU saw significantly fewer mosquitoes in canopies than the 14,168 mosquitoes trapped in 2011.

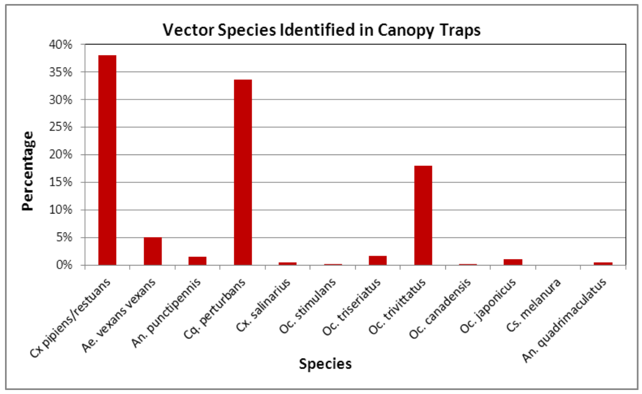

Figure 6-3: Canopy trap vector species composition.

A similar decrease was also observed in terrestrial traps. The decrease observed in both canopy and terrestrial traps can be associated with fewer mosquitoes being trapped from Terrestrial Trap H and Canopy Trap 10 located in Parkhill. Both of these traps collected the greatest number of adult mosquitoes in 2011. However due to decreased precipitation this year, combined with extensive efforts by both the MLHU and North Middlesex to remediate standing water issues in Parkhill, the traps collected far fewer adult mosquitoes in 2012.

6.5 Terrestrial Traps versus Canopy Traps

Overall, 18,464 adult mosquitoes were collected from terrestrial and canopy traps in 2012. This is less than the 148,599 mosquitoes trapped in 2011. This can be attributed to a reduction of nearly 108,000 mosquitoes collected from traps in Parkhill when compared to 2011. The 2012 season saw fewer mosquitoes in both terrestrial and canopy traps in Parkhill due to less snowmelt in the early spring and decreased precipitation during the summer months. The remediation of several locations which held standing water also contributed significantly to decreased mosquito counts in Parkhill this year. The Municipality of North Middlesex worked diligently to clear a stretch of stagnant water located in the Cameron-Gillies drain, which contributed to fewer mosquito breeding areas this year.

In 2012, there was an increased proportion of vector mosquito species in both terrestrial and canopy traps, with a combined total of 94% vector species. In comparison 84% of mosquitoes collected in 2011 were vector species, and in 2010, 90% were vector species. This increased proportion of vector mosquito species can account for the 17 WNV-positive mosquito traps identified in 2012, an increase from the 11 WNV-positive traps found in 2011. Following the confirmation of all WNV-positive mosquito traps, the MLHU set up hotspot traps in the same geographic area in an effort to identify additional positive mosquito populations. Twelve hotspot traps were set up in 2012, accounting for the collection of 179 mosquitoes. None of the mosquitoes collected in hotspot traps were found to be WNV-positive, however 98% of all mosquitoes collected in hotspots were vectors for WNV and/or EEE.

Interestingly, when comparing mosquito species from terrestrial and canopy traps, canopy traps had a larger percentage of *Culex pipiens/restuans* than terrestrial traps this season. The increased presence of vectors observed in canopy traps can account for the seven WNV-positive mosquito traps. Additionally, two trap sites of significance were identified where both the canopy and terrestrial traps were identified as WNV-positive on more than one occasion. Together, Huron Conservation Area (Can 8 and Trap M) and Dearness (Can 2 and Trap C), account for over 50% of positive traps confirmed this season (nine WNV-positive mosquito traps). (Sporometrics, 2012).

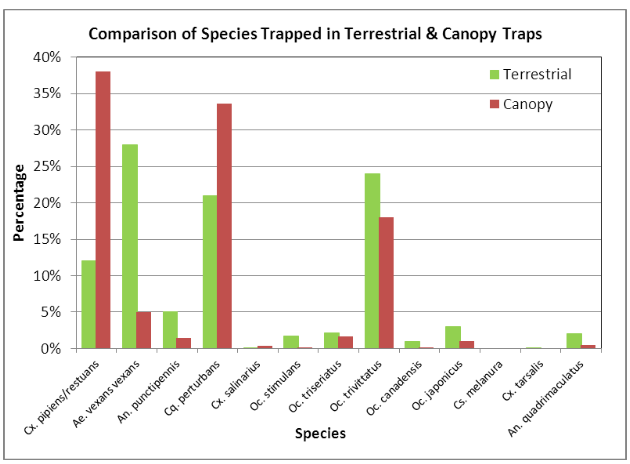

Figure 6-4: Comparison of vector species composition in terrestrial and canopy traps.

6.6 Discussion

This season, the MLHU observed a decrease in the number of mosquitoes trapped, however the proportion of vector species increased overall [**Table 6-3**]. Many traps had a vector mosquito composition of 90% or greater. An increased proportion of vector mosquitoes can account for increased WNV-positive mosquito traps. In 2012, 17 WNV-positive traps were identified, an increase of six traps over the 11 confirmed in 2011. Of particular interest was the increase in WNV-positive canopy traps this season. In previous seasons very few canopy traps were found to be positive, (two in 2011; one in 2010) however this season there were seven positive canopy traps. All of the WNV-positive mosquitoes from these canopy traps were *Cx. pipiens/restuans,* the most effective WNV vector.

In 2012, Sporometrics performed 334 viral tests for EEE based on Public Health Ontario's EEE guidelines and Testing Order of Preference, which focused on the primary enzootic vector *Culiseta melanura,* and three others, *Ochlerotatus canadensis*, *Coquillettidia perturbans*, and *Aedes vexans vexans.* The EEE testing order of preference tests species that are considered to be 'high-risk' vectors in Ontario due to their ability to carry and transmit EEE. In comparison to other seasons, fewer EEE tests were performed in 2012 because significant decreases in EEE vector populations were observed. This season, there was a 71% decrease in populations of *Ae. vexans vexans* identified, a 94% decrease in the number of *Oc. canadensis* identified and no *Cs. melanura* identified within Middlesex-London. It is important to note that in addition to fewer EEE viral tests this season, the primary enzootic vector for EEE, *Culiseta melanura*, was not found in any traps this season. In 2011, 19 specimens of *Culiseta melanura* were identified, six from a terrestrial trap and 13 from a canopy trap, all from one site; Sifton Bog, located in London. Although a few *Cs. melanura* have been identified in past seasons, their populations are not dispersed throughout Middlesex-London, rather only concentrated in one small area. Since there was no *Cs. melanura* specimens identified this season, EEE viral testing was conducted on only three species, *Aedes vexans vexans*, *Oc. canadensis* and *Cq. perturbans*, of which none were found to be positive.

The vector species *Coquillettidia perturbans* increased in number for the third straight season. This species has been identified in greater numbers over the past three seasons, however a significant spike was observed this year. *Coquillettidia perturbans* are a known vector for EEE; but a difficult species to target with larvicide treatment due to their modified feeding siphon, during the larval stage, which is shaped like a hook and attaches to underwater stems or roots of emergent and floating vegetation. With its modified siphon, this species receives its oxygen and nutrients through the plant's tissue, not needing to rest at the water's surface to breathe, like other larval species, with a regular siphon. It is therefore much more difficult to target this species in its larval form since it spends the duration of its life cycle below the water's surface. Since the larvae receive nutrients and ingest only the plant's tissue through the modified feeding siphon, this species does not ingest diluted larvicide as readily as other mosquito larva species, who come to the surface of the water to feed and breathe, where they ingest the diluted larvicide. (Brothers, 2005) Because it is difficult to target this species in its larval form, the MLHU has observed increases in its adult form. This is because the species has more success developing into the adult stage than other mosquito species with regular siphons.

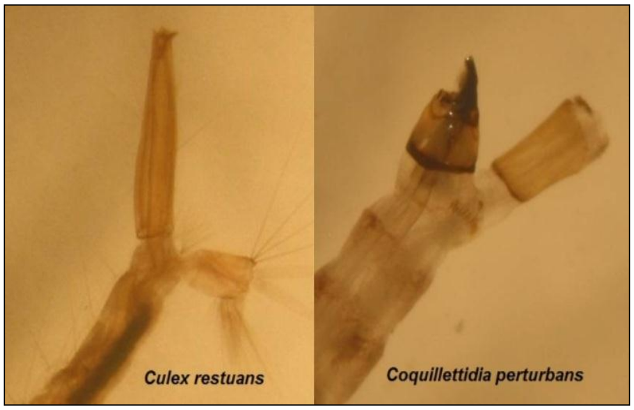

Figure 6-5: Comparison of *Coquillettidia perturbans* siphon to more common mosquito larvae siphons.

In 2011, the MLHU trapped significantly more adult mosquitoes than in 2012. The traps that collected the greatest number of mosquitoes in 2011 were Trap H in Parkhill, Trap J in Glencoe, Trap M at Huron Conservation area in London and Trap I in Strathroy. Adult mosquito counts in these traps increased from 20% to 370% at some locations. The increased number of mosquitoes collected in 2011 can be attributed to several factors. First, with more snowfall last year and increased levels of standing water following the spring thaw, a greater number of standing water habitats were present in early March and April for spring mosquito species to breed. Second, increased precipitation in April and May and then from mid-July to September, allowed stagnant water to persist in ditches and depressions, creating favourable conditions for larval mosquito development. Third, the number of adult mosquitoes that emerged and were trapped in Parkhill also contributed to the spike in mosquito population data recorded by the MLHU in 2011. With an influx of nearly 108,000 adult mosquitoes from traps located in Parkhill, the number of mosquitoes collected in the community also contributed significantly to the overall increase observed in 2011. Increased mosquito counts in Parkhill resulted from higher than average precipitation and also a lack of remediation at several standing water sites located in North Middlesex. In response to these increased mosquito counts, the MLHU focused its efforts on larval mosquito surveillance and the identification of new sites to monitor. Efforts also focused on the remediation of potential larval breeding sites in Parkhill, where the MLHU worked closely with the Ausauble Bayfield Conservation Authority and the Municipality of North Middlesex to remove areas where a high number of mosquito larvae were identified. Remediation efforts also focused on clearing areas of stagnant water to allow the natural flow of water through the Cameron-Gillies drain, which runs through the town of Parkhill. Following the initiation of remediation efforts in the summer of 2011, and continued work into the 2012 season, the MLHU observed significant decreases in adult mosquito populations throughout Middlesex-London, and in particular, in all three traps located in Parkhill. In 2012, only 1,738 mosquitoes were collected from the three traps located in Parkhill. This is a decrease of approximately 108,000 mosquitoes.

The non-vector species *Ochlerotatus blacklegged* (also known as *Ochlerotatus sticticus*), was identified in much lower numbers this season. In 2010 1,083 *Oc. blacklegged* were identified and in 2011, 3,368 of these specimens were identified. This season, only 2 *Oc. blacklegged* specimens were identified, none of which were identified from Parkhill, where their populations were recorded in very high numbers in the past two seasons. The two *Ochlerotatus blacklegged* identified this season were from Trap Q, located at Warbler Woods in West London.

6.7 Conclusions and Recommendations

Adult mosquito trapping has been an important aspect of the MLHU's mosquito surveillance and viral testing program this season, identifying 17 WNV-positive mosquito traps.

The following adult mosquito surveillance conclusions have been made:

This season, a significant decrease was observed with only 18,464 mosquitoes collected. This decrease can be attributed to environmental factors and also from a significant decrease in mosquitoes collected from traps located in Parkhill.

Culex pipiens/restuans were the most abundant vector species identified in canopy traps this season, making up 38% of all vector species identified. The number of adult *Cx. pipiens/restuans* has increased in canopy traps in recent seasons. Additionally, there has been increased WNV-positive activity in *Cx. pipiens/restuans* trapped at canopy heights.

In 2010 one canopy trap containing *Cx. pipiens/restuans* tested WNV-positive, and in 2011, two WNV-positive canopy traps were identified. In 2012 WNV-positive activity increased, with the identification of seven WNV-positive canopy traps.

With the absence of *Culiseta melanura* from mosquito traps this season, in addition to decreased counts of EEE-vector species, the number of EEE viral tests decreased by 42% this season. Since the MLHU has been actively monitoring for EEE, there have been no human, mosquito or veterinary cases in Middlesex-London. Additionally, the historical incidence of EEE within Ontario remains very low. With decreased EEE vector species in traps, the MLHU will remain focused on WNV surveillance and will continue to test for EEE as per PHO guidelines.

Overall, the MLHU observed a decrease in the total number of mosquitoes collected this season, however 2012 was still one of the most active seasons in terms of West Nile Virus activity. Despite fewer mosquitoes being collected, the MLHU observed one of the highest proportions of vector species in both terrestrial and canopy traps and also noted increased WNV-positive activity in adult mosquitoes. The 17 WNV-positive mosquito traps identified by Sporometrics in 2012 are comparable to WNV-positive mosquito activity observed in previous seasons “high WNV activity” seasons, such as 2002, 2003 and 2004. Similarly, the Province of Ontario also observed an increase in WNV-positive mosquito activity, with the third worst year for WNV activity since the 2002 and 2007 seasons. The MLHU should continue to collect adult mosquitoes and perform testing for WNV in order to identify areas with high numbers of vector species, and/or WNV-positive activity, which may pose a potential threat to human health in the future.

Table 6-3: Vector species identified in terrestrial traps.

Vector	Number Identified (2012)	Percent	Number Identified (2011)	Percent	Number Identified (2010)	Percent
Culex pipiens/restuans	1676	17.8%	1339	7%	1284	7%
Aedes vexans vexans	2158	23%	7365	38%	8423	44%
An. punctipennis	400	4%	891	5%	703	4%
Cq. perturbans	2262	24%	1953	10%	1644	8.5%
Culex salinarius	16	0.2%	3	0.01%	1	0.00%
Oc. stimulans	131	1%	1097	6%	680	3.5%
Oc. triseriatus	217	2%	459	2%	600	3%
Oc. trivittatus	2165	23%	4480	23%	4718	24%
An. quadrimaculatus	172	2%	345	1.95%	239	1.2%
Cx. tarsalis	1	0.00%	-	-	-	-
Oc. canadensis	53	0.5%	951	5%	348	1.8%
Oc. japonicus	238	2.5%	465	2%	656	3%
Culiseta melanura	-	-	6	0.03%	1	0.00%
Oc. cantator	-	-	2	0.01%	1	0.00%
Total	**9489**	**100%**	**19356**	**100%**	**19298**	**100%**

Chapter 7: Human Surveillance of Vector-Borne Diseases

7.1 Introduction

This season, the VBD Team continued to monitor tick and mosquito populations in an effort to reduce the potential risk of vector-borne diseases associated with exposure to mosquito and tick bites in Middlesex-London.

7.2 Objective of Human Surveillance

The objective of human surveillance is to understand the epidemiology of vector-borne diseases within the human population. The collection of epidemiological data, which includes the incidence, prevalence, source and cause of infectious diseases, assists in determining biological and environmental risk factors for acquiring infections. West Nile Virus, Lyme disease, and the encephalitic symptoms caused by Eastern Equine Encephalitis are all classified as both *Reportable Diseases* and *Communicable Diseases* under the *Health Protection and Promotion Act.* Physicians are required to report suspected, probable, and confirmed cases to the local Medical Officer of Health, who must then report the probable and confirmed human cases to the Infectious Diseases Branch of the Ontario Ministry of Health and Long Term Care. (MOHLTC, 2010)

7.3 Human Surveillance of West Nile Virus

Using incidence data from mosquito, bird and human surveillance, risk assessments of local WNV trends are used to develop comprehensive control efforts and awareness campaigns to protect human health from vector-borne disease activity in the community. Human surveillance of reportable diseases such as WNV allows the MLHU to continually develop and update strategies to reduce the incidence of vector-borne diseases. As WNV activity continues to be present in the community, it is essential to track cases on a year-by-year basis to understand the changing dynamics of WNV infection and what can be done to mitigate the risk to local residents.

Background

The Public Health Agency of Canada's (PHAC) WNV case definition is used by healthcare providers to diagnose WNV in human populations. Case definitions are continually updated to reflect additional information concerning the signs and symptoms of the disease.

West Nile Virus Infections are classified into three infection types: West Nile Virus Neurological Syndrome (WNNS), West Nile Virus Non-Neurological Syndrome (WN Non-NS), and West Nile Virus Asymptomatic Infection (WNAI). WNNS and WN Non-NS cases may be classified as suspect, probable, or confirmed, and WNAI cases as probable or confirmed.

Both clinical symptoms and laboratory findings based on blood work must be interpreted in order to reach a diagnosis, and specific criteria must be met in order to classify a case as suspect, probable, or confirmed. The clinical and laboratory criteria for diagnosis of WNV and case classification criteria based on the Ontario Ministry of Health and Long Term Care's (MOHLTC) *Infectious Disease Protocol, 2013* case definitions are outlined in **Appendix E**.

Methods

In the event of a human WNV diagnosis in Middlesex-London, staff with the MLHU's Infectious Disease Control Team will initiate an investigation into the case. Preliminary actions include notifying the MOHLTC through the Integrated Public Health and Information System (iPHIS). A comprehensive assessment of the case's travel history, recent blood donation/transfusion history, symptoms, and results is conducted. Results of each investigation are forwarded to the MOHLTC where they once again review the blood donation history of the patient. Canadian Blood Services is also notified of human, mosquito, bird, and sometimes equine surveillance, which provide a more complete picture of the presence of WNV in a community.

Results

The number of reported cases of WNV-related illness increased significantly in 2012 when compared to the past three years. In 2009 and 2010, WNV illness remained low at the national and provincial levels while in 2011 the MLHU reported one confirmed WNV positive human case and one probable WNV human case. The positive human cases in 2011 were the first cases in Middlesex-London in two years. In 2012, there were seven human WNV cases reported from Middlesex-London. The first case of the season was reported on August 11, 2012 and the last case to date was reported September 14, 2012.

In Ontario, the province experienced one of the worst years for human WNV activity, with 252 human cases reported as of October 20, 2012. In 2011, 72 human WNV cases were reported in the province. The last time Ontario saw greater than 10 human cases was in 2006 and 2007, which were outbreak years for WNV at both the national and provincial level. Prior to 2006, positive human cases were reported in high numbers on an annual basis, following the initial WNV outbreak in 2002.

Nationally, there were a total of 433 clinical cases in 2012 (PHAC, 2012). In 2011, 110 human cases were reported within Canada. An increased number of human WNV cases this season indicates that WNV activity has begun to reflect the activity in years leading up to 2007. This is problematic as 2007 was the worst year for WNV activity in Canada with 2200 confirmed human cases.

The United States (U.S) also experienced a considerable spike in WNV human infection this year. Reporting just 474 human cases in 2011, the U.S reported 5,387 human cases in 2012. In states that border southern Ontario, Michigan reported 202 cases, Ohio reported 121 cases and New York reported 107 cases. By comparison fewer than 30 human cases were reported from each of these states in 2011. (USGS, 2012) Human WNV infections confirmed in regions just South of Ontario pose a significant concern for the MLHU. The identification of WNV human cases and other positive mosquito activity can have an effect on local mosquitoes through travel and tourism, the migration of avian specimens, and/or through the displacement of mosquito vectors in artificial and shipping containers moving in and out of the country. (CDC, 2010)

Discussion

A WNV-positive human case is identified when a person visits a physician and symptoms of a West Nile Virus infection are identified. The health care provider then submits a blood sample to the Public Health Laboratory. The first test performed is the IgM Enzyme-Linked Immunosorbent Assay (ELISA), which, if positive, is run once more to rule out false positive results. These two tests may then be followed by Plaque Reduction Neutralization Test (PRNT) to confirm the diagnosis. If the IgM ELISA tests are positive, the patient is advised that they are a 'Probable' WNV case. The ELISA results are available within 24 hours, while the PRNT confirmation testing takes an additional seven days.
Upon laboratory confirmation of WNV, the Health Unit conducts interviews with the patient to determine exposure information. Following the confirmation of WNV human cases this season, the MLHU contacted the clients to follow up. During initial follow-up, the Health Unit reviews the client's age, risk factors and history, including any hobbies and/or activities which may have been the cause of the exposure to WNV. This season, of the seven human cases reported, 71% of cases were female and the mean age of patients was 53, with the age of cases ranging from 20 to 64 years old. Of the cases, 43% were classified as having neurological complications and three of the cases were hospitalized for four to nine days. The other 57% of cases were classified as having mild symptoms (no neurological complications) and did not require hospitalization. To date, 71% of cases most likely acquired WNV within London; the remaining cases reported travel to Toronto, Trenton and Woodstock. Of the seven cases, 57% reported camping, hiking or other outdoor activities and 71% of cases did not always wear insect repellent when outdoors. In addition, 71% of cases lived in proximity to standing water and 43% could recall a mosquito bite or exposure to mosquitoes. One hundred percent (100%) of cases did not always wear adequate clothing protection when exposed to mosquitoes. In response to WNV human case confirmation the MLHU heightened standing water surveillance in areas near the residences of those human cases, in addition to setting up additional hotspot adult mosquito traps in the area. The hotspot traps were set up for a total of two weeks after the confirmation of each human case but did not yield any positive results.

The epidemiology and risk assessment of WNV transmission in Ontario is facilitated through the evaluation of human trends. Although the number of reported WNV cases declined in past seasons, the increase in human WNV cases at the local, provincial and national level in 2012 indicates that there is still a risk of acquiring WNV infection. Many WNV infections can go undetected, as 80% of cases are asymptomatic and 20% of cases result in only flu-like symptoms. With less than 1% of those infected experiencing life-threatening symptoms, the number of clinically diagnosed WNV infections may sometimes go unreported for a length of time.

This season adult mosquito viral testing and dead bird monitoring indicated the presence of WNV in Middlesex-London. Prior to the confirmation of WNV-positive mosquitoes, the MLHU identified three WNV-positive dead birds. Overall, several dead birds indicated the presence of WNV, which allowed VBD staff to focus on monitoring standing water in the areas where they were found, setting up hotspot traps to further monitor local mosquito populations. The identification of WNV activity in Middlesex-London this season indicates the continued need for WNV adult mosquito monitoring and viral testing, including the control of vector mosquito larvae, in order to reduce the risks for human WNV transmission.

Conclusions and Recommendations

Human infection typically occurs by mid-summer or towards the end of a season once the virus has increased within local bird and mosquito populations. Human surveillance of WNV is important for understanding the epidemiology and clinical course of infection in local populations. A comprehensive West Nile Virus monitoring program not only monitors for the human incidence of WNV, but also considers the transmission within local bird and mosquito populations. Additionally, a comprehensive WNV campaign will also take preventive action to reduce the risk of WNV, prior to human infection, this is done through public education campaigns and the distribution of promotional materials which encourage the public to protect themselves against mosquito bites and to identify the symptoms of WNV if a known mosquito bite has occurred. A combination of human, mosquito, bird, and equine surveillance provides a thorough understanding of the presence of WNV in a community, serving to protect residents through standing water surveillance, the implementation of public education campaigns, the use of personal protection, and additional control measures when required.

7.4 Human Surveillance of Lyme Disease

Background

Lyme disease (LD) is caused by the bacterium *Borrelia burgdorferi* and is transmitted through the bite of an infected *Ixodes scapularis* species, commonly known as the blacklegged or deer tick. Lyme disease can have serious symptoms; however, it is a bacterial infection, so it may be treated by anti-biotics. Symptoms become increasingly worse if an infection remains undiagnosed and/or untreated.

The 3 Stages of a Lyme Disease Infection:

Not every person infected with LD experiences symptoms at each stage, and patients typically only experience the latter stages of infection if it remains untreated.

Stage 1: A circular, or “Bulls-Eye”, rash called an erythema migrans (EM) is indicative of the initial infection. This occurs in approximately 70-80% of cases three days to one month after infection at the site of the bite. Flu-like symptoms may also be experienced.

Stage 2: This stage may last up to several months and include: central and peripheral nervous system disorders, multiple skin rashes, arthritis and arthritic symptoms, heart palpitations, extreme fatigue and general weakness.

Stage 3: This stage may last several months to years, and include chronic arthritis and neurological symptoms or adverse fetal affects in pregnant women.

In order to diagnose Lyme disease, a health care practitioner must first evaluate a patient’s clinical symptoms and risk of exposure to infected ticks. A blood test may be ordered by a practitioner in order to detect the presence of antibodies for *Borrelia burgdorferi* by means of two IgM/IgG ELISA tests performed simultaneously. (PHAC, 2006)

Results

In 2012, there were 87 tick submissions from the public. Ten of these submissions were identified as *Ixodes scapularis* or blacklegged ticks, the known vector species for the LD causing bacterium. Three of the blacklegged ticks identified were positive for Lyme disease. Results were confirmed by the National Public Health Lab in Winnipeg. The three blacklegged ticks positive for LD were acquired through travel to Christie Lake, Ontario, Rondeau Provincial Park and Wolfeville, Nova Scotia. This season there was one human Lyme disease case reported in Middlesex-London. The case was reported late in the summer of 2012 and was travel-related. The total number of Lyme disease cases for the Province of Ontario has yet to be confirmed.

Discussion

Although the risk of acquiring Lyme disease remains low in Middlesex-London, residents can acquire LD from an infected tick anywhere in Ontario, especially when travelling to known endemic regions. This is because ticks can travel on migratory birds or mammals. Although Middlesex-London does not have an established blacklegged tick population, there are endemic areas within 100 kilometers, in Norfolk County and Windsor-Essex County. This season the MLHU performed occasional tick dragging as part of a passive tick surveillance program.

Conclusions and Recommendations

It is important that the MLHU continue to implement public education strategies that outline personal protection measures and tick removal techniques, the recognizable symptoms and the locations to submit a tick, in order to prevent and/or detect the early signs of LD. The MLHU must also continue to perform tick dragging in areas identified as having a high number of tick submissions, or in areas where residents reported a high number of tick sightings or tick bites.

7.5 Human Surveillance of Eastern Equine Encephalitis

Background

Eastern Equine Encephalitis is a viral infection that causes high mortality rates in humans; approximately 5% of EEE infections advance to include severe encephalitic symptoms and 33% of those who develop severe encephalitis die from the disease. Those who survive typically experience progressive mental and physical disabilities. (MOHLTC, 2011; CDC, 2011)

Eastern Equine Encephalitis is a mosquito-borne disease that can be transmitted to humans through a bite from *Coquillettidia perturbans, Ochlerotatus canadensis* and *Aedes vexans vexans* species of mosquitoes. *Culiseta melanura* have been identified as the main mosquito vector amplifying EEE within avian populations. Although several EEE vector species were identified in Middlesex-London this season, no mosquitoes tested positive for the virus, and there were no reported local cases of EEE in horses or humans. Currently the risk of human infection in Middlesex-London is low, although Ontario has reported some positive veterinary cases and positive mosquitoes in previous years. The presence of EEE in the United States supports the need for continued surveillance of vector mosquito populations in Middlesex-London.

A lack of positive EEE activity within Middlesex-London this season was not due to a lack of surveillance or testing. The MLHU and its service provider, Sporometrics, followed Public Health Ontario's guidelines for Eastern Equine Encephalitis Surveillance and Management, testing species of concern for EEE, with no positive results. Although there have been no reported human cases of EEE in Canada to date, guidelines for the detection of the disease were developed, which provide a comprehensive overview of EEE, outline an adult mosquito testing order of preference and provide information on how to perform risk assessments and develop EEE contingency plans, if required.

Although the Public Health Agency of Canada has not published a nation-wide case definition for the diagnosis of EEE, the Center for Disease Control and Prevention (CDC) in the United States (U.S) has published case definitions for Arboviral Encephalitides caused by any of the following virus agents: Eastern Equine Encephalitis (EEE), Western Equine Encephalitis (WEE), St. Louis encephalitis (SLE) and La Crosse (LAC) encephalitis which are transmitted by mosquitoes. These case definitions, in conjunction with the new EEE guidelines provide a technical reference for the MLHU to effectively monitor for EEE.

Discussion

Although there was no EEE activity within the province, since the prognosis for those infected with EEE is poor, the MLHU will continue to follow PHO guidelines to monitor for EEE in adult mosquito species.

In 2012, the U.S. still identified EEE-positive activity and reported human cases, positive mosquitoes, birds, and veterinary cases. The U.S. reported a total of 12 human cases; seven in Massachusetts, two in Vermont and one in each of the following states: North Carolina, Virginia, and Florida. (CDC, 2012, USGS, 2012)

7.6 Human Surveillance Conclusion

Human surveillance of vector-borne diseases is an important part of the MLHU's Vector-Borne Disease Program. Knowing that WNV, EEE or LD is present in an area puts the general public on alert. This includes doctors and healthcare providers who may also be alerted in order be watchful for associated signs and symptoms in their patients. It also provides more clues to Health Unit staff about who may be at risk for the serious health effects vector-borne diseases can cause. In addition, human surveillance provides information which can help ensure the safety of the blood supply in Canada. Every time a WNV case is confirmed, the patient is interviewed in detail and asked if they have recently given blood. Canadian Blood Services is contacted in order to ensure that the blood supply remains safe and protected.

Chapter 8: Mosquito Control

8.1 Introduction

Controlling vector mosquito larvae populations is one of the most important aspects of West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE) management. The effective control of mosquito larvae populations can help minimize the amplification of vector-borne diseases and can also help to reduce the spread of infection to humans. Controlling vector mosquito populations before they reach adult and/or the biting stages of development is a key component of the Middlesex-London Health Unit's (MLHU) Vector-Borne Disease Program. The objective of control activities is to reduce vector mosquito larvae using strategies that are economically and environmentally sound. The MLHU and its service provider, The Canadian Centre for Mosquito Management (CCMM) employ an Integrated Pest Management (IPM) approach, which is a decision-making process that includes: planning, identification, surveillance, control and continual evaluation. This approach ensures that the MLHU only controls mosquito larvae that have the potential to harm human health through the transmission and spread of vector-borne diseases.

8.2 Products and Application

All staff involved in the application of pesticides hold a Pesticide Technician Licence or an Exterminator Licence, both of which are provincially regulated by the Ministry of the Environment (MOE) and issued in accordance with the *Pesticides Act* under the Pest Management Regulatory Agency of Canada (PMRA). The MLHU's Vector-Borne Disease Program continued to use larvicides that are applied directly to water. These products are designated as "Class 2" by the Ministry of the Environment (MOE). The MOE requires that Class 2 pesticides be applied by trained and licenced personnel.

Bacillus thuringiensis israelensis (*B.t.i.*) and *Bacillus sphaericus* (*B.s.*)

Bacillus thuringiensis israelensis (*B.t.i.*) and *Bacillus sphaericus* (*B.s.*) are biologically safe, target specific pesticides utilized by the MLHU. Both *B.t.i.* and *B.s.* contain bacteria that create a lethal reaction in the alkaline environment a mosquito larva's digestive system.

Figure 8-1: MLHU staff member treating a woodland pool with VectoBac 200G.

While the modes of action for these two bacteria are similar, *B.t.i.* endures for approximately 48 hours, whereas *B.s.* can remain in a treated body of water for up to seven days.

AquaBac® 200G, VectoBac® 200G, and VectoBac® 1200L contain *B.t.i.* as the active ingredient, and Vectolex® products contain *B.s.* as the active ingredient. This season, the MLHU and CCMM used products containing *B.t.i.* for the treatment of standing water located in ditches, woodland pools, ponds and storm water management facilities. Although the MLHU chose to use *B.t.i.* this season, permits did allow for the use of *B.s.*, which may be used in future surveillance seasons.

Figure 8-2: Area of standing water displaying public notification (signage) following a larvicide treatment; a permit requirement issued by the MOE.

Methoprene

Catch basins are primarily treated with Altosid® pellets or briquettes, which are Methoprene-based products. Methoprene is an insect growth regulator, which works by disrupting the lifecycle of mosquitoes. Methoprene products prevent the development of the mosquito beyond the larval stage. Laboratory tests reveal it is slightly toxic to fish, and can be toxic to some freshwater invertebrates; however when used according to proper label directions, field research has shown low toxicity levels and no permanent adverse effects on non-target populations of amphibians and mammals, including humans (Health Canada, 2010). This season, CCMM utilized Altosid® products to treat vector mosquitoes located in catch basins, sewage lagoons within the City of London's Pollution Control Plants, and some standing water locations in Middlesex-London.

8.3 Standing Water Treatments

In 2012, 260 hectares (ha) of potential mosquito habitat was monitored by the MLHU and CCMM. These sites were monitored on a weekly basis and treatments were conducted when moderate to high counts of vector mosquito larvae were identified. Throughout the 2012 season, 1047 treatments were made at 229 sites monitored by both the MLHU and CCMM. Larvicide was applied to 13 ha of standing water located on public property. Surface water surveillance and control activities were conducted in the municipalities of Adelaide-Metcalfe, London, Lucan Biddulph, Middlesex Centre, Newbury, North Middlesex, Southwest Middlesex, Strathroy-Caradoc and Thames Center. The majority of treatments were made at sites located in the London, Strathroy and Dorchester. The high number of treatments in London can be attributed to the large number of storm water management facilities and naturalized woodlands located in the City, which includes standing water treatments performed in Byron and Lambeth.

Once again, there was an increase in treatments this season, as 128 more treatments were done in 2012 than in 2011. Treatment numbers had also increased from 2010 to 2011. This increase in treatment numbers over the past few seasons indicates that as standing water sites become more naturalized, more mosquito larvae are identified, increasing the need for additional treatments.

Figure 8-3: MLHU staff member preparing for a treatment by measuring VectoBac 200G.

An increase in the number of frequently treated sites (10 or more times) also supports this reasoning. The number of sites frequently treated increased significantly this season, from 34 in 2011 to 55 in 2012 (**Appendix F**). A 38% increase in the number of frequently treated sites correlates with the overall increase in total treatments made. As SMWFs begin to age they develop more vegetation and organic content, becoming naturalized and an ideal mosquito breeding habitat. As these sites continue to naturalize more treatments will be required. Through the monitoring of SWMFs and other artificial structures containing standing water over the past ten seasons, the MLHU has correlated an increase in treatments to the maturity of many naturalized sites located across Middlesex-London.

8.4 Canadian Centre for Mosquito Management Inc., (CCMM) Activities

Catch Basin Treatments

In 2012, each municipal catch basin received three treatments using Altosid® pellets. A calculated approach to catch basin treatments was taken, spacing the three treatment rounds to achieve optimal mosquito control at the most critical times known for mosquito amplification. Early phases of catch basin larviciding are considered important in order to reduce the emergence of early spring mosquito species. The elimination of mosquito populations early in the season slows the amplification of WNV throughout summer months. The final round of catch basin treatment is conducted in an effort to reduce the amount of over-wintering mosquito populations. The 2012 Catch Basin treatment flyer (**Appendix G**) describes catch basin treatment rounds and includes the colour code used to indicate the treatment count on roadside catch basins.

Throughout the 2012 season, 64.8 kg of Altosid® pellets were used to treat a total of 87,732 roadside catch basins. Twenty (20) VectoLex® pouches were also used to treat roadside catch basins that had outflows into environmentally sensitive areas. In addition, 933 Altosid® XR Briquettes were applied to non-roadside catch-basins, including: catch basins located in rear yards of residential properties [93]; catch basins located in municipal green-spaces [260]; and catch basins located on sites such as government buildings, social housing units, and long-term care facilities [654]. These applications were generally made early in the season and were considerate of the extended period of residual activity associated with the briquette formulation. (CCMM, 2012)

Figure 8-4: CCMM staff treating a roadside catch basin.

Mapping

Standing water sites established as part of the mosquito surveillance schedule are mapped using Global Positioning System (GPS) coordinates. These coordinates represent the exact geographic locations of standing water sites located on public property. Standing water sites are often located a considerable distance from roadways or well-established paths. The specificity of GPS coordinates used to identify these sites is helpful to MLHU and CCMM staff, allowing team members to easily locate standing water through accurate coordinates and detailed site descriptions.

8.5 Pollution Control Plants

Larval mosquito surveillance was also conducted within the City of London's pollution control plants (PCPs) this season. CCMM accessed seven PCP's in partnership with City of London staff, monitoring these sites for vector mosquito larvae. When vector mosquito larvae were identified the water was treated with Altosid® Granules. The first application of Altosid® to standing water located within the PCPs was June 8, 2012, and the abatement program continued until August 7, 2012. In total, seven PCPs were monitored and 20 applications Altosid® were made at five municipal pollution control plants in the London. CCMM staff applied 8.92 kg of Altosid® Granules to 0.797 hectares of surface water located in PCPs. The success of this control strategy was monitored following treatment. The effectiveness of this strategy was considered to be excellent. On no occasion was re-treatment necessary. (CCMM, 2012)

8.6 Source Reduction

While the treatment of standing water with larvicide is effective at temporarily reducing larval mosquito populations, the elimination of standing water through source reduction is more effective as it results in permanent control. The removal of standing water eliminates suitable environments for mosquitoes to lay eggs; therefore any further development is prevented. The removal of standing water sites requires collaboration between the MLHU and local community partners. This season sites located in Parkhill continued to be remediated, as the Municipality of North Middlesex moved forward with plans to clear the Cameron Gillies drain. Continued collaboration with city and municipal partners is crucial in order to identify areas of concern and reduce artificial or made-made habitats that may allow standing water to collect and vector mosquito larvae to develop in these unmaintained structures.

8.7 Adulticiding

Adulticiding is a method of control that reduces the adult mosquito population through the application of insecticides. The MLHU determined that adulticiding was not a necessary component of the VBD control program this year. In the event that positive West Nile Virus activity posed significant risk to human health, and current control measures did not adequately prevent amplification of the virus, Middlesex-London's Medical Officer of Health would determine whether adulticiding would be a necessary course of action. This decision would be based on the results of a local risk assessment. A local risk assessment takes into account: standing water surveillance data, the presence of WNV in humans; adult mosquitoes; birds; and the efficacy of control methods already in place. (MOE, 2009)

8.8 Conclusions and Recommendations

In order to maintain the quality of the MLHU's mosquito control program, the following recommendations should be considered:

The MLHU's mosquito control program reduces the number of vector mosquito larvae in standing water on publicly-owned property. Once again the MLHU observed an increase in the number of treatments performed. This increase was observed for the third straight season and indicates the continued need for a vector mosquito control program in Middlesex-London, as surface water areas continue to naturalize and facilitate larval mosquito development.

The MLHU should continue recording pre- and post-treatment larval counts and the assessment of environmental conditions when monitoring standing water sites, as it currently does. This data allows the MLHU to evaluate larvicide efficacy and to identify trends related to the maturity of sites, including levels of vegetation and organic matter.

As a standing water site ages, it becomes more naturalized, meaning the amount of vegetation along the water's edge increases, creating an ideal habitat for vector mosquito larvae. This results in an increase in the number of treatments required each season. By monitoring these variables, the MLHU is able to evaluate the role that the environment and naturalization plays in facilitating larval mosquito development. Although the MLHU will continue to monitor these sites, remediation is always recommended. In the past year, the MLHU has observed two remediation efforts at SWMFs located within the City of London, in addition to ongoing remediation in North Middlesex. The MLHU hopes that through the maintenance of these overgrown sites, fewer mosquito larvae will have the potential to breed, resulting in the need for fewer larvicide treatments.

Figure 8-5: MLHU staff performing a dip in standing water located in a ditch in Parkhill.

Chapter 9: Complaints, Comments, Concerns

9.1 Introduction

This season the Middlesex-London Health Unit (MLHU) continued to monitor, record and respond to all complaints, comments and concerns (CCCs) received from the public. The initial intake of inquiries was handled by the VBD field technician and then triaged to seasonal Vector-Borne Disease (VBD) staff, according to the location and complexity of the concern. When standing water related concerns were received, appropriate actions were taken to resolve and eliminate the area of concern. Concerns were received by phone, email, or in person, and were documented in the MLHU's complaints database. In some cases, the assistance of Public Health Inspectors (PHI's) and/or local community partners was required to assist the VBD Team in resolving issues on public and/or private property.

9.2 Results

In 2012, the VBD Team received and responded to a total of 364 complaints (including dead bird and tick reporting). This is a 5% increase over the number of complaints reported during the 2011 season. An increased number of complaints, comments and concerns in the past two seasons indicates that the MLHU's public education efforts and promotional brochures have been effective. These efforts have encouraged residents to call to report standing water, West Nile Virus (WNV) or tick-related concerns, to inquire about personal protection methods and/or advice on how to prevent mosquito or tick bites.

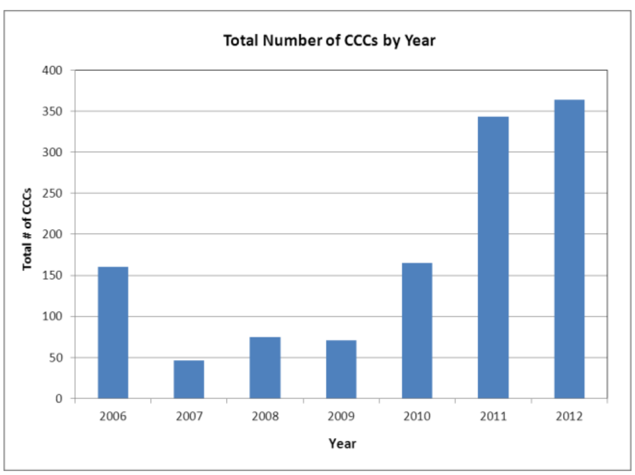

Figure 9-1: Total number of Complaints, Comments and Concerns by year.

Figure 9-2: Standing water concern addressed this season in an empty builder's lot.

9.3 Overview of Complaints

Dead bird reporting once again represented the greatest proportion of concerns accounting for 56% of all CCCs during the 2012 season. This season, dead bird reporting assisted with the identification of 23 WNV-positive birds, aiding the MLHU in notifying the public of the presence of WNV in the community.

Prior to 2010, standing water complaints represented the highest proportion of concerns. However, in the past three seasons, dead bird and tick reporting have increased to become the most frequent concerns received throughout the VBD season (May to October). The MLHU has also observed an increase in the total number of VBD-related calls it received. In earlier years, the public was not calling the Health Unit to ask questions, but now with the availability of the VBD Team's contact information and awareness campaigns aimed at encouraging public participation, the MLHU has noted an increase in number of calls classified as 'inquiry'. These inquiries covered a range of issues including questions regarding personal protection products; tick and mosquito bite prevention methods; tips to reduce standing water around the home; and inquiries on how to talk to a neighbor who may have standing water located on their property. The MLHU has also received vector-borne disease inquiries regarding protection methods, travel tips and information on the use of insect repellent products.

Between 2006 and 2009 most CCCs reported to the MLHU were related to standing water, but in the past three seasons there has been greater diversity in the type of concerns reported by the public. In the past, residents have contacted the MLHU about standing water however in recent years, the public has become more specific in identifying standing water sites that lead to VBD-related concerns.

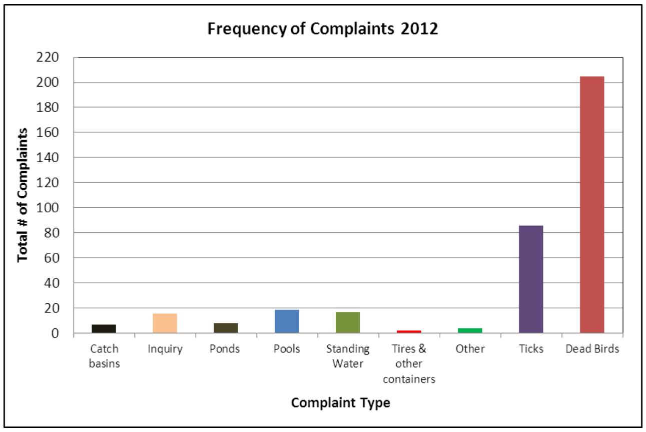

Figure 9-3: Frequency of complaints in 2012.

It is important to note that the number of standing water concerns often fluctuates from season to season depending on the amount of precipitation as well as accumulated water due to winter snowmelt and rainy spring months. From March to September, 2011 precipitation levels were 88% higher those observed in 2012. As a result there were only 17 concerns received this season, half of the 34 standing water concerns received in 2011. The decrease in precipitation this season can be attributed to fewer standing water concerns reported, as there was less rainfall to allow water to collect in containers.

Although standing water concerns may increase following winters with heavy snowfall, and/or rainy spring and summer months, the reporting of standing water concerns can also be attributed to the MLHU's public education efforts. These campaigns encourage residents to reduce areas of standing water around their homes in order to eliminate potential mosquito breeding sites. Additionally, the increased number of tick submissions observed over the past four seasons can also be attributed to the MLHU’s public education efforts to promote protection against Lyme disease (LD), encouraging the public to prevent tick bites and submit ticks to the Health Unit.

In past seasons, the MLHU has seen increases in the number of catch basin concerns that have been reported. The number of these concerns has increased each season since 2007. In an effort to address this, the MLHU created a new system to communicate with homeowners once their backyard catch basin had been treated. This system included notification left at the home following treatment, and also a follow up call to confirm receipt of the notification and treatment with the homeowner.

This new system of communication was discussed with the service provider who performed the work, and resulted in fewer catch basin concerns received this season; in fact, the MLHU received only seven catch basin concerns this season, a 77% decrease from 2011.

9.4 Discussion

Once again this season, the MLHU observed an increase in dead bird and tick-related concerns. This followed previous increases in 2010 and 2011. In 2012, there was a 30% increase in reports of dead birds and a 14% increase in the number of tick submissions/tick inquiries.

The MLHU has also observed an increase in the number of inquiries made to the VBD Team. This increase was first noted in 2011, and continued into the 2012 season. In previous seasons, there were very few general questions or inquiries made regarding vector-borne diseases, however the past two seasons have indicated that the public is more willing to contact the MLHU for questions regarding mosquito viral testing and personal protection methods against tick and mosquito bites. The 16 inquiries were made in 2012 were a slight increase over the 13 received in 2011. Although these inquiries only represent 4% of the total number of CCCs received, it is significant because it demonstrates that the public is actively seeking information from the Health Unit and the VBD Team is able to give the public accurate information according to the nature of their inquiry.

A majority of the inquiries made this season were regarding ticks and adult mosquitoes. Tick-related questions ranged from how to submit a tick, to what to do if bitten by a tick. Questions about adult mosquitoes were answered easily by referring clients to the Health Unit’s website, where a weekly vector-borne disease update was provided. This update included the results of weekly adult mosquito viral testing, WNV-positive human cases, WNV-positive birds identified, total treatments performed on standing water and a summary of concerns received by the MLHU. This weekly update was an effective resource used to answer several inquiries regarding adult mosquito concerns. The MLHU will continue to direct the public to the Health Unit’s website where they can read about all activities related to the Vector-Borne Disease Team and the specific areas within Middlesex-London where positive West Nile Virus activity has been confirmed. The MLHU is pleased with the discussion and education that was facilitated through public inquiries made by email or phone to the Health Unit this season.

It is important to note that a large part of this chapter's discussion in the *2011 Vector-Borne Disease Report* focused on the increase of mosquito-related concerns observed in Parkhill that season. Because of the increased number of adult mosquitoes in Parkhill in 2011, the MLHU received a high number of mosquito concerns, catch basin inquiries and standing water-related concerns from Parkhill. Compared to 2011, the town experienced fewer adult mosquitoes this season, which resulted in fewer calls to the MLHU. Although there were still calls regarding dead birds and catch basin treatments (which have occurred from this area in the past), there were fewer calls from North Middlesex residents regarding adult mosquitoes, personal protection or general inquiries about mosquito bites. During the 2011 season the MLHU worked diligently with the community to address public concerns, while maintaining a rigorous mosquito surveillance and treatment schedule to try and reduce vector mosquito populations. This work paid off as the number of concerns from Parkhill decreased significantly in 2012, amounting to about half the number of concerns received in 2011.

The MLHU will continue to work closely with community partners in North Middlesex to ensure that standing water located on public property is monitored effectively to reduce the breeding of vector mosquito larvae in Parkhill. The MLHU will continue to address public concerns and ensure Parkhill residents are aware of how they can reduce standing water, prevent mosquito breeding, protect themselves against mosquito bites and better understand the work the MLHU does in Middlesex-London.

Mosquito Dunks® was a product that assisted the MLHU in resolving unmaintained pool and standing water concerns once again this season. Mosquito Dunks® contain the biological larvicide, *Bacillus thuringiensis israelensis* (*B.t.i.*), which is the same ingredient found in products used by the MLHU for seasonal vector mosquito control on public property. This product eliminates mosquito larvae by applying a 'dunk' to the water, where it dissolves and is ingested by mosquito larvae, which starve following ingestion. One 'dunk' lasts approximately one month, so with the purchase of one package (6 dunks), homeowners have enough product to apply to the standing water of concern for the duration of the VBD season, or until the concern can be permanently remediated. This product has been helpful to the MLHU in resolving unmaintained pool concerns and as a last resort for the resolution of standing water concerns. In the past, the MLHU could not verify whether homeowners carried out these practices beyond the follow-up visits of a complaint. The use of Mosquito Dunks® has made the process of eliminating larval mosquito breeding at complaint sites, as it provides a straightforward solution to eliminating larvae for approximately one month. Overall, Mosquito Dunks® are an important product assisting the MLHU in resolving standing water and unmaintained pool concerns

Figure 9-4: Unmaintained pond concern investigated in 2012.

9.5 Community Partnership

The MLHU maintained effective community relations this season with a variety of local partners. Working closely with the City of London, the Municipality of North Middlesex, and staff from local Conservation Authorities, the MLHU was able to effectively reduce standing water, address public concerns and participate in public education regarding tick and mosquito bite prevention.

The MLHU collaborated with municipal official on matters related to the presence of vector mosquito populations at several public sites of concern this season. On several occasions the MLHU was assisted by the City of London in addressing standing water located on private property.

The MLHU also worked with the Municipality of North Middlesex this season to continue remediation efforts in the town of Parkhill [**Figure 11-2 & 11-3**]. In addition, the MLHU maintained its larval mosquito surveillance and control schedule, conducting additional trapping of adult mosquito populations in Parkhill, with the integration of a third adult mosquito trap. Due to the large number of concerns received from Parkhill in 2011, the VBD Team continued to meet with the Ausauble Bayfield Conservation Authority and the Municipality of North Middlesex to further support the work being done to clear the Cameron-Gillies drain and advise the community group of ongoing efforts to closely monitor adult and larval mosquito populations in North Middlesex. Collaboration with North Middlesex is ongoing as remediation efforts in the town continue. The VBD Team will remain in contact with community partners in order to inform them of the work the MLHU does in Parkhill to control mosquito species that pose a threat to human health.

The MLHU strives to collaborate with all community partners in order to better serve the concerns of local residents, develop public education strategies and ultimately reduce the transmission of vector-borne diseases. This season's larval mosquito monitoring, control activities, public education initiatives and community development with local partners are great examples of the VBD Team's dedication to protecting public health and wellbeing in the communities of Middlesex-London.

9.6 Conclusions and Recommendations

The MLHU should continue to support public education campaigns which inform residents about the services provided by the Vector-Borne Disease Team, and the work done by the MLHU to protect against West Nile Virus, Eastern Equine Encephalitis and Lyme disease transmission. Continuing to develop and improve education strategies is an important step in reducing the number of concerns received over the course of a season. It is also important to maintain consistent public messaging to educate homeowners on eliminating breeding areas and reporting potential VBD-related concerns. It is important that residents are educated to do their part to help reduce the transmission of vector-borne diseases.

The MLHU will continue to investigate complaints regarding not only standing water, but any location that poses an immediate or potential threat to human health. The VBD Team will continue to develop strong community ties, including partnerships with municipal governments, city developers and Public Health Inspectors. Community partnerships will help to address public concerns and reduce the time required to resolve those matters over the course of the season.

Figure 9-5: Pre-clearance of King Street ravine, located in Parkhill.

Figure 9-6: Post-clearance of King Street ravine located in Parkhill, part of ongoing remediation efforts.

Chapter 10: Weather Trends and Special Projects

10.1 Introduction

Research has shown that global climate change is expected to have broad public health implications. These effects could occur in various ways, such as frequency and intensity of extreme temperatures, precipitation, floods and droughts. Vector-borne disease incidence is also affected by fluctuations in temperature, humidity, rainfall, and sea level rise. Both mosquitoes and ticks are cold-blooded insects that are susceptible to environmental changes. The impact of vector-borne diseases carried by mosquitoes and ticks is dependent on several environmental factors which include increased temperatures, humidity, drought, precipitation and rainfall, all of which are influenced by climate change. (Patz and Ueijo, 2008)

By monitoring weather trends, which include temperatures, rainfall and Accumulated Degree Days (ADD), the MLHU strives to better prepare for the impact that these may have on local mosquito and tick populations. The Vector-Borne Disease (VBD) Team has established an annual review of weather trends in order to better understand the environmental factors that favour larval mosquito development and West Nile Virus activity. Weather trends play a role in the habitat preferences and generational longevity of mosquito larvae, in addition to the influence that climate has on the development of mosquito larvae in a variety of natural and artificial habitats.

10.2 2012 Weather Trends in Middlesex-London

This season the Middlesex-London Health Unit (MLHU) reported 17 West Nile Virus (WNV) positive mosquito traps. In 2011 there were 11 WNV-positive traps. Similarly, the Province of Ontario also saw an increase in the number of WNV-positive mosquito traps compared to previous year's results. In 2009, the province reported 14 positive traps, in 2010, 56 positive traps and in 2011, 278 WNV-positive mosquito traps. This season Ontario observed increased WNV-positive activity with a total of 464 WNV-positive mosquito traps.

Since temperature and precipitation can have a significant effect on mosquito populations and viral replication, it is important to consider the weather as a factor in this season's increased viral activity. Additionally, an increased number of mosquito breeding habitats can be supported by certain weather conditions; precipitation, flooding, humidity and drought, are all factors which can create ideal ecological environments for the proliferation of larval mosquito populations and viral transmission.

The relationship between weather and mosquito abundance can also be explained through the Accumulated Degree Day (ADD) model. External temperature plays a key role in the development rate of many organisms, including viruses. In the case of WNV, a certain amount of heat and time is required before the viral titre in an infected mosquito is high enough for human infection risk. The combination of time and temperature needed for an organism's development is expressed in units called degree days. The amount of heat required to raise the viral infectivity rate is taken as temperature measured above the threshold of 18 degrees Celsius. Degree days are measured as one degree day rating for every degree Celsius the average mean temperature is above 18 degrees. (Public Health Ontario, 2011) Each degree over the threshold of 18 degrees Celcius is considered to be one degree day. For example, a day with an average mean temperature of 20 degrees Celcius has two degree days, since the average temperature exceeds 18 by two degrees.

This season there were 235 consecutive degree days observed from June 27 to August 16, 2012. This means that accumulated daily mean temperatures exceeded 18 degrees by several degrees for a consecutive period of time. Accumulated Degree Days can account for the increased viral replication observed in Middlesex-London from mid-July to early September. Ultimately, ADD contributed to the greater number of WNV-positive mosquito traps observed this year as greater than 100 accumulated degree days is associated with an increased risk of WNV activity in mosquitoes and greater than 200 with an increased risk of human infection.

10.3 Weather Trends and West Nile Virus

Meteorological monitoring is important in the study of vector-borne diseases, as many types of weather conditions can give way to outbreaks of mosquito related diseases. For example, after the outbreak of WNV in 1999, everyone was concerned that hot, dry climate conditions may support vector-borne disease transmission, and many began to monitor that type of weather to prepare for future outbreaks (Mutebi, 2010). Traditionally, hot, humid weather has been known to favour WNV viral production. Following the initial outbreak of WNV in 1999, meteorological data was studied in detail in order to better monitor and prepare for future outbreaks of vector-borne diseases.

This season, Middlesex-London experienced increased precipitation in the month of June and then moderate levels of precipitation for the remainder of the season. This is the opposite of what occurred in 2011, when May, August and September saw heavy rainfall. Temperatures also played a role in viral activity this season, with a drop in precipitation by mid-July, accompanied by a spike in temperatures, creating ideal conditions for the transmission and amplification of West Nile Virus [**Figure 10-1 & 10-2**].

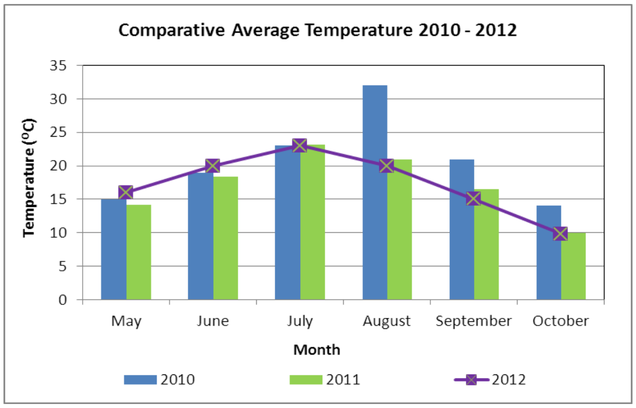

Figure 10- 1: 2010, 2011 and 2012 comparative precipitation.

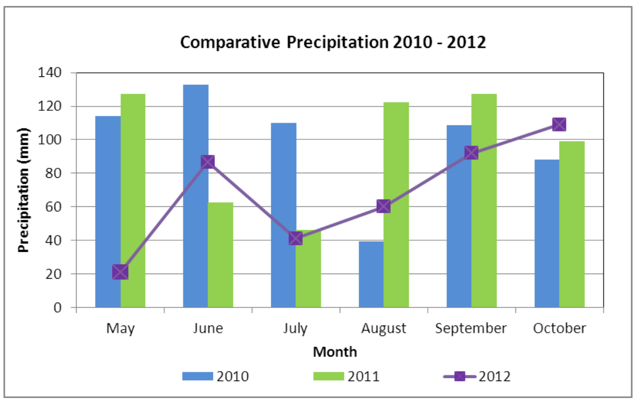

Figure 10-2: Comparison of 2010, 2011 and 2012 average temperature.

West Nile Virus activity in Middlesex-London can be associated with the number of consecutive degree days recorded from June 27 to August 16, 2012. It is often understood that several very hot seasons are required in order to see WNV activity. Taking into account the above-average temperatures from July and August 2010 and 2011, combined with unseasonably warm temperatures July of 2012, in addition to 235 consecutive degree days recorded, this combination can account for the increased viral activity [**Figure 10-3**]. The number of West Nile Virus-positive mosquitoes and birds can be attributed to the accumulated warmer temperatures from the 2010, 2011 and 2012 seasons, which amplified viral transmission throughout Middlesex-London and the province.

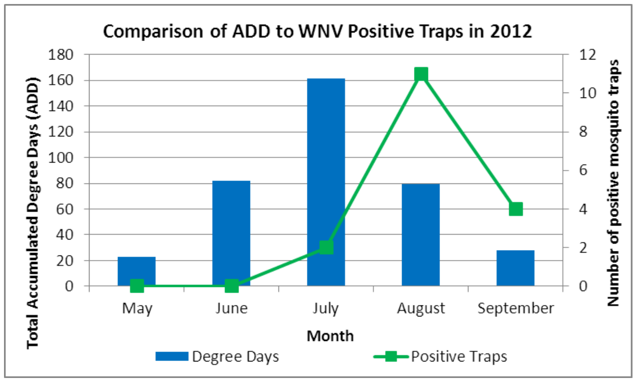

Figure 10-3: Comparison of consecutive degree days to the number of WNV-positive mosquito traps confirmed in 2012.

10.4 Weather Trends and Eastern Equine Encephalitis

In recent years, Eastern Equine Encephalitis (EEE) activity has been identified in North America. Since some outbreak years of EEE have been recorded in American states bordering Ontario, the environmental conditions associated with this emerging vector-borne disease have been monitored closely following these outbreaks. Rainfall has been highly associated with Eastern Equine Encephalitis, as significant correlations in the United States have been drawn between the occurrence of EEE-positive human cases and the excess of rainfall present at the time of infection. Eastern Equine Encephalitis was associated with rainfall when more than 20 centimetres above average precipitation was observed for two years in Massachusetts, correlating with the outbreak of three human cases at that same time (AMCA, Mutebi, 2010). The MLHU continues to record degree days and precipitation in order to monitor trends and weather conditions that may be favourable to vector-borne disease transmission. The MLHU did not experience high levels of precipitation this season, and there were no EEE-positive human cases, or EEE-positive mosquitoes. There was also a significant decrease in the number of EEE vector species collected this season, and zero *Culiseta melanura* specimens identified. The decrease in EEE vector species, in addition to no EEE positive mosquito traps indicates that EEE remains non-existent in Middlesex-London.

10.5 Weather Trends and Larval Surveillance

This season, larval surveillance began on March 12, 2012 (week 11). The average temperature in these standing water pools caused by snowmelt was 7.3 degrees Celsius (7.3°C). For the past three seasons, the first day of larval surveillance has occurred earlier in March each year. Due to above average temperatures in March 2012, the VBD Team found mosquito larvae earlier than any previous years.

10.6 Weather Trends and Environmentally Sensitive Areas

When comparing past seasons, Middlesex-London has experienced peaks of precipitation over the course of a vector-borne disease season. Environmentally Sensitive Areas (ESAs) typically hold larger amounts of standing water for longer periods of time, and tree cover, which provides shade and does not allow sunlight to dry up small pools of standing water that form as a result of run-off from larger ponds or increased precipitation. Often, due to the ESA's ability to support standing water for a longer period of time, increased numbers of vector mosquito larvae are observed and more frequent standing water treatments are required. However. this season, the MLHU collected fewer mosquito larvae from ESAs than in the past three seasons. As well, decreased precipitation and fewer mosquito larvae led to fewer treatments by MLHU staff at ESAs in 2012.

Weather trends resulted in Sifton Bog being very dry this season, a contrast from historical data which shows the bog has retained water for the duration of a season due to its characteristics. For the past three seasons, Sifton Bog has become drier each season; retaining very little standing water and therefore producing lower levels of mosquito larvae. This season's decreased snowmelt, lesser precipitation in the spring and decline in precipitation from August to October played a significant role in the bog's decreased mosquito activity. Lower levels of precipitation kept Sifton Bog quite dry in 2012 and overall, very few larvae were collected. As a result, only two treatments were performed there in 2012. Due to drier conditions at the bog this season, the species of adult mosquitoes found in the trap set up at Sifton Bog were also affected, with no *Culiseta melanura* collected from the trap (which has been the only trap location to collect *Cs. melanura* in the past three seasons).

10.7 Weather Trends and Adult Mosquito Surveillance

Once again this season's weather played a role in the results of adult mosquito surveillance. Unlike in 2011 when increased snowmelt and spring precipitation contributed to high populations of the non-vector species *Ochlerotatus blacklegged*, 2012's mild winter, kept this spring floodwater species at bay. Traditionally, the MLHU collects a very high number of spring floodwater species, *Aedes vexans vexans, Ochlerotatus canadensis, Oc. stimulans* and *Oc. trivittatus*. This season saw a significant decrease in these spring species; a 71% decrease in *Ae. vexans vexans*, a 94% decrease in *Oc. canadensis*, an 88% decrease in Oc. stimulans and a 52% decrease in *Oc. trivittatus*. With a mild winter and decreased spring precipitation this season, the populations of spring mosquitoes did not spike in numbers as high as those recorded in 2011 and 2010.

The Accumulated Degree Day (ADD) model used by the MLHU helped to prepare for WNV-positive activity this season. Accumulated Degree Days allowed the MLHU to anticipate this season's WNV-positive mosquito traps, in addition to the confirmation of WNV positive birds, which act as an early warning that WNV is present within the community. Typically, more than 100 accumulated degree days is associated with an increased risk of WNV activity in mosquitoes and greater than 200 ADD is associated with an increased risk of human WNV infection. This season, 168 consecutive degree days were observed prior to the first WNV-positive mosquito trap identified on July 18, 2012. In total, the MLHU recorded 235 consecutive degree days from June 27 to August 16, 2012. These consecutive degree days contributed to accelerating the viral incubation period required to amplify WNV within a community. During these degree days, the MLHU confirmed 17 WNV-positive mosquito traps, and 7 WNV positive human cases were reported. The first case was reported on August 11, 2012 and the last case to-date was reported on September 14, 2012.

A mild winter also contributed to increased viral activity in over-wintering adult mosquitoes in Middlesex-London. Some populations of *Culex pipiens/restuans*, which could have been carrying WNV from the summer of 2011, may not have died off due to the mild winter. These species would normally be eliminated by the end of a heavy Canadian winter, with snowfall and temperatures below freezing. The MLHU trapped these species in much higher numbers this season, and additionally, observed a significant increase of these species in canopy traps.

10.8 Weather Trends and Seasonal Complaints

Weather and precipitation often play a role in the nature of the public concerns reported each season. A winter with increased snowfall often results in stagnant water following spring snowmelt, additionally increased precipitation in March, April and May can, contribute to jumpstarting the development of spring floodwater mosquito species. This season's weather played a role in some aspects of complaints, as above average temperatures in March initiated public inquiries to the Health Unit beginning on March 2, 2012. In past seasons heavy snowfall has increased the amount of standing water, in spring, however with little snowfall in the winter of 2012, fewer standing water concerns were observed this year.

Temperate conditions were also favourable for tick populations this season, as the MLHU observed a third straight increase in the number of ticks submitted. Since winter temperatures were so mild in 2012, the first tick submission was made in January 2012. Tick submissions typically begin once warm spring temperatures arrive following snowmelt in late March or early April, however due to the mild winter, ticks were present in grassy fields and wooded areas much earlier than usual. Tick submissions were made to the Health Unit throughout the winter, spring, summer and fall of 2012. The last tick was submitted on October 16, 2012.

10.9 Weather Trends and Mosquito Control

Weather often plays a significant role in the MLHU's control activities each year. There are several aspects of weather which may affect the MLHU's control program. First, if a season brings warmer temperatures, it can accelerate the development of mosquito larvae, increasing vector mosquito populations and therefore requiring more treatments to control mosquito larvae before they emerge as adults. Conversely, a season with cooler temperatures can prolong the maturation of certain larval mosquito species, therefore requiring fewer treatments. Mosquitoes also require certain amounts of precipitation to jump-start their life cycle in the spring months. The mosquito life cycle can continue throughout summer months and into the fall if ideal habitats are provided.

In 2011, precipitation played a significant role in larval mosquito development as increased snowmelt caused high water levels throughout Middlesex-London, hatching several generations' worth of mosquito larvae. With increased larval development due to snowmelt in the spring of 2011, there were more adult mosquitoes collected during the 2011 season overall. In 2012 however, with a mild winter and little precipitation, fewer spring mosquito species were identified in larval form or collected in adult mosquito traps. Decreased snowmelt, and as a result less floodwater, affected spring mosquito counts as fewer spring species were hatched and emerged as adult mosquitoes in 2012. Although fewer spring species were identified, the overall number of standing water treatments was not affected as a high number of vector species were still identified, requiring treatment, due to high average temperatures recorded from late June to mid-August.

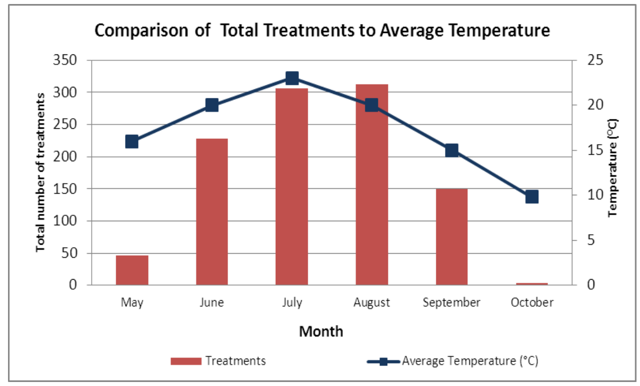

Figure 10-4: Comparison of total treatments made to average temperatures recorded from May to October, 2012.

10.10 Weather Trends Conclusion

Due to the variability of weather trends that can facilitate larval mosquito development and contribute to the amplification of vector-borne diseases, it is important to monitor the weather throughout each surveillance season in order to understand the conditions that favour mosquito development and viral production. In order to better monitor the conditions that foster mosquito breeding, the MLHU must continue to monitor temperatures, precipitation and drought conditions to better prepare for the impacts that that these climates may have on local mosquito and tick populations. Ultimately, it is important to monitor a region's changing climate and weather patterns in order to draw connections and understand the links between changing climates and the spread of vector-borne diseases.

Chapter 11: Public Education

11.1 Introduction

The 2012 season saw the Vector-Borne Disease (VBD) Team continue its comprehensive public education campaign, focusing on community relations and teaching residents to protect themselves against West Nile Virus (WNV), Lyme disease (LD) and Eastern Equine Encephalitis (EEE). Educational and promotional materials were distributed to stakeholders and the community at local events throughout the season. Advertising, educational brochures and participation in a range of community events were essential elements of the VBD Team's public education strategy.

11.2 Printed Resources

The central message of the VBD education campaign remained to 'Reduce and Repel' mosquito and tick bites. Brochures which contained basic information about WNV, preventing mosquito breeding and protecting against mosquito bites were distributed to residents. The Health Unit's Lyme disease brochure was also distributed to increase awareness about LD and to educate the public on how to submit a tick, how to protect against tick bites and how to take precautions when travelling to endemic regions in the spring and summer months. The VBD Team also placed an advertisement in the City of London's Waste Reduction & Conservation Calendar. This ad, which focused on LD, appeared in the calendar during the month of August reminding residents to protect themselves from tick bites.

11.3 Media

This season, the VBD Team received considerable attention in the media due to the high number of WNV positive human cases reported locally and provincially. With 2012 being the worst year for WNV activity since 2002, members of the VBD Team conducted many media interviews with local newspapers and CTV News, and provided an educational segment, which aired on Rogers TV. The VBD Coordinator was also a frequent guest on local radio programs. Following the confirmation of WNV-positive birds, mosquito traps and human cases, the MLHU issued media releases that informed the public of local WNV activity, and that the VBD Team had increased mosquito surveillance and control efforts. Local media coverage following this positive activity was also beneficial as it informed the public of the MLHU's continued efforts to actively monitor and control mosquito larvae across Middlesex-London.

Figure 11-1: Lyme disease bus shelter ad.

The MLHU continued its work in Parkhill with local partners to try and manage what was a serious nuisance mosquito issue. After much work and collaboration in 2011, the 2012 season saw a dramatic decrease in the number of adult mosquitoes observed in the town of Parkhill. The Parkhill Gazette described it as "Heavenly", (Whitehead, 2012) and the London Free Press referred to the town as a "paradise" (Van Brenk, 2012). Local residents were very happy with the way the season went.

11.4 Online Education

The Vector-Borne Disease page on the MLHU's website provides the public with access to relevant information on WNV and LD monitoring and treatment activities within Middlesex-London. When WNV positive adult mosquito traps or birds were identified, the general locations were listed on the MLHU's website. The website was also a way for residents to report dead crows or blue jays to the VBD Team. Frequently asked questions regarding WNV, as well as treatment reports, standing water status reports, and final reports from previous seasons may all be accessed through the MLHU's website. The MLHU also aimed to reach a younger audience through the use of Facebook advertising. The ads were designed to drive users of that social media to a specific page on the MLHU website which provided facts and information about vector-borne diseases.

The Communications department assisted the VBD Team by promoting Reduce and Repel messages through the Health Unit's Twitter account. VBD-related tweets were used to quickly update residents on WNV positive activity. Twitter also featured general information on protecting against mosquito bites, reducing mosquito breeding habitats, and shared important information from media releases.

11.5 Community Events

The VBD Team participated in various community events this season in order to enhance public education and network with community partners. Early in the season, the VBD Team presented personal protection information to new moms at several of the Health Unit's 'Well baby/Child Clinics' in Strathroy, Glencoe, Parkhill and Mount Brydges. The main focus of these information sessions was to answer questions regarding insect repellents and provide alternative methods of avoiding mosquito and tick bites on babies and children under five years old. Throughout the summer months, the VBD Team set up information booths at the Strathroy Turkeyfest, Fanshawe Dragon Boat Festival, and the Glencoe Fall Fair. The MLHU once again donated promotional materials and Lyme disease brochures to the annual Children's Make a Wish Foundation Golf Tournament.

Figure 11-2: VBD booth at Strathroy Turkeyfest.

At these events, the public was given an opportunity to inquire about WNV, LD, EEE and the VBD Program. Live mosquito larvae and pupae were also on display to show the public what they look like. In addition to distributing brochures, promotional material such as frisbees, "skeeter" swatters, temporary tattoos, and pens were distributed to the public. All promotional materials featured the 'Reduce and Repel' logo as the VBD Team encouraged the community to reduce standing water and repel tick and mosquito bites.

As new Lyme disease data becomes available the MLHU has placed more emphasis on educating the public about LD. Educational messages that the Lyme disease campaign focused on were encouraging the public to be aware of Lyme disease and use protection when travelling to endemic areas, wear insect repellent to avoid tick bites, check for ticks after outdoor exposure; learn how to remove ticks when they are found on a person; and know how to submit ticks to the Health Unit for identification and testing.

11.6 Rapid Risk Factor Surveillance System (RRFSS)

This season, the Vector-Borne Disease Team worked with Environmental Health's Epidemiologist and Program Evaluator to analyze data collected from the Rapid Risk Factor Surveillance System (RRFSS) on the topic of Lyme disease. RRFSS data is collected through an ongoing telephone survey of adults in households in Middlesex-London. Responses from the Lyme disease survey questions provide baseline data about levels of awareness, perceived risk, risk behaviours, and use of protective measures related to Lyme disease. This information is valuable in the evaluation of MLHU's public education initiatives and allows measurement of changes over time. Survey responses from December 2011 and January to April 2012 were analyzed.

This is the first time that MLHU has utilized RRFSS to assess Lyme disease. Since Lyme disease became a permanent part of the VBD program in 2009, and a reportable disease in 2010, the MLHU has developed comprehensive public education strategies to promote Lyme disease awareness and protection against tick bites. Public education initiatives relating to Lyme disease awareness, protection and prevention have been in place for approximately four years. Results from the RRFSS modules on Lyme disease will provide the MLHU with baseline data to assist in tailoring public education initiatives and, in the long-term, evaluate the effectiveness of these activities.

Preliminary results suggest that educational initiatives may be needed to target males, those aged 20-44 years of age, and parents, since these population groups were less likely to have heard about Lyme disease and more likely to travel in grassy or wooded areas. A possible focus for future educational initiatives is the signs and symptoms to look for when bitten by a blacklegged tick, including Lyme disease's most distinguishing symptom, "the Red Bull's Eye". Results also indicated a need to promote awareness of personal protection methods to prevent tick bites when spending time in wooded or grassy areas, and increasing awareness about the need to send ticks for Lyme disease testing if found on the skin. A summary of key results is provided in **Figure 11-3**.

Lyme disease questions were also asked from May 2012 to September 2012. Results from this timeframe will be available in early 2013. These results will be used to inform modifications to the delivery of the Lyme disease program to better reach the target populations.

11.7 Conclusions and Recommendations

The VBD Program will continue to work with the public to ensure that vector-borne disease messages are understood and disseminated throughout Middlesex-London.

Based on the analysis of public education initiatives this season, the following recommendations have been made:

The MLHU must continue to advance the LD education campaign, ensuring that residents are using an insect repellent to protect against tick bites and are aware that a tick can be submitted to the Health Unit when found or removed from themselves or others. The VBD Team will continue to engage residents at local events in addition to accessing new forms of communication, such as social media, to reach new and larger audiences within the communities of Middlesex-London.

In future seasons, the VBD Team will work to circulate vector-borne disease program messages through the Health Unit's Twitter account, to reach vast audiences within the Middlesex-London community. By using new communication methods such as Twitter, the VBD Team hopes to reach unique and larger audiences as part of the 2013 public education campaign.

The VBD Team will continue to maintain and develop operative community relations in order to better resolve; standing water concerns, effectively monitor or remediate standing water sites located on public property or to ensure information regarding WNV-positive activity is clearly communicated to stakeholders or regional partners whose local populations or residents may be directly affected.

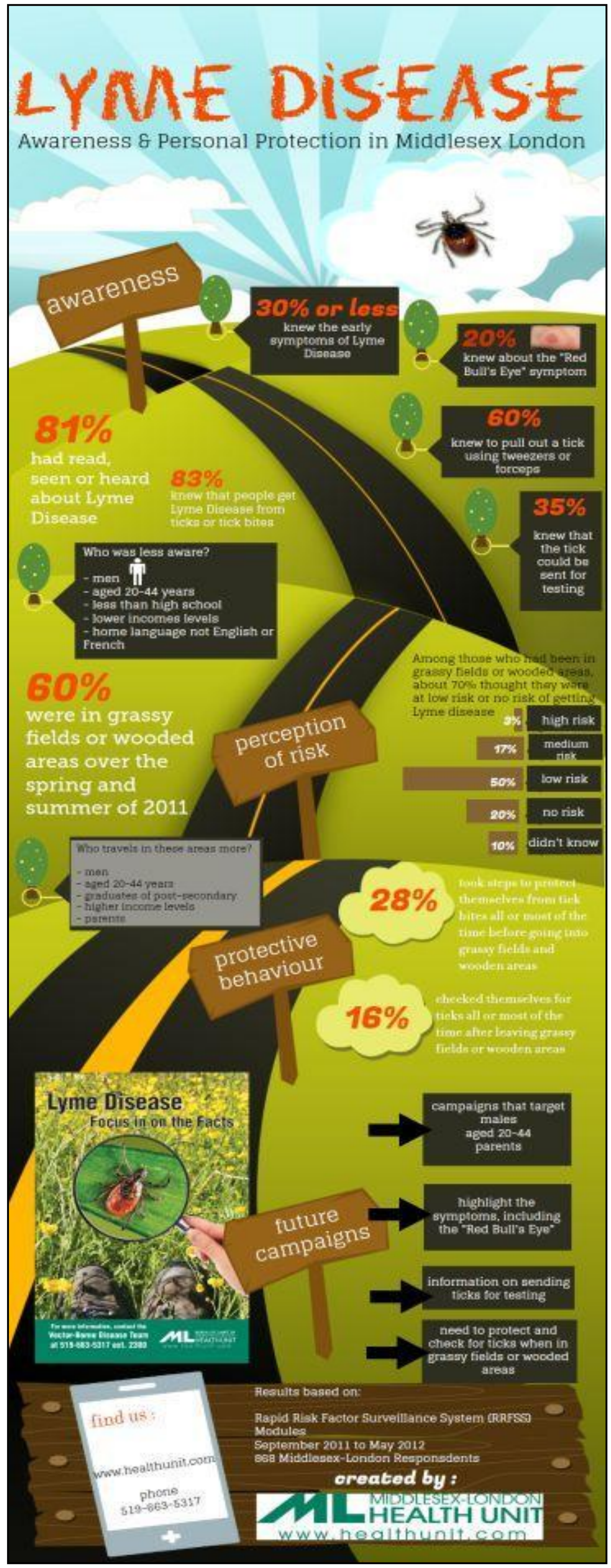

Figure 11-3: Summarized results from the RRFSS survey.

Chapter 12: Conclusions and Program Evaluation

12.1 Conclusions and Recommendations

Vector-borne diseases can be transmitted through the bite of an infected mosquito or tick. Over the past 11 seasons, the MLHU has employed a comprehensive surveillance, control and public education program to 'Reduce and Repel' insect bites which may transmit West Nile Virus (WNV), Eastern Equine Encephalitis (EEE) and/or Lyme disease (LD).

Following the 2012 season, the following conclusions and recommendations have been made:

West Nile Virus:

- This season, Middlesex-London experienced yet another season with increased viral activity with seven human cases, 17 WNV-positive mosquito traps, and 23 WNV-positive birds.

- West Nile Virus activity also increased across the province with a total of 464 WNV-positive mosquito traps for the 2012 season.

The MLHU will continue to monitor for the presence of WNV in vector mosquito populations in order to protect human health from mosquito bites and the possible transmission of West Nile Virus.

Lyme Disease:

- A total of 87 ticks were submitted to MLHU this year from January 16, 2012 to October 16, 2012.

- Ten tick submissions were identified as blacklegged ticks, three of which were positive for Lyme disease.

- One LD-positive human case was reported, which was travel-related.

- No blacklegged ticks originating from Middlesex-London were found as a result of dragging.

This season, the MLHU observed an increase in tick submissions and as a result, the number of blacklegged ticks submitted to the Health Unit also increased. Although the incidence of LD and blacklegged ticks within Middlesex-London remains low, there are still nearby regions within the province that have been identified as endemic areas. The MLHU must maintain its LD surveillance and education program in order to provide residents with protection information, tick removal strategies and information on the signs and symptoms of LD. Informative materials will continue to enhance public education strategies to bring awareness to Lyme disease when travelling to endemic regions and following exposure to a tick bite.

Eastern Equine Encephalitis:

- Eastern Equine Encephalitis is a more serious vector-borne disease. An estimated 5% of EEE infections advance to include severe encephalitic symptoms. Approximately one third (33%) of those who develop severe symptoms of encephalitis will die from the disease.

- This season, 334 EEE viral tests were performed on species identified as *Ochlerotatus canadensis*, *Coquillettidia perturbans*, and *Aedes vexans vexans*. All of these specimens tested negative when subjected to Sporometrics standardized testing for EEE.

- The MLHU saw a significant decrease in the number of adult mosquitoes that have the potential to transmit EEE infection (51% in 2011 to 31% in 2012).

- Zero specimens of the main EEE vector *Culiseta melanura* were identified in Middlesex-London in 2012.

Although EEE remains is non-existent in Middlesex-London, the MLHU will continue to follow Public Health Ontario's Viral Testing Order of Preference which places preference on the testing of four species for EEE; *Culiseta melanura*, *Ochlerotatus canadensis*, *Coquillettidia perturbans*, and *Aedes vexans vexans*.

Dead Bird Surveillance:

- This season 205 dead birds were reported to the Health Unit, a 27% increase from the number of birds reported in 2011.

- Forty-one (41) birds were suitable for testing in the Strathroy laboratory this season.

- In total, 23 birds tested positive for WNV in the Strathroy lab this season.

- WNV-positive birds served as early indicators to the MLHU that WNV was present in the community. Prior to the first five adult mosquito traps of the season being confirmed as positive, WNV-positive birds were identified. Following confirmation of WNV-positive birds, the MLHU issued media releases and informed the public how to protect against mosquito bites.

The MLHU will continue to accept dead bird submissions and perform WNV testing as the identification of WNV-positive dead birds provides important information on WNV activity in the community. In the past three seasons, dead bird surveillance has indicated the presence of WNV activity prior to adult mosquito traps being confirmed positive. This information allows the MLHU to issue media releases and to remind residents to protect against mosquito bites.

Larval Mosquito Surveillance:

- *Culex restuans* and *Culex pipiens* were the most abundant vector species identified once again this season.

- *Culex territans* was the most abundant non-vector species identified this season and should be monitored closely since they have been identified with virus-carrying capabilities in the United States.

Monitoring larval mosquito species is an important aspect of the MLHU's VBD Program. As populations of vector mosquito larvae continue to increase each season, the MLHU should maintain its current larval surveillance schedule and begin monitoring standing water in the early spring. The MLHU should also continue to monitor the composition of vector larvae collected from Parkhill to try and mitigate the spike in adult mosquito populations that was experienced in 2011.

Storm Water Management Facilities (SWMFs):

- In 2012, 1,788 visits were made to SWMFs, comprising 36% of all standing water visits.

- Overall, 7,152 larvae were identified from samples collected from SWMFs. Approximately 34% of all larvae identified in 2012 were from SWMFs within Middlesex-London.

The MLHU should continue to monitor SWMFs, as mature sites develop more vegetation and organic content, creating more favourable habitats for larval mosquito development.

Environmentally Sensitive Areas (ESAs):

- Approximately 300 hectares of environmentally sensitive area were monitored by the MLHU this season.

- Overall, 2,937 mosquito larvae were identified from samples collected in ESAs this season.

- Although standing water within Westminster Ponds ESA was treated regularly throughout 2012, Sifton Bog was only treated twice throughout the 2012 season.

- Sifton Bog experienced a considerable decline in standing water, resulting in fewer mosquito larvae collected and fewer standing water treatments overall.

- This season a high number of the non-vector species *Culex territans* were identified making it the most abundant species collected from ESAs this season, a contrast from past seasons when *Culex pipiens* and *Culex restuans* were the most common species identified in ESAs.

The MLHU should continue its surveillance and treatment of vector mosquito species within ESAs. Although this season the MLHU observed fewer mosquito larvae due to decreased precipitation, the MLHU should continue to monitor larval mosquito populations as changing conditions can present a season with more standing water and/or increased vector mosquito compositions, which would require greater control efforts.

Adult Mosquito Surveillance:

- Overall there were 18,464 adult mosquitoes collected in both terrestrial and canopy traps this season.

- Ninety-four (94%) of all adult mosquitoes identified were vector species capable of transmitting WNV and/or EEE. This is an increase from the composition of vectors in 2011, which was 85%.

- The MLHU observed a decrease in adult mosquitoes collected this season, however 2012 was still one of the most active seasons in terms of WNV-positive activity. Despite fewer mosquitoes collected, the MLHU observed one of the highest vector ratios, in both terrestrial and canopy traps and also increased WNV-positive activity in adult mosquitoes.

- A significant decrease in adult mosquitoes was observed in North Middlesex this season, with a decrease of approximately 108,000 mosquitoes from traps located in Parkhill.

- Seventeen (17) WNV-positive mosquito traps were confirmed this year. Ten positives were from terrestrial traps, and seven positives were from canopy traps.

This season, 17 WNV-positive mosquito traps were confirmed by the MLHU's service provider, Sporometrics. Since WNV positive activity was identified in both canopy and terrestrial traps. The MLHU should continue to monitor adult mosquito populations in order to identify and report positive activity to residents of Middlesex-London.

Human Surveillance:

- In 2012, there were seven human WNV-cases reported within Middlesex-London.
- This season there was one human case of LD reported. The case was travel-related.
- Although the risk of acquiring Lyme disease is low in Middlesex-London, it is possible to acquire LD from an infected tick anywhere in Canada. The number of blacklegged ticks submitted to the MLHU this season increased, therefore residents of Middlesex-London should take particular care in protecting against tick bites and checking for ticks when travelling to endemic regions or when spending time in grassy fields or wooded areas.

Human surveillance of Lyme disease and West Nile Virus is important for understanding the clinical course of infection that these vector-borne diseases can take. With a combination of human, mosquito, tick, and bird surveillance the MLHU is able to thoroughly monitor the presence of WNV, LD and EEE in the community. The MLHU will also continue to monitor emerging tick populations in nearby regions. It is also important that the MLHU continue to educate residents on how to protect against tick and mosquito bites in the first place, while at the same time, ensuring the public knows the symptoms of WNV and LD so that they can be recognized if an insect bite does occur.

Mosquito Control:

- In 2012, 1,047 treatments were performed at 229 sites monitored by the MLHU and its service provider.
- Fifty-five (55) of the 229 sites were treated ten or more times this season, an increase from 34 sites which were treated frequently in 2011.
- This season's most frequently treated sites were in areas identified as having WNV activity; Huron Conservation Area in North-East London and Pond Mills Storm Water Management Facility in South-East London.
- This season there were 20 applications of Altosid® granules to standing water located in the City of London's pollution control plants.

The MLHU will continue to monitor larval mosquito populations in standing water, and perform larvicide treatments when vector mosquito larvae are identified. This Integrated Pest Management system allows the MLHU to target known vector species in order to reduce the number of adult mosquitoes that emerge and have the potential to transmit WNV infection. The MLHU will also monitor environmental data following larvicide treatment in order to evaluate product efficacy and the impact of larvicide use on non-target populations. In 2012, the MLHU did not observe any adverse effects on local aquatic invertebrates or mammal populations or their habitats in the peripheral pools which were monitored and/or treated.

The MLHU will continue to encourage source reduction, when possible, as an alternative to larvicide treatment. This season, the MLHU observed the remediation of several sites located in North Middlesex and continues to encourage remediation whenever possible as this provides permanent removal of standing water, reduces mosquito breeding sites, and reduces the amount of larvicide used over the course of a season.

Catch Basin Treatment:

- This season, a total of 87,732 catch basins in Middlesex-London were treated in three rounds.
- In 2012, 933 Altosid® XR Briquettes were applied to non-roadside catch-basins, which included: catch basins located in backyards of residential homes [93]; catch basins located in municipal green-spaces [260]; and catch basins located on sites such as government buildings, social housing units, and long-term care facilities [654].
- Catch basins were primarily treated with Altosid® pellets or briquettes, which are Methoprene products and/or VectoLex® pouches.

Catch basin treatment remains an important part of the VBD Program. Treatment of catch basins provides successful reduction of mosquito larvae which proliferate in these structures due to their warm, ideal organic environments, which provide optimal breeding conditions.

Complaints, Comments and Concerns (CCCs):

- In 2012, the MLHU received and responded to a total of 364 complaints, a 5% increase from the 343 reported in 2011.
- Dead bird reporting was the most frequent type of concern, representing 56% of all CCCs this season.

- There was an increased number of tick submissions this season, which can be attributed to the MLHU's public education messages encouraging residents to protect themselves when travelling to endemic regions, to check themselves for ticks following any time spent in long grass or wooded areas and to submit ticks to the Health Unit when they are found on humans. Key messages and educational brochures outlined how to properly remove a tick and where to submit ticks for identification.

The MLHU will continue to encourage public participation in the VBD program, with the reporting of dead birds, ticks and standing water concerns. Continuing to promote WNV and LD awareness through public education campaigns will also increase public participation and awareness of the VBD Team's services. The MLHU will continue to educate residents on how to properly remove ticks and submit them to the Health Unit. It is important that the public know the most common places to look for ticks, how to remove them and/or how to protect themselves against acquiring a tick when travelling to endemic regions.

2012 Weather Trends:

- This season, Middlesex-London experienced decreased snowmelt following a temperate winter combined with relatively dry spring months. This season's weather was quite different from 2011 when increased snowmelt and floodwater created spikes in populations of the *Ochlerotatus* blacklegged species of mosquito causing particular discomfort to residents of North Middlesex. With ongoing remediation efforts by the Municipality of North Middlesex, and continued adult mosquito trapping and standing water surveillance by MLHU staff, the number of mosquitoes observed in North Middlesex this season significantly decreased.

- When monitoring Accumulated Degree Days (ADD), greater than 100 consecutive degree days can be an indicator for WNV-positive mosquito activity, and greater than 200 degree days can be an indicator of human WNV-positive cases. This season, 168 consecutive degree days were observed prior to the first WNV-positive mosquito trap being confirmed on July 18, 2012. In total, the MLHU recorded 235consecutive degree days from June 27 to August 16, 2012. These consecutive degree days contributed to accelerating the viral incubation period required to amplify WNV within a community. During the accumulation of these degree days, the MLHU confirmed 17 WNV-positive mosquito traps, and 7 WNV positive human cases were reported.

It is important to monitor weather trends in order to better understand the implications of WNV-positive activity, the generational periods of mosquito larvae and the possible viral incubation periods within adult mosquito populations. Research has proven that one very hot season is required in order to see a year with positive WNV activity. This was by the MLHU with very high temperatures recorded in both the 2010 and 2011 seasons, in addition to record temperatures recorded throughout the summer of 2012.

Increased temperatures in previous seasons, in addition to the hot, relatively dry weather observed in 2012, are significant contributing factors to the increased WNV activity observed in Middlesex-London. In order to plan and prepare for possible WNV activity, the MLHU must continue to monitor weather trends in order to anticipate the conditions that are favourable to viral amplification, protecting the health of residents.

Public Education:

- This season the VBD Team provided educational Lyme disease materials and brochures to the annual Children's Make a Wish Foundation Golf Tournament, in addition to running commercials on Rogers TV to enhance LD awareness and ads in the City of London's Waste Reduction and Conservation calendar. Some key messages from the LD campaign were: encouraging the public to protect themselves when travelling to endemic regions; wearing insect repellent to avoid tick bites; checking for ticks after outdoor exposure; removing ticks when found on a person; and knowing where to submit ticks for identification and testing.

- Once again, the MLHU will make Lyme disease education a priority in 2013 as early results from a RRFSS survey indicate that many residents still do not know how to remove a tick, or where to submit it if one is found on a human. In order to emphasize the importance of personal protection and tick removal in order to prevent LD, the MLHU will continue to promote a multi-faceted LD-education campaign in future seasons.

- The VBD Team also participated in various community events across Middlesex-London this season which included presenting personal protection information to new moms at several of the Health Unit's *'Well Baby/Child Clinics'* held in Strathroy, Glencoe, Parkhill and Mount Brydges. The VBD Team also had a booth at the Fanshawe Dragon Boat Festival, Strathroy Turkeyfest and the Glencoe Fair this season.

- The VBD Team continued to work with the public and local officials in North Middlesex to support ongoing remediation efforts in Parkhill which included the clearing of the Cameron Gillies drain and other efforts in wetlands maintained by the Ausauble-Bayfield Conservation Authority (ABCA).

- This season, the MLHU also reached out to the public through social media. With the use of Twitter, the MLHU informed residents of WNV positive activity and reminded residents to protect themselves against insect bites and wear repellent throughout the season.

It is important that the MLHU continue to measure and enhance public education efforts in order to make informed decisions about the promotion of vector-borne disease protection and prevention messages. It is also important that the MLHU monitor how its campaigns are being received by the public, in order to adjust program planning and promotional campaigns for future seasons. The Rapid Risk Factor Surveillance System (RRFSS), utilized by the MLHU this season will help to determine the public's current awareness of Lyme disease following three years of initial Lyme disease awareness programming in Middlesex-London. The MLHU must continue to educate the community on preventive measures that protect against tick and mosquito bites, evaluate the effectiveness of these campaigns in encouraging residents to protect themselves and/or identify the signs and symptoms of WNV or LD. Following initial results of the RRFSS survey, conducted from September 2011 to May 2012, the MLHU will work to further enhance Lyme disease education strategies, promoting increased awareness about protection against bites (wearing insect repellent when in grassy field or wooded areas), proper tick removal, proper identification of symptoms associated with LD and locations that ticks can be submitted for identification/testing.

12.2 Program Evaluation

Following a review of vector-borne disease activities each season, the MLHU analyzes the VBD Program to plan the following season's surveillance. In addition field and education activities are analyzed in order to continually improve the quality of services and public education strategies the VBD Team provides to the public, other Health Unit Service Areas and the Board of Health.

There were very different weather and viral trends observed in 2012, when compared to the 2011 season. Overall in 2012, there were seven WNV-positive human cases of WNV, 17 WNV-positive mosquito traps and 23 dead birds confirmed WNV-positive in Middlesex-London. Ten blacklegged ticks were submitted to the MLHU, three of which were positive for Lyme disease. One travel-related human LD case was also reported. There was no positive EEE activity in humans, mosquitoes or horses in Middlesex-London. In addition, the MLHU observed a 20% decrease in the number EEE-vector mosquito species identified this season. There were also no specimens of *Culiseta melanura* collected in adult or larval form this season.

- The MLHU will continue to focus on increased Lyme disease promotion to residents of Middlesex-London. Although Middlesex-London is not endemic for blacklegged ticks, the MLHU has identified that it is important to educate residents on personal protection and tick removal strategies so they are better informed when travelling to endemic regions, which are often popular family vacation destinations in the spring and summer months. The MLHU will continue to enhance its LD promotion efforts so residents have a better understanding of how to protect against tick bites, where a blacklegged tick is most likely to be acquired in Ontario, how to properly remove a tick and where to submit a tick once removed.

- Each season the MLHU has become more efficient at monitoring adult mosquito populations and identifying areas where to set up "hot-spot" traps and where to increase the number of surveillance visits. In addition, the MLHU is becoming more efficient in the lab, identifying larval mosquito samples, tick specimens and performing RAMP tests for WNV on dead crows and blue jays. The MLHU also aims to improve its work in all aspects of VBD monitoring, education and research. It strives for the utmost accuracy and advancement within the VBD Program in order to provide the very best services for vector-borne disease prevention and personal protection to the residents of Middlesex-London.

- An effective VBD Program includes a multi-faceted public education campaign that can engage local residents who, in turn, contribute to the community-wide prevention of vector-borne disease amplification and transmission. In 2013, the VBD Team would like to further enhance its public education campaign in order to reach, engage and inform a greater number of Middlesex-London residents. The MLHU would like to continue to see residents submit ticks, call in dead bird sightings, and report standing water.

- As a greater number of people continue to use smart phones and receive information through smart phone technology and various forms of social media, it has become increasingly important to engage audiences through these new forms of mobile or, ‘on the go’ communication. Social media allows a message to reach a large audience very quickly, at little to no cost (compared to traditional print advertisement campaigns). In the 2013 season, the VBD Team will work to disseminate more VBD-related messages through the Health Unit’s Twitter account, reminding residents to protect against insect bites and how to reduce and repel mosquitoes. By accessing new communication strategies, the VBD Team hopes to reach a larger audience with its 2013 public education campaign.

12.3 Final Comment

The Vector-Borne Disease Program is based on local risk assessment, minimizing the exposure of vector-borne diseases to humans within Middlesex-London.

Each season, it is important to evaluate program outcomes and seasonal surveillance data, in order to adjust monitoring, control and public education strategies. Adjustments can be based on the changing dynamics of local mosquito and tick populations, positive vector-borne disease activity, and the emergence of new tick or mosquito populations within Middlesex-London. This season, the VBD Team identified that increased promotional efforts can be focused on Lyme disease education, as not all residents are protecting against tick bites by using an insect repellent. In addition, many do not know how to remove a tick, identify the symptoms of LD, or know where to submit a tick. With more focused efforts on Lyme disease education in the 2013 season, the MLHU hopes to reach more residents of Middlesex-London who may spend time in grassy fields or wooded areas, or who travel to endemic regions which are often popular family vacation destinations for camping or hiking in the summer months.

Figure12-1: 2012 VBD Team members.

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Appendix A:
Vector and Non-vector Mosquito Species Found in Middlesex-London and Ontario

Vector Mosquito Species Identified in Middlesex-London:

Culex pipiens
Culex restuans
Culex quinquefasciatus
*Culex salinarius**
Culex tarsalis
Aedes vexans
*Coquillettidia perturbans**
*Culiseta melanura**
*Ochlerotatus canadensis**
Ochlerotatus cantator
Ochlerotatus hendersoni
Ochlerotatus trivittatus
Ochlerotatus triseriatus
Ochlerotatus stimulans
Ochlerotatus japonicus
Anopheles walkeri
Anopheles punctipennis
Anopheles quadrimaculatus

Vector Mosquito Species Identified in Ontario:

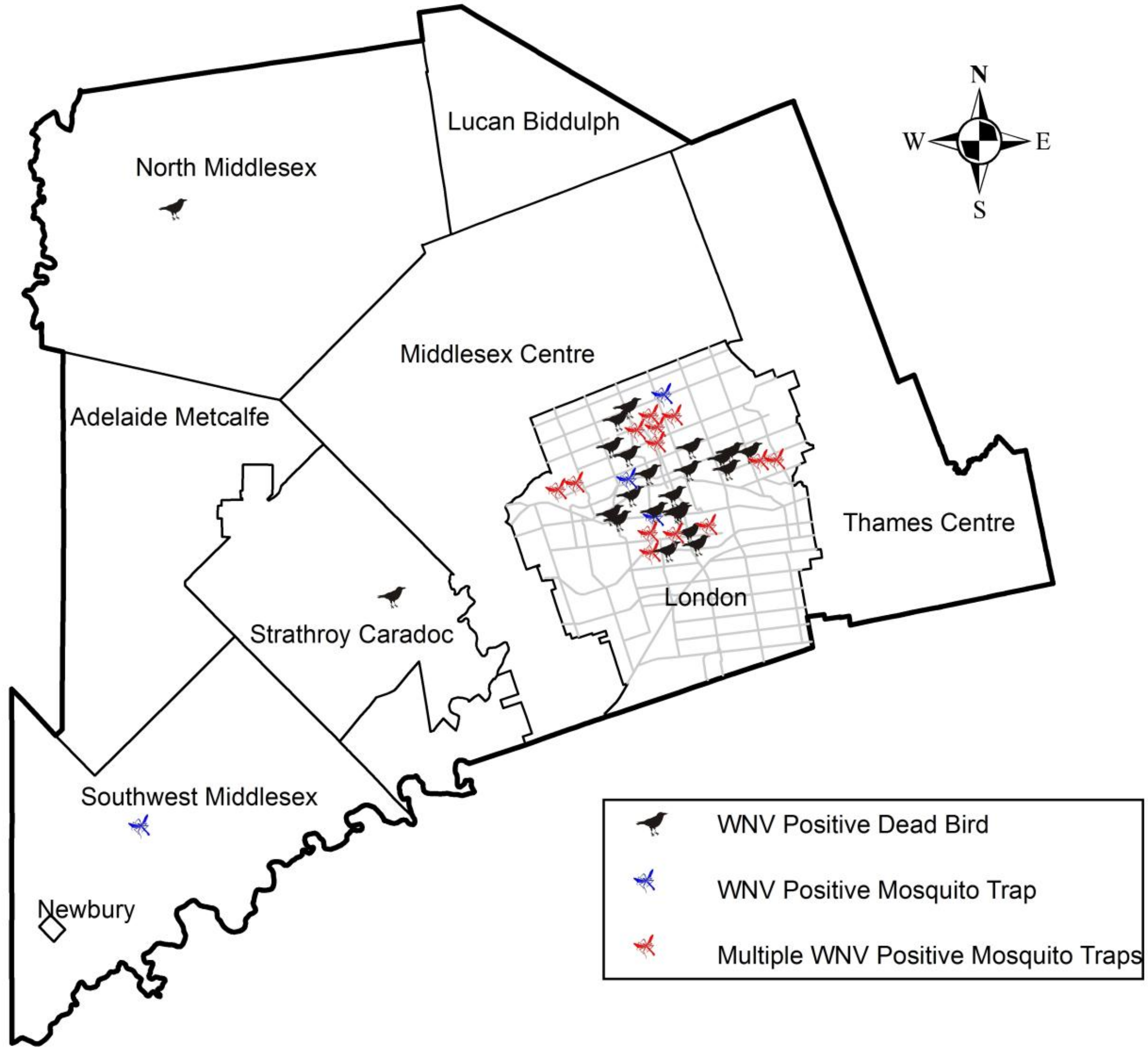
Culex pipiens
Culex restuans
Culex quinquefasciatus
*Culex salinarius**
Culex tarsalis
*Aedes albopictus (Stegomyia albopicta)**
*Aedes vexans vexans**
Aedes vexans nipponii
*Coquillettidia perturbans**
*Culiseta melanura**
*Ochlerotatus canadensis**
Ochlerotatus cantator
Ochlerotatus hendersoni
Ochlerotatus trivittatus
Ochlerotatus triseriatus
Ochlerotatus stimulans
Ochlerotatus japonicus
Ochlerotatus sollicitans
Anopheles walkeri
Anopheles punctipennis
Anopheles quadrimaculatus

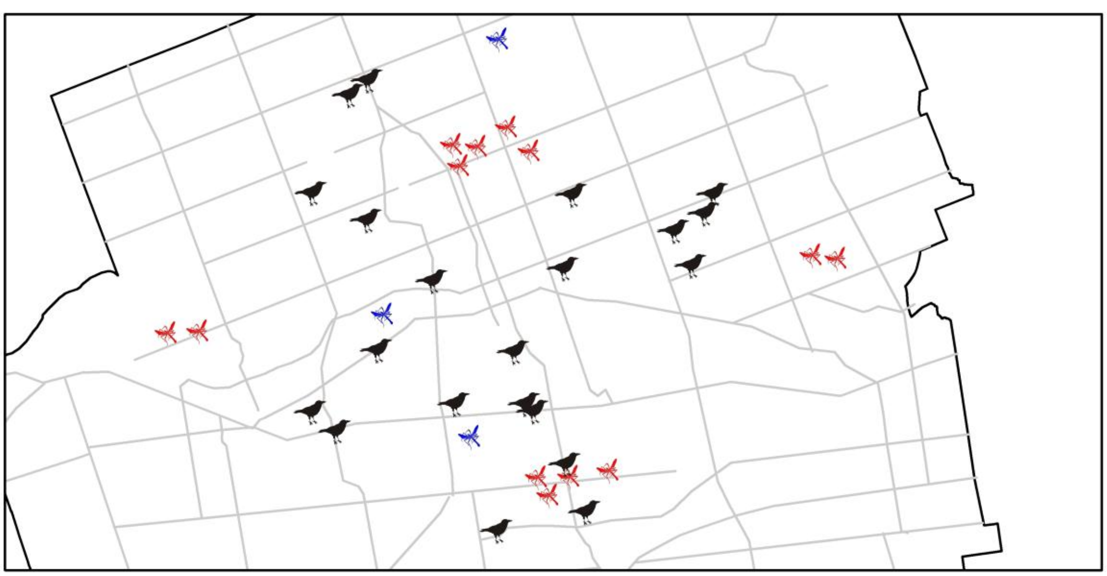
Non-vector Mosquito Species in Ontario:

Aedes cinereus
Anopheles barberi
Anopheles earlei
Anopheles perplexans
Culiseta impatiens
Culiseta inornata
Culiseta minnesotae
Culiseta morsitans
Culex erraticus
Culex territans
Ochlerotatus abserratus
Ochlerotatus aurifer
Ochlerotatus churchillensis
Ochlerotatus communis
Ochlerotatus diantaeus
Ochlerotatus dorsalis
Ochlerotatus eudes
Ochlerotatus excrucians
Ochlerotatus fitchii
Ochlerotatus flavescens
Ochlerotatus grossbecki
Ochlerotatus hexodontus
Ochlerotatus impiger
Ochlerotatus intrudens
Ochlerotatus mercurator
Ochlerotatus provocans
Ochlerotatus punctor
Ochlerotatus riparius
Ochlerotatus spencerii
Ochlerotatus sticticus
Orthopodomyia alba
Orthopodomyia signifera
Psorophora ciliata
Psorophora columbiae
Psorophora ferox
Toxorhynchites rutilus
Uranotaenia sapphirina
Wyeomyia smithii

***Vectors of WNV *and* EEE**
** Since 2002, adult mosquito trapping and larval identification has resulted in the identification of approximately 55 different mosquito species from within Middlesex-London.

Appendix B: 2012 West Nile Virus Positive Birds and Mosquito Traps





Appendix C:
Storm Water Management Facilities Monitored in 2012

Site Name	Component	Larvae Collected	Most Common Vector Species Identified
Adelaide North	F	127	*Culex pipiens, Anopheles punctipennis, An. quadrimaculatus*
Applegate	F, C	599	*Culex pipiens, Anopheles punctipennis, An. quadrimaculatus*
Beattie Street	Ch, C	230	*Culex pipiens, Cx. restuans, Aedes vexans, Anopheles punctipennis,*
Corlon	F, C	646	*Culex pipiens, Cx. restuans, Anopheles punctipennis,*
Cranbrook	F, C	172	*Culex pipiens, Aedes vexans, Ochlerotatus japonicus, Anopheles punctipennis,*
Crestwood	F, C	676	*Culex pipiens, Ae. vexans, Oc. japonicus, An. punctipennis, An. quadrimaculatus*
Commissioner's Road	C	117	*Culex pipiens, Cx. restuans, Anopheles punctipennis, An. quadrimaculatus*
Dorchester	F1, F2, C	411	*Culex pipiens, Cx. restuans, Anopheles punctipennis, An. quadrimaculatus*
Duncarin	F, C	93	*Culex pipiens, Anopheles punctipennis, An. quadrimaculatus*
Evans Boulevard	F, C	17	*Culex pipiens, Cx. restuans, An. quadrimaculatus*
Fanshawe Ridge North	F, C	321	*Culex pipiens, Cx. restuans, Anopheles punctipennis, An. quadrimaculatus*
Ilderton - Meredith Drive	F	352	*Culex restuans, Aedes vexans, Anopheles punctipennis, An. quadrimaculatus*
Ilderton - Meadowcreek	F, C	538	*Culex pipiens, Anopheles punctipennis, An. quadrimaculatus*
Ilderton- King Street	F	Nil	*Nil*
Hamilton Road	C	260	*Culex pipiens, Cx. restuans, Anopheles punctipennis, An. quadrimaculatus*
Hunt Club	F, Ch, C	482	*Culex pipiens, Cx. restuans, Oc. japonicus, An. punctipennis, An. quadrimaculatus*
Killaly I	F	333	*Culex pipiens, Cx. restuans, Aedes vexans,*
Killaly II	F, C	142	*Culex pipiens, Cx. restuans, Anopheles punctipennis, An. quadrimaculatus*
Manning Dump	F1, F2	106	*Anopheles punctipennis, An. quadrimaculatus*
Meadowlilly Woods	F,C	117	*Culex pipiens, Cx. restuans, Anopheles punctipennis, An. quadrimaculatus*
Meander Creek	F	157	*Culex pipiens, Anopheles punctipennis, An. quadrimaculatus*
Mornington	F, C	99	*Culex pipiens, Cx. restuans, Anopheles punctipennis, An. quadrimaculatus*
North Lambeth	F, C	439	*Culex pipiens, Cx. restuans, Anopheles punctipennis, An. quadrimaculatus*
Parkview	F1, F2	202	*Culex pipiens, Cx. restuans, Anopheles punctipennis, An. quadrimaculatus*
Parkwood	F, C	NIL	*Nil*
Pinecourt	F, C	539	*Culex pipiens, Cx. restuans, Anopheles punctipennis, An. quadrimaculatus*
Pond Mills	F, Ch	1,727	*Culex pipiens, Cx. restuans, Ae. vexans, An. punctipennis, Oc. japonicus*
River Road	F	297	*Culex pipiens, Cx. restuans, Ae. vexans , An. punctipennis, An. quadrimaculatus*
Jack Nash	F	849	*Culex pipiens, Cx. restuans, Anopheles punctipennis, An. quadrimaculatus*
Saintsbury	F	78	*Culex pipiens, Ae. vexans , An. punctipennis, An. quadrimaculatus*
Lowe's SWMF	F, C	821	*Culex pipiens, Cx. restuans, Oc. japonicus, An. punctipennis, An. quadrimaculatus*
Third Street	F	155	*Culex pipiens, Cx. restuans, Oc. japonicus*
South River	F, C	518	*Culex pipiens, Cx. restuans, An. punctipennis, An. quadrimaculatus*
South Wenige	F,C	102	*An. punctipennis, Culex territans, Cx. pipiens,*
South Wenige 2	F, C	42	*Culex pipiens, Cx. restuans, An. punctipennis*
Summercrest	F, C	513	*Culex pipiens, Cx. restuans, Oc. japonicus, An. punctipennis, An. quadrimaculatus*
Talbot Village	F, C	Nil	*Nil*
Ted Earley Park	Ch, C	581	*Culex pipiens, Cx. restuans, An. punctipennis, An. quadrimaculatus*
Thornhead	F, C	1,131	*Culex pipiens, Cx. restuans, Ae. vexans, An. punctipennis, Oc. japonicus*
Turnberry	F,C	348	*Culex pipiens, Cx. restuans, An. punctipennis, An. quadrimaculatus*
Upland Hills	F1, F2, C	376	*Culex pipiens, Cx. restuans, Ae. vexans , An. punctipennis, An. quadrimaculatus*
White Oak	F,C	201	*Culex pipiens, Cx. restuans, An. punctipennis, An. quadrimaculatus*
Wilton Grove Road	F	107	*Culex pipiens, An. punctipennis, An. quadrimaculatus*

F= forebay C= cell Ch= channel

Appendix D:
Adult Mosquito Trap Names and Locations

Trap Name	Trap Type	Location	Total Mosquitoes Collected	Number of Positive Mosquito Traps
Trap A (Dorchester)	Terrestrial	Dorchester	382	-
Can 5 (Dorchester)	Canopy	Dorchester	275	-
Trap J (Glencoe)	Terrestrial	Glencoe	1035	***1 positive***
Trap H (Parkhill)	Terrestrial	Parkhill	983	-
Trap H-A (Parkhill)	Terrestrial	Parkhill	400	-
Can 10 (Parkhill)	Canopy	Parkhill	355	-
Trap I (Strathroy)	Terrestrial	Strathroy	398	-
Trap G (Lambeth)	Terrestrial	London	269	-
Trap O (Exmouth)	Terrestrial	London	307	***2 positives***
Trap L (Glenora)	Terrestrial	London	154	***1 positive***
Trap D (Greenway)	Terrestrial	London	264	***1 positive***
Can 3 (Greenway)	Canopy	London	80	-
Trap F (Upper Thames)	Terrestrial	London	121	-
Can 6 (Upper Thames)	Canopy	London	105	-
Trap N (CC Mews)	Terrestrial	London	338	-
Can 7 (CC Mews)	Canopy	London	68	***1 positive***
Trap C (Dearness)	Terrestrial	London	8544	***3 positives***
Can 2 (Dearness)	Canopy	London	950	***1 positive***
Trap Q (Warbler Woods)	Terrestrial	London	190	-
Trap S (Sifton)	Terrestrial	London	248	-
Can 12 (Sifton)	Canopy	London	168	***2 positives***
Trap M (Huron Conservation Area)	Terrestrial	London	2119	***2 positives***
Can 8 (Huron Conservation Area)	Canopy	London	532	***3 positives***
MM-12	Hotspot	London	0	-
NN-12	Hotspot	London	11	-
OO-12	Hotspot	London	17	-
PP-12	Hotspot	London	5	-
QQ-12	Hotspot	London	32	-
RR-12	Hotspot	London	30	-
SS-12	Hotspot	London	14	-
TT-12	Hotspot	London	9	-
UU-12	Hotspot	London	0	-
VV-12	Hotspot	London	32	-
WW-12	Hotspot	London	0	-
XX-12	Hotspot	London	6	-
YY-12	Hotspot	London	3	-
ZZ-12	Hotspot	London	20	-

Trap Type	Description
Terrestrial	Adult mosquito trap set 4 to 6 feet off the ground, also known as a “ground trap”.
Canopy	Adult mosquito trap set up on a rope and pulley system attached to a large tree branch, raised 13 to 20 feet off the ground.
Hotspot	Adult mosquito trap set up within a 2km radius of any WNV-positive bird, mosquito or human case confirmation.

Appendix E:
Criteria for Diagnosis and Classification of West Nile Virus Cases

Clinical Criteria for Diagnosis of WNV (WNV)

(with excerpts from the Ministry of Health and Long Term Care's Infectious Disease Protocol, 2013)

West Nile Virus Neurological Syndrome (WNNS) Diagnostic Criteria

- History of exposure in an area where WNV activity is occurring **OR**
- History of exposure to an alternative mode of transmission (i.e. lab-acquired, in utero; receipt of blood components, organ/tissue donation; possibly via breast milk)

AND

- Onset of fever

AND recent onset of at least **one** of the following:

- Encephalitis, viral meningitis, acute flaccid paralysis, movement disorder, Parkinsonism or Parkinsonism-like disorders, or other neurological symptoms (as defined by the PHAC)

West Nile Non-Neurological Syndrome (WN Non-NS) Diagnostic Criteria

- History of exposure in an area where WNV activity is occurring **OR**
- History of exposure to an alternative mode of transmission
- **AND** at least **two** of the following:
- Fever, myalgia, arthralgia, headache, fatigue, lymphadenopathy, or maculopapular rash

West Nile Virus Asymptomatic Infection (WNAI) Diagnostic Criteria

- **There is an absence of clinical criteria in WNAI

Laboratory Criteria for Diagnosis of WNV

(with excerpts from the Ministry of Health and Long Term Care's Infectious Disease Protocol, 2013)

Probable Case Laboratory Criteria:

At least **one** of the following:

- Detection of flavivirus antibodies in a single serum or CSF sample using a WN virus IgM ELISA without confirmatory neutralization serology (e.g. Plaque Reduction Neutralization Test -PRNT) **OR**
- A 4-fold or greater change in flavivirus HI titres in paired acute and convalescent sera or demonstration of a seroconversion using a WN virus IgG ELISA **OR**
- A titre of > 1:320 in a single WN virus HI test, or an elevated titre in a WN virus IgG ELISA, with a confirmatory PRNT result **OR**
  [Note: A confirmatory PRNT or other kind of neutralization assay is not required in a health jurisdiction/authority where cases have already been confirmed in the current year]
- Demonstration of Japanese encephalitis (JE) serocomplex-specific genomic sequences in blood by NAT screening on donor blood, by Blood Operators in Canada.

Confirmed Case Laboratory Criteria:

At least **one** of the following:

- A 4-fold or greater change in WN virus neutralizing antibody titres (using a PRNT or other kind of neutralization assay) in paired acute and convalescent sera, or CSF **OR**
- Isolation of WN virus from, or demonstration of WN virus antigen or WN virus-specific genomic sequences in tissue, blood, CSF or other body fluids **OR**
- Demonstration of flavivirus antibodies in a single serum or CSF sample using a WN virus IgM ELISA, confirmed by the detection of WN virus specific antibodies using a PRNT (acute or convalescent specimen) **OR**
- A 4-fold or greater change in flavivirus HI titres in paired acute and convalescent sera or demonstration of a seroconversion using a WN virus IgG ELISA AND the detection of WN specific antibodies using a PRNT (acute or convalescent serum sample).

Case Classification of WNV

(with excerpts from the Ministry of Health and Long Term Care's Infectious Disease Protocol, 2013)

WNNS and WN Non-NS Case Classification Criteria

Suspect

- Clinical criteria AND absence or pending laboratory criteria AND absence of any other obvious cause

Probable

- Clinical Criteria AND at least one of the probable case laboratory criteria

Confirmed:

- Clinical criteria AND at least one of the confirmed case laboratory criteria

WNAI Case Classification Criteria

Probable:

- Probable case laboratory criteria AND absence of clinical criteria

Confirmed:

- Confirmed case laboratory criteria AND absence of clinical criteria

Appendix F:
Standing Water Sites Treated 10 or More Times in 2012

>20 Treatments	Site Name	Component
CCMM017 & 053	Huron Conservation Area	Woodland Pool & Ditch
CCMM006	Graham Place Park	Field Pool
HULON062 & 063	Pond Mills SWMF	Forebay & Channel
HUTC007 & 008	Turnberry Drive SWMF	Forebay & Cell
HUSC011 & 012	Thornhead SWMF	Forebay & Cell
HULON013 & 014	Applegate SWMF	Forebay & Cell
18 Treatments		
CCMM060	1324 Adelaide Street	Woodland Pool
16 Treatments		
HULON066	Hamilton Road SWMF	Cell
HUTC002	Millpond Dorchester	Pond
HULON002	Storybook Frog Pond	Pond
15 Treatments		
HULON004	Southwest Optimist Park	Ditch
CCMM072	Watson Park	Woodland Pool
HUSWM008	Dundonald Road, Glencoe	Ditch
CCMM021	Edward Baker Park	Field Pool
HULON001	800 Springbank Drive	Pond
HULON030	Beaver Pond	Woodland Pool
HULON004	Lowe's SWMF	Cell
HULONESA04	Westminster Ponds Zone 2	Woodland Pool
14 Treatments		
HULOM031	Jack Nash Terrace	Forebay
CCMM040	West Lions Park	Woodland Pool
CCMM056	Cavendish Park	Woodland Pool
HULON048	Fanshawe Ridge SWMF	Cell
13 Treatments		
HULON067	River Road SWMF	Forebay
HULON060	South River SWMF	Cell
12 Treatments		
HUNM018	Mill Craig Street Parkhill	Ditch
CCMM003	651 Southdale Road	Ditch
HULON012	8435 Longwoods Road	Ditch
HUSC009	Parkview Drive SWMF	Forebay
HULON005	Crestwood SWMF	Forebay
HUMC001	Weldon Park	Field Pool
HULONESA05	Westminster Ponds Zone 3	Woodland Pool
11 Treatments		
HULON021	White Oak SWMF	Forebay
HULON044	Upland Hills SWMF	Forebay
CCMM038	Ted Early SWMF	Forebay
HUMC010	Coldstream Conservation Area	Woodland Pool
HUNM010	King Street Ravine Parkhill	Ditch
HUSC015	Millpond Strathroy	Woodland Pool
HUMC015	23195 Nairn Road, Lobo	Ditch
HUNM023	Union Street Parkhill	Woodland Pool
HULON027	Hunt Club SWMF	Cell
CCMM016	1742 Hyde Park Road	Ditch
HULON010	Summercrest SWMF	Forebay
10 Treatments		
HULON007	Buttonbush Swamp	Woodland Pool
HULON057	City Wide Sports Park	Plunge Pool
HUMC003	Denfield Road	Ditch
HULON017	North Lambeth SWMF	Cell
HULON011	Summercrest SWMF	Cell
HULON037	Sunningdale Road Pond	Pond
HULON070	Glenora Drive	Woodland Pool
HUSC006	Victoria Centennial Park	Woodland Pool

Appendix G: 2012 Catch Basin Flyer

MIDDLESEX-LONDON HEALTH UNIT

CATCH BASIN TREATMENT 2012

Why treat catch basins?

Catch basins are a significant breeding site for vector mosquitoes such as *Culex pipiens*, the most competent mosquito species to carry and transmit West Nile Virus. Treating catch basins will prevent larvae from maturing into adult mosquitoes and will reduce the risk of amplification and spread of the virus into the human population.

How will I know if the catch basins in my area have been treated?

Each catch basin will be assigned a colour based on the treatment status (see table below). Canadian Centre for Mosquito Management Inc. will treat catch basins in every urban center in the Middlesex-London region approximately 3-4 times between June and September. The method of control used will depend on the area. Catch basins within 50m of an outfall to water bodies such as streams, lakes and wetlands are considered sensitive and will be treated with the biological larvicide, bacillus sphaericus water soluble pouches. If the catch basin is not near an outfall, the pesticide methoprene will be used for treatment. Treatment will involve the use of 30-day methoprene pellets for most public catch basins. A 120-day methoprene briquette will be used in rear yard catch basins, park catch basins and other areas that may be difficult to access. Dry catch basins will not be treated. For further information, please contact the Middlesex-London Health Unit Strathroy office at (519) 245-3230.

TREATMENT COLOUR CODES	
Purple	Treatment #1
White	Treatment #2
Orange	Treatment #3
Pink	Sensitive Area
Brown	Methoprene Briquette