

# COMPREHENSIVE MOSQUITO SURVEILLANCE AND CONTROL PLAN

2016



The City of New York  
DEPARTMENT OF HEALTH AND  
MENTAL HYGIENE

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## **PREFACE**

This plan summarizes New York City's Mosquito Control Program. The program's goal is to prevent New Yorkers from getting sick with mosquito-borne diseases. New York City's Mosquito Control program is overseen by the New York City Health Department's Office of Vector Control and Surveillance.

At this time, West Nile virus is the only locally transmitted mosquito-borne disease in New York City. In 1999, West Nile virus first appeared in the United States, in Queens. Most people infected with the virus have no symptoms. Of those who develop symptoms, most get better on their own, but in rare cases the virus can cause inflammation of the spinal cord and brain.

Health experts are planning for the possibility the Zika virus, which is spread by certain types of mosquitoes, could also affect New York City. The steps outlined in this plan help control all mosquito populations and prevent all mosquito-borne diseases. If the Zika virus is found in local mosquito populations, the City will amplify these measures.

To reduce the risk of West Nile virus and other mosquito-borne diseases, the New York City Health Department uses integrated pest management (IPM). IPM is safer and more effective than other pest control methods; it takes away the things pests need to survive, such as food, water, shelter and ways to get around.

Each mosquito season, the Health Department takes these pest control steps:

- Reducing mosquito breeding by removing standing water and applying larvicide to sites that cannot be emptied or drained. Larvicides are pesticides that affect only mosquitoes and are harmless to people.
- Working with the public to reduce standing water through public outreach/education and by investigating complaints about mosquito breeding sites and standing water to 311.
- Monitoring mosquito populations and disease. When monitoring data shows an increased risk of disease, the Health Department spays pesticides to control adult mosquitoes. These applications are carefully planned and conducted to avoid human exposure to the pesticides.

This document explains the technical steps of mosquito control. It is intended for pest control professionals.

For general health guidance on how to prevent mosquito bites, visit [nyc.gov/health](https://www.nyc.gov/health) and search **mosquitoes**.

## **EXECUTIVE SUMMARY**

In 1999, New York City (City, NYC) experienced an unprecedented outbreak of encephalitis caused by West Nile (WN) virus, a mosquito-borne virus never before detected in the Western Hemisphere. That year, 59 cases of neuroinvasive disease (encephalitis, aseptic meningitis or acute flaccid paralysis) due to WN virus occurred in the New York City metropolitan region. Since 1999, WN virus has reappeared in New York City each year during the adult mosquito season. A total of 288 human cases of WN neuroinvasive disease (primarily encephalitis, aseptic meningitis, or acute flaccid paralysis), including 42 deaths, have occurred among New York City residents from 1999-2015. Human cases of WN fever (a less severe form of disease) have also been reported (n=67), although the estimated number of undetected or unreported WN fever cases is much higher over the same time period. Over the past sixteen mosquito seasons, WN virus has established itself in most of the continental United States, emerging as a major public health problem, and causing large outbreaks of neuroinvasive disease since 2002. Last year 2,060 human cases of WN viral disease, including 119 deaths, were identified nationwide.

The Department of Health and Mental Hygiene (DOHMH) routinely analyzes surveillance and control data from previous years in order to better prepare for the upcoming mosquito season. To ensure a coordinated approach in managing mosquito-borne disease outbreaks in the City, DOHMH has worked closely with the New York State Departments of Health (NYSDOH) and Environmental Conservation (NYSDEC), the U. S. Centers for Disease Control and Prevention (CDC), and local agencies such as the Mayor's Offices of Operations (MOO) and Environmental Coordination, the New York City Office of Emergency Management (OEM), Departments of Environmental Protection (DEP), Parks and Recreation (Parks, DPR), Sanitation (DSNY), Police (NYPD), Citywide Administrative Services (DCAS), Information Technology and Telecommunications (DIIT) and the New York City Housing Authority (NYCHA).

The key to DOHMH's planning efforts is a primary emphasis on prevention. DOHMH devotes considerable resources to a citywide effort to prevent mosquito breeding, while enhancing existing disease surveillance, and public and medical provider education activities. The goal of this plan is to prevent diseases transmitted by mosquitoes through aggressive source reduction and larviciding. If surveillance findings indicate that a substantial risk exists for WN virus transmission to humans; adult mosquito control (adulticiding) is considered.

Surveillance data collected from 2000-2015 demonstrate that WN virus can be detected in mosquitoes weeks before there is a significant risk to human health. Therefore, routine surveillance of mosquito populations provides the City the opportunity to specifically target those neighborhoods and communities where the virus is reappearing or newly appearing. The goal of early detection is to enhance mosquito control in high-risk areas in an attempt to interrupt the amplification of the virus before it has a significant impact on human health.

Although mosquitoes are active in New York City from April through October, our strong mosquito prevention, surveillance and control efforts are year-round activities. The current Comprehensive Mosquito Surveillance and Control Plan is based on the principles of Integrated Pest Management. This plan is designed to minimize the impact of mosquito-borne

diseases through citywide surveillance measures and an integrated approach to mosquito management with control practices that are commensurate with the risk posed. The comprehensive nature of the plan ensures the efficacy of the control measures while minimizing potential adverse impacts to the environment and human health from these measures. Below is a brief summary of the components of the plan:

### **Integrated Pest Management**

Integrated Pest Management or IPM is defined as “a decision support system for the selection and use of pest control tactics, singly or harmoniously coordinated into a management strategy, based on cost/benefit analyses that take into account the interests of and impacts on people, society, and the environment” [Modified from Bajwa, W. I. and M. Kogan. 2002. Compendium of IPM Definitions (CID) - What is IPM and how is it defined in the Worldwide Literature? IPPC Publication No. 998, Integrated Plant Protection Center (IPPC), Oregon State University, Corvallis, OR 97331, USA]

The objective of the DOHMH WN Virus IPM Program is “to prevent or reduce human cases of WN virus in the City”. IPM, especially for WN virus, involves using all the tools available for prevention and control of mosquitoes and WN virus. Key components of WN virus IPM include community outreach and education, prevention of biting of humans by vectors (infected mosquitoes), surveillance and control (non-chemical considered first and if a chemical pesticide is used that it be the lowest toxicity pesticide that is efficacious on mosquitoes

### **Public Education and Community Outreach**

The Office of Vector Surveillance and Control (OVSC) conducts public education and community outreach through the media, advertising, presentations to community groups, collaboration with community boards and elected officials, and weekly posting of neighborhood level surveillance data and maps on the Department’s website visit [nyc.gov/health](http://nyc.gov/health) and search **mosquitoes**. OVSC works in collaboration with the Offices of Intergovernmental and Public Affairs within DOHMH Bureau of Communications to increase public awareness of mosquito-borne disease risk, surveillance, prevention and control. If surveillance data indicate a possible increase in human disease risk that requires the application of pesticides to control adult mosquitoes, accurate and timely information of these mosquito control activities will be provided to the public. Communications will provide the public with application schedules, the type of pesticides being used and how to reduce exposure. Additionally, the public will be informed about what to do in the event of pesticide exposure.

### **Human Surveillance and Provider Education**

The DOHMH system for detecting mosquito-borne diseases among humans includes passive surveillance for cases of viral encephalitis and aseptic meningitis in hospitals (considered to be suspect cases of WN viral illness during peak mosquito season), and required reporting of laboratory results indicating current WN infection. Health care providers play a critical role in the detection, prevention and clinical management of mosquito-borne diseases. Advisories are sent at the beginning of the season and periodically throughout the season by e-mail to all

hospitals and providers in New York City. The DOHMH's Bureau of Communicable Disease makes ongoing efforts to educate New York City health care providers regarding diseases transmitted by mosquitoes, especially WN virus, dengue virus and Chikungunya, and encourages reporting and testing of patients with encephalitis, aseptic meningitis, fever syndromes compatible with WN fever, and other diseases possibly caused by arboviral infection. While providers are encouraged to pursue testing using commercial laboratories, the DOHMH Public Health Laboratory (PHL) can test blood and cerebrospinal fluid samples for WN virus in special situations. Providers can also submit specimens directly to the New York State Department of Health for WN virus PCR testing as well as additional testing for other arboviruses.

### **Management of Mosquito Populations in New York City**

DOHMH's OVSC utilizes IPM techniques to manage mosquito breeding sites by eliminating, where practical, sources of standing water and treating with biological larvicides to kill the immature larval mosquitoes in areas of standing water that cannot be completely drained. DOHMH actively emphasizes, through public education and outreach efforts, the need to eliminate or report standing water. DOHMH conducts inspections following complaints of standing water and actively conducts surveillance for standing water and the presence of larvae. Mosquitoes trapped from all over the City are regularly tested for WN virus throughout the spring, summer and early fall.

### **Mosquito Surveillance**

OVSC monitors mosquitoes citywide by collecting larval and adult mosquitoes to determine distribution, density and species. DOHMH will continue to test adult mosquitoes collected in the City for WN virus at its Public Health Laboratory. With testing taking place locally, the time required to receive results is minimized allowing for increased public education, more focused mosquito-breeding reduction activities as well as more targeted control of larval and mosquitoes in areas with increased viral activity.

### **Larval Mosquito Control**

DOHMH will reduce mosquito breeding through the aggressive elimination of standing water and the application of larvicide to sites that cannot be emptied or drained. Through a public information campaign, DOHMH will urge residents to eliminate breeding sites around their homes and commercial properties and to report potential standing water in their neighborhoods. DOHMH will collaborate with elected officials, other City agencies and large property owners to eliminate standing water in empty lots, tire piles and other containers. DOHMH will also aggressively enforce the NYC Health Code that requires elimination of standing water from properties throughout the City. These activities will be augmented with the application of larvicide to potential breeding sites where water cannot be eliminated, including catch basins citywide. When WN virus is detected in an area, DOHMH will increase public education, breeding site reduction and larviciding.

## **Adult Mosquito Control**

A timely and appropriate response to mosquito and human surveillance findings is key to preventing an outbreak of human disease. DOHMH will implement a phased response to surveillance findings that will expand education, prevention and control activities in relation to the threat of an outbreak of human disease. If surveillance indicators meet established thresholds indicating that the level of WN virus activity poses a significant threat to human health, adult mosquitoes will be controlled through the use of adulticides. Mosquito density and distribution, mosquito species, persistence of WN virus activity, weather, time of year, and the proximity to human populations will be carefully considered in determining the necessity for adult mosquito control. The accuracy, quality and efficacy of the adulticide application will be closely monitored to ensure compliance with Federal and State guidelines. If application of adulticides becomes necessary, DOHMH will provide advance notice to the public and to health care providers.

## **Surveillance of Potential Adverse Health Effects from Pesticide Exposure**

DOHMH completed a comprehensive environmental impact study on the pesticides used for adult mosquito control in 2001. The study concluded that at the relatively low levels at which adulticides are applied, the occurrence of adverse public health effects to the population from applying pesticides to reduce the adult mosquito population would not be considered significant when compared to the potential risk to the public health from West Nile virus or other mosquito-borne illness. However, health care professionals are informed and reminded throughout the mosquito season about potential health effects of pesticide exposure and the need to report pesticide-related illness to DOHMH and NYSDOH. DOHMH will monitor the adverse health effects associated with the application of pesticides for adult mosquito control.

## **Host Surveillance**

DOHMH's OVSC in collaboration with the Zoonotic, Influenza and Vector-borne Disease Unit (ZIVDU) in the Bureau of Communicable Disease monitors disease among pet birds and other domestic animals, particularly horses. Veterinary alerts will be faxed at the beginning of the season to all veterinarians in New York City. Veterinarians are required to report any suspicious animal cases with neurological abnormalities to DOHMH.

## **Research and Evaluation**

DOHMH uses its surveillance data to help determine where mosquito breeding occurs in New York City and how WN virus and other mosquito-borne viruses are maintained in our environment. DOHMH evaluates more specific bird, mammal and mosquito surveillance indicators that signal a threat to human health and to assess the efficacy of larval and adult mosquito control.

## INTRODUCTION

In late August 1999, the New York City Department of Health and Mental Hygiene (DOHMH) detected an unusual cluster of encephalitis cases in northern Queens. This was caused by West Nile (WN) virus, a mosquito-borne virus that had not been recognized in the Western Hemisphere prior to 1999. In 1999, the outbreak resulted in 59 cases of neuroinvasive disease of which 44 were NYC residents that were hospitalized. There were 4 fatalities.

Since its introduction to New York City in 1999, WN virus has caused successive outbreaks in the United States each summer and fall, and has moved steadily westward. In 2003, WN virus caused the largest outbreak of neuroinvasive disease ever recorded in the Western Hemisphere, with 9,862 cases reported overall, including 264 deaths. In New York City, the virus has persisted and has become endemic, causing at least 288 neuroinvasive cases and 42 deaths. From 2000-2015, the number of neuroinvasive cases due to WN virus among New York City residents has ranged from 2 to 45 (median 17) per year.

In 2015, 38 cases of WN disease were detected among New York City residents, almost all of which were possibly or probably acquired in New York City.

Data from CDC indicate that there were 2,060 human cases and 119 human deaths reported in the United States in 2015. Please see the CDC homepage at <http://www.cdc.gov/ncidod/dvbid/westnile/index.htm> for more information.

Since 2003, universal screening of donated blood products has been conducted in New York City by the New York Blood Center, and 22 presumptively infected donors have been identified in New York City from 2003-2015. All implicated blood products were retrieved and removed from the blood supply.

The considerable and rapid spread of the virus throughout the country after 2002 provides ample evidence that WN virus is permanently established in New York City and in the United States. With this establishment of WN virus throughout the City and the region, having a routine, year-round Integrated Mosquito Management (IMM) program has become a necessity.

There are three probable mechanisms for WN virus sustainability within the City. The principle enzootic vector, *Culex pipiens*, overwinters in the adult stage; and it is believed that at least some infected mosquitoes successfully survive the winter. Alternatively, infected birds that remain in the area may harbor the virus throughout the winter months. As spring returns, the virus recrudesces within the birds and is readily passed to early season mosquitoes. A third mechanism is reintroduction of the virus into the area during the spring or early summer by infected migratory birds. Hence, a number of infected mosquitoes and/or birds are present within the City during the early spring months. At this time, the virus resumes its amplification cycle. As mosquitoes feed on birds, the virus is transmitted back and forth between the vector and the reservoir host populations allowing an increasing number of birds and mosquitoes to become infected. If environmental conditions are optimum for transmission, the virus amplifies to a theoretical point of “spill over”. At this point in the amplification cycle, the virus bridges out of the enzootic, bird-mosquito cycle via bridge vectors. Bridge vectors are



mosquito species that readily feed on humans and other mammals. It is at this point in the season, that transmission to humans occurs and when management actions are most critical.

An effective surveillance and control program is designed to detect virus during the amplification cycle prior to bridge vector involvement allowing for targeted, effective control of the mosquito population that are limited in scope. Typically, infected mosquitoes signal the presence of local WN virus activity, and occur a month or more prior to human transmission. Eventually, proper surveillance will detect viral presence in the bridge vectors and finally in humans and other mammalian hosts. The goal of DOHMH's vector surveillance program is to detect the WN virus in local mosquito populations before sufficient amplification of the virus can occur, so that targeted IPM practices can be implemented thereby reducing the number of infected mosquitoes and simultaneously reducing the risk of human transmission.

DOHMH extends its gratitude to the following collaborators with whom it has worked closely to develop a plan that meets the specific needs of New York City: the U.S. Centers for Disease Control and Prevention (CDC); the New York State Departments of Health (NYSDOH), Environmental Conservation (NYSDEC) and Agriculture and Markets; and New York City agencies, including the Mayor's Offices of Operations, New York City Office of Emergency Management and the Departments of Environmental Protection, Parks and Recreation, Sanitation, Police, Citywide Administrative Services, Information Technology and Telecommunications, the New York City Housing Authority, Wildlife Conservation Society and its other partners.

## **INTEGRATED PEST MANAGEMENT (IPM)**

### **Prevention of Mosquitoes and WN Virus in Humans**

Prevention is the key to the DOHMH WN virus IPM mosquito program. OVSC focuses its prevention efforts on source reduction, identifying locations of key permanent and semi-permanent breeding sites, and larviciding (backpack, aerial and catch basin). A major part of breeding source reduction involves citywide community outreach and education to engage the help of the public. Preventing the mosquito larvae from emerging into adults is the easiest and most environmentally-sound way to reduce the number of mosquitoes that may transmit West Nile virus in New York City. Larval habitats or breeding sources include stagnant water in artificial and natural containers (tires, birdbaths, tin cans, clogged gutters, puddles, pot holes, tree holes) or an open area (flood-prone areas, marsh areas and other wetlands).

Key recommendations for preventing WN virus in humans include:

- a) People, especially those 50 or older, should take special care to prevent WN virus because they are more susceptible to severe WN virus symptoms
- b) Know the symptoms of WN virus
- c) If outside at dusk or dawn, or if mosquitoes are biting during the day, wear long pants, long-sleeved shirts and socks
- d) Consider the use of an EPA and DEC approved insect repellent containing picaridin, IR3535, DEET or oil of lemon eucalyptus according to the label's directions
- e) Make sure doors and windows have tight-fitting screens. Repair or replace screens that have tears or holes
- f) Reduce the number of mosquitoes in your area by getting rid of containers with standing water that provide breeding places for the mosquitoes.

### **Community Outreach and Education**

Getting the message out to the public regarding personal prevention and breeding source reduction is a major part of the OVSC WN virus IPM Program. The more people know about mosquitoes and WN virus, the better they can protect themselves and help in reducing breeding sources. Through community outreach and education, OVSC makes presentations and provides information through its website (visit [nyc.gov/health](http://nyc.gov/health) and search **mosquitoes**) and with literature on the personal prevention of WN virus.

### **Surveillance**

The DOHMH WN virus Surveillance Program includes 1) monitoring of human cases 2) "in-season" surveillance of larval and adult mosquitoes and 3) "off-season" surveillance of overwintering adult mosquitoes and 4) identification and characterization of breeding sites.

Larval surveillance helps OVSC determine where to treat by ground equipment (manual and backpack pesticide applicators) and determine the timing for aerial larviciding. Larval surveillance includes dipping, breeding site identification and larval identification. Dipping is performed by taking a small amount of water using a sampling device called "dipper" and examining the sample for the presence or absence of mosquito larvae.

Adult mosquito surveillance is key to determining the type and density of mosquitoes present throughout the City and through their testing to determine the presence, location and intensity of WN virus. The mosquitoes are trapped using light, gravid and/or sentinel traps in about 61 (2015) locations strategically located throughout the City. Locations of these traps are based on current and past surveillance data. If WN virus is found in a location, supplemental traps are added to better define the distribution of WN virus in the area.

## **Control**

Control of mosquitoes using the principles of IPM includes 1) breeding source reduction, 2) habitat modification, 3) use of mass mosquito-trapping devices, 4) larviciding and 5) adulticiding. Non-chemical methods are always considered first, but if a chemical pesticide is required, then it will be the lowest toxicity (and least persistent) pesticide that is efficacious on mosquitoes.

### **Larviciding**

Larviciding is the most efficient method of controlling mosquitoes. By larviciding aquatic breeding sites with naturally occurring biological pesticides, the larvae are killed before they emerge from water into adults. The larviciding effort includes 1) manual or backpack treatment of key breeding source locations, 2) manual treatment of catchbasins, and 3) aerial application to inaccessible breeding areas.

### **Adulticiding**

DOHMH performs adulticiding only as a last resort, when WN virus infected mosquitoes have been identified and meet established criteria for adulticiding. The decision to adulticide is based on data obtained from mosquito surveillance and testing, and established and successful algorithms/decision trees. OVSC uses two different algorithms depending on whether or not a human WN virus case is involved. The Positive Mosquito Pool Algorithm is driven by 1) the presence of WN virus in mosquitoes, 2) the persistence (ongoing activity) of WN virus in locations where positive mosquitoes were found, 3) the competency of infected mosquito species in transmitting WN virus, 4) the propensity of WN virus positive mosquito to bite humans and 5) the population density in areas where WN virus positive mosquitoes were trapped. The Positive Human Case Algorithm is driven by 1) the presence of human case(s) in an area and 2) the evidence of local transmission of the virus (presence of positive WN virus mosquitoes in area near the human case).

Detailed descriptions of above mentioned mosquito IPM practices are provided in the succeeding sections of this plan.

## **PUBLIC EDUCATION & COMMUNITY OUTREACH**

### **Objective**

To increase public awareness of mosquito-borne diseases

### **Background**

Each year, DOHMH launches a public education campaign to increase awareness of WN virus with a press release. This press release highlights the need for New Yorkers to take personal protective measures against mosquito bites and to eliminate mosquito breeding sites around their homes. In past campaigns, this message was aired on television and radio and published in newspapers and magazines. DOHMH has developed over 20 educational fact sheets and made information available in multiple languages to community-based organizations, community boards, elected officials, schools, and the general public. This information can also be downloaded from the DOHMH's website (visit **nyc.gov/health** and search **mosquitoes**). The campaign also features presentations from DOHMH staff to various community groups in the neighborhoods with higher risk of WN virus infection.

DOHMH promotes WN virus prevention strategies and community participation through a number of venues. In 2015, the Offices of Vector Surveillance and Control and the Office of Community Affairs conducted 104 WNV presentations targeting outreach to senior citizen centers and community boards throughout the City. The Health Media and Marketing Office updated the informational materials for print and radio to promote personal protective measures and elimination of standing water. The Press Office made spray notifications and personal precaution announcements through the media. Materials were made widely available in hard copy and electronic form (through email and the Agency's website), in multiple languages. Information was also made available through 311.

In 2016, DOHMH will take standing water reports via the New York City's Citizen Service Center (311) and DOHMH's enhanced website (visit **nyc.gov/health** and search **mosquitoes**). Callers can receive comprehensive information about WN virus, including updated information about adulticiding (mosquito spraying) schedules by dialing 311. The Citizen Service Center will provide callers with a live operator 24 hours a day, 7 days a week. DOHMH will also provide information on WN virus through its web site ((visit **nyc.gov/health** and search **mosquitoes** in the form of fact sheets, press releases, larviciding, adulticiding schedules, and WN virus activity maps. This information is routinely faxed and/or electronically mailed to City agencies, elected officials, community boards, the Department of Education, hospitals, nursing homes, and associations of green grocers, day camps, and community organizations. DOHMH will work with the Department for the Aging (DFTA) for distribution of WN virus literature and insect repellents to the senior citizens at social gatherings and formal meetings.

Adulticiding information is made available through DOHMH's web site and 311, regular news broadcasts, scheduled advertising times on local radio, print media, and web sites of news organizations.

In 2015, DOHMH also utilized the Notify NYC System to reach out to the public in areas at higher risk of disease transmission. This system allows residents of the City to receive alerts on many different communication devices such as cell phones, landlines, pagers, and email accounts. The public is encouraged to register with Notify NYC via 311 or the web, to receive advanced notification of ground spray (adulticiding) and aerial larviciding events in their neighborhoods.

### **Planned Activities**

#### WNV Summer Intern Initiative

- The OVSC and the Office of Community Affairs will hire summer interns (undergraduates and graduate students) to develop and implement the 2016 WN Virus Community Engagement Project. These interns will perform community education and outreach at different locations throughout the City including making presentations to senior centers and other community groups, distributing literature at health fairs and answering questions about WN virus and other public health issues.
- Should neighborhood spraying become necessary due to elevated WN virus activity, student interns will work in the affected neighborhoods distributing literature to notify residents and merchants about upcoming spray events. The distribution of literature written in English (and other languages as appropriate) will inform the community about the times, dates and locations of spray (adulticiding) event(s) in and around the spray/treatment zones.

The following key messages will be communicated:

- The public will be informed about the City's comprehensive preventive strategies and activities (community education, surveillance, source reduction, larviciding, etc.) to address the threat of WN virus and to minimize the necessity of pesticide application for adult mosquito control.
- The public will be asked to help eliminate mosquito-breeding sites and to report standing water using the Citizen Service Center (311) and via DOHMH's Website (visit [nyc.gov/health](http://nyc.gov/health) and search **mosquitoes**). The public will be advised to eliminate standing water sites (tires, buckets, and other water-holding objects) where mosquitoes can breed from their property. They will also be urged to change the water in bird baths once each week; to clean and chlorinate swimming pools or drain and cover if not in use; to prevent water from accumulating in pool covers; and to unclog gutters and down spouts.
- The Office of Community Affairs will increase public awareness of the nature of mosquito-borne diseases and the signs and symptoms of WN virus infections (headache, high fever, muscle pain, weakness and disorientation).
- The public will be informed about the proper personal protective measures to avoid mosquito bites such as ensuring that screens fit tightly on doors and windows, wearing

protective clothing (long pants, long-sleeved shirts, and socks) and appropriate use of insect repellents.

- Maps and tables showing recent WN virus activity by zip code will be posted on the DOHMH website in order to provide the public with up to date information on location of WN virus activity in the City. This information will be updated on a weekly basis until viral activity has ceased.

If the application of pesticides to control adult mosquitoes becomes necessary, the public will be informed in a timely manner (at least 24 hours in advance with a goal of 48 hours prior to event) to reduce exposure to pesticides. The public will also be provided detailed information about the pesticides being used and the potential risks associated with exposure. The public will be encouraged to contact the Poison Control Hotline (212-POISONS/764-7667 or 1-800-222-1222) with any suspected pesticide-related illness, symptoms or exposure.

- Fact sheets in several languages will be distributed to community-based organizations, community boards, elected officials, schools, senior care facilities, libraries, outdoor activity sites, and many other organizations Citywide.
- The Citizen Service Center (311) will be updated regularly with information pertaining to DOHMH pesticide spraying activities. This service will begin on April 1 and will be available 24 hours a day, 7 days a week for WN virus related inquiries and reports.
- DOHMH's web site (visit [nyc.gov/health](http://nyc.gov/health) and search **mosquitoes**) will be regularly updated and, beginning in April, the public can use web-based forms for reporting standing water.
- Regular updates will be made to elected officials and community boards, who are essential to the City's communication activities about WN virus activity. Presentations, available in multiple languages, will be offered by DOHMH staff to community boards and a wide variety of organizations. These will include information about mosquito breeding site reduction and related DOHMH activities.
- Press releases regarding all activities will be issued regularly and DOHMH will work closely with the media to achieve accuracy of the WN virus coverage.
- In the event adulticiding is necessary:
  - Information will be released at least 24 hours in advance (in compliance with Local Law 37 and NYS DEC Regulation) with a goal of 48 hours in advance through the media, DOHMH Website, Citizen Service Center (311), and Notify NYC (if applicable). In addition, hospitals, key City agencies, elected officials, community boards, schools, nursing homes, day camps, and community organizations will receive notice via fax and/or electronic email. Under certain conditions and with the approval of the NYSDOH, applications in green spaces (parks/cemeteries) may take place with less than the required

24 hour notice. For these cases, the green area will be closed to the public during and a few hours after the application of adulticide.

- Police Department cars or other vehicles will escort the DOHMH applicator's trucks to announce that adulticiding is about to take place, and will urge people to go indoors to reduce exposure to pesticides.

## **HOST SURVEILLANCE**

### **Objective**

To monitor mammal and bird populations as a means of early detection of potential arthropod-borne diseases in the City

### **Background**

Arthropod-borne viruses (arboviruses) cause diseases such as WN virus infection, Eastern equine encephalitis (EEE), St. Louis encephalitis (SLE), and La Crosse (LAC) encephalitis. These viruses are maintained in nature in a cycle of transmission between an animal host (the reservoir) and the mosquito. All of these viruses can cause human infections and have been responsible for epidemics over the past several decades. These viruses have their own specific ecologic and epidemiologic characteristics, and each has exhibited a tendency to extend geographic range and become established in new areas, which is of growing concern.

Among arboviruses, WN virus is currently endemic in New York City. Many species of birds have tested positive for WN virus; however, American robins, house sparrows and blue jays are among major contributors to amplification of the virus in the City. Other potential WN virus reservoir host birds in New York City are grackles and house finches.

There will be no dead bird surveillance conducted by the DOHMH in 2016 as they have limited use as an early warning system for human disease in NYC. Also, with the exception of horses, mammals do not appear to be sensitive to WN virus. In the past, DOHMH's animal surveillance efforts have been assisted by a number of partner organizations, including the New York City Department of Parks and Recreation, the New York State Department of Agriculture and Markets, the Animal Medical Center, the Staten Island Zoo, and the Wildlife Conservation Society.

DOHMH will continue to ask veterinarians and other animal specialists to monitor for unusual illness and death among birds and mammals. The DOHMH will also continue to work with and receive animal test results for WN virus (and other arboviruses) from the New York City Wildlife Conservation Society. These data may be used in setting up supplemental mosquito traps in the areas from where infected mammals and/or dead birds are recently found.

### **Planned Activities**

- At the onset of WN virus season, DOHMH will alert veterinarians to be vigilant for neurologic illness in vertebrates and to consider the possibility of an arbovirus as an etiology. WN virus and other arboviral infections are reportable diseases in animals, and any laboratory or veterinarian is required to report confirmed cases in New York City animals to DOHMH.



## HUMAN SURVEILLANCE AND PROVIDER EDUCATION

### Objective

To quickly detect human illness due to mosquito-borne diseases, especially WN virus

### Background

During 1999-2015, 288 New York City residents developed neuroinvasive disease due to WN virus. Among these cases, 42 died as a result of West Nile infection. Most of the neuroinvasive cases have occurred in older New Yorkers (median: 64 years; range 1-93). Sixty-seven (67) cases of WN fever were also detected during this time period. In 2015, 29 New York City residents were diagnosed with WN neuroinvasive disease. All but one of these cases of WN viral disease possibly or probably became infected locally. The tables below summarize WN virus disease by borough and syndrome.

West Nile Viral Disease by Borough, NYC, 1999-2015 (includes neuroinvasive and non-neuroinvasive cases)

Year	Bronx	Brooklyn	Manhattan	Queens	Staten Island	Unknown	Total
2015	2	12	1	18	6	-	38
2014	1	6	2	4	2	-	15
2013	1	3	0	2	4	-	10
2012	4	12	9	10	6	-	41
2011	2	2	2	5	0	-	11
2010	7	6	6	14	9	-	42
2009	1	1	0	1	0	-	3
2008	1	3	1	5	5	-	15
2007	1	7	1	7	1	1	18
2006	1	0	1	2	8	-	12
2005	3	3	1	5	2	-	14
2004	0	0	3	1	1	-	5
2003	6	8	2	11	4	1	32
2002	8	2	1	13	5	-	29
2001	0	2	3	2	2	-	9
2000	0	2	1	1	10	-	14
1999	9	3	1	34	0	-	47
<b>Total Cases</b>	<b>45</b>	<b>60</b>	<b>34</b>	<b>117</b>	<b>59</b>	<b>2</b>	<b>355</b>

The table below summarizes morbidity and mortality due to WN virus in New York City from 1999-2015:

**West Nile Viral Disease, NYC, 1999-2015**

	Cases	Syndrome		Median Age*		Deaths	
		Neuroinvasive	WN Fever	Yrs	Range	#	Case Fatality Rate*
<b>2015</b>	38	29	9	59	(22-89)	4	14%
<b>2014</b>	15	12	3	59	(36-81)	3	25%
<b>2013</b>	10	8	2	64	(45-81)	0	--
<b>2012</b>	41	26	15	60.5	(1-88)	6	23%
<b>2011</b>	11	9	2	69	(41-82)	2	22%
<b>2010</b>	42	34	8	64	(19-87)	1	3%
<b>2009</b>	3	3	0	63	(60-73)	0	--
<b>2008</b>	15	8	7	64	(33-87)	1	13%
<b>2007</b>	18	13	5	75	(41-90)	5	38%
<b>2006</b>	12	8	4	64.5	(44-80)	2	25%
<b>2005</b>	14	11	3	61	(27-84)	2	18%
<b>2004</b>	5	2	3	34	(1-66)	0	--
<b>2003</b>	32	31	1	67	(8-93)	7	23%
<b>2002</b>	29	28	1	72	(22-86)	3	11%
<b>2001</b>	9	7	2	51	(44-75)	1	14%
<b>2000</b>	14	14	0	62	(36-87)	1	7%
<b>1999</b>	47	45	2	71	(5-90)	4	9%
<b>Summary</b>	<b>355</b>	<b>288</b>	<b>67</b>	<b>64</b>	<b>(1-93)</b>	<b>42</b>	<b>15%</b>

\* Median age and case fatality rate calculated for neuroinvasive cases only.

Serosurveys performed in Queens (1999) and Staten Island (2000) provided an estimate of the proportion of WN viral infections that are asymptomatic or subclinical. Accordingly, an estimated 140 subclinical WN virus infections, including 30 cases of WN fever, occur for each case of neuroinvasive disease. Therefore, approximately 38,640 asymptomatic infections and 8,280 cases of WN fever have likely occurred among New York City residents from 1999-2015. The majority of asymptomatic infections and WN fever cases are undetected and unreported in New York City, since many individuals with febrile illness may not seek medical attention and may not be tested for WN virus even if they do see a provider.

As part of a surveillance and provider education program, the Bureau of Communicable Disease offers presentations to health care providers. Medical alerts and advisories are issued via the Health Alert Network (broadcast e-mail) to all NYC hospitals and providers, encouraging providers to promptly report cases of encephalitis, aseptic meningitis and acute flaccid paralysis from July through October, and to test these cases for WN virus. In July, 2010, the DOHMH Public Health Laboratory discontinued serologic testing for WN virus.

Providers are now asked to send specimens to commercial laboratories for WN virus testing. Under special circumstances specimen transportation and testing is arranged by DOHMH (e.g. high suspicion for WN virus, possible transfusion or transplantation related case or unusual clustering suggestive of an outbreak of WN virus or another cause of encephalitis).

If physicians request antibody testing for other arboviruses, such as dengue, eastern equine encephalitis and/or St. Louis encephalitis (SLE) viruses, specimens can also be referred to the NYSDOH Wadsworth Laboratory or the Centers for Disease Control and Prevention (CDC) for testing. Physicians may send cerebrospinal fluid (CSF) specimens from hospitalized patients with encephalitis to the Wadsworth Laboratory New York State Department of Health (NYSDOH) for testing by polymerase chain reaction (PCR) for a panel of viruses that cause human encephalitis.

In addition to West Nile, three other mosquito-borne infections have been diagnosed among NYC residents. Cases of dengue fever are detected every year. Investigations have determined that all infections were acquired outside NYC in areas where dengue is known to be endemic. In 2015, NYC reported 75 cases of dengue among NYC residents. In 2014 a new outbreak of chikungunya virus in the Caribbean resulted in over 600 cases identified among NYC residents, and 96 in 2015. Interviews with the patients revealed all the patients had acquired their infection while traveling in the Caribbean and Central and South America. No cases of Zika virus infection were identified among NYC residents in 2015. DOHMH conducts passive surveillance for dengue fever, chikungunya and Zika, and facilitates testing for new arboviruses not normally found among NYC residents.

### **Planned Activities**

- Beginning in early July, DOHMH will remind providers to report all suspected cases of WN virus neuroinvasive disease (encephalitis, aseptic meningitis or acute flaccid paralysis), and to test all hospitalized patients with these conditions for WN virus. Providers will also be reminded to consider dengue, chikungunya and Zika in patients with a history of travel and compatible illness.
- From July through October, periodic e-mail advisories will be sent to all City hospitals and healthcare providers describing current WNV activity in NYC and emphasizing the importance of reporting suspected WN virus cases. DOHMH will provide the criteria for reporting and submission of appropriate laboratory specimens for WN virus testing.
- DOHMH will work closely with NYSDOH and CDC to ensure that surveillance data are standardized and remain confidential.
- DOHMH will educate health care providers to increase knowledge about the proper detection, prevention and clinical management of mosquito-borne diseases and other types of encephalitis and meningitis.
- Presentations will be made at local hospitals and to specialty societies as requested.

- The Bureau of Communicable Disease will work with partners to ensure that cases of WN virus infection in persons who have received or donated blood products or organs are rapidly investigated and reported so that other affected blood products or organs can be promptly identified and withdrawn before they are used.
- BCD will facilitate diagnostic testing for cases in which arboviral diseases other than WN virus, dengue, chikungunya or Zika are suspected by clinicians.

## **MOSQUITO SURVEILLANCE**

### **Objective**

To monitor the abundance of mosquito populations and detect the presence of arboviruses

### **Background**

Mosquitoes were collected weekly with 122 mosquito traps (light & gravid) from 61 permanent locations throughout New York City in 2015. To enhance virus surveillance in the areas where WN virus activity had been identified in mosquitoes and humans, 400 supplemental mosquito traps were placed at 200 locations throughout the City. In 2015, a total of 141,199 adult mosquitoes were identified to species levels, of which 120,891 belonging to seventeen species that were tested for the presence of WN virus infection. Seven mosquito species, *Aedes albopictus*, *Culex pipiens*, *Culex restuans*, *Culex salinarius*, *Ochlerotatus sollicitans*, *Ochlerotatus taeniorhynchus* and *Ochlerotatus triseriatus* were found infected with WN virus. Of the 4,397 mosquito pools tested, 827 tested positive for WN virus: 58 in Manhattan; 88 in the Bronx; 133 in Brooklyn; 188 in Staten Island; and 360 in Queens. *Cx. pipiens* was identified as the primary enzootic vector of WN virus from 1999-2015 based upon the number of positive pools. In fall and winter 2015, hibernating *Culex* females were collected from indoor resting sites and were kept at - 80<sup>o</sup> C with 14:10 (L:D) photoperiod for 20-30 days and later tested for the presence of WN virus. No WN virus was detected in these mosquitoes.

The risk of mosquito-borne disease depends on both the number of mosquitoes capable of transmitting the virus and the prevalence of the virus among those mosquitoes. Proper surveillance data for larval and adult mosquitoes are important for guiding appropriate prevention and control activities. Larval surveillance can help predict expected adult mosquito density and can indicate areas where efforts to eliminate mosquitoes at their source (breeding sites) should be targeted. Adult mosquito surveillance and viral testing provide early predictive information about the potential for a disease outbreak.

### **Planned Activities**

- DOHMH will continue to work closely with other City agencies to collect and map information on potential mosquito-breeding habitats.
- DOHMH will determine which areas should be regularly inspected for the presence of larvae. These sites will be subjected to routine inspection to determine the presence of mosquito larvae.
- Larval habitat information will be collected and updated throughout the season.
- In the urban areas, mosquito trapping will be conducted from sewer and adjacent buildings by using light traps in response to resident complaints.

- From June to October, DOHMH will trap adult mosquitoes at 61 permanent sites throughout the five boroughs. The trapping season may be lengthened or shortened depending on the weather.
- Mosquitoes will be collected on a weekly basis using DOHMH light and gravid traps. Each trap collection will be sorted by species of mosquitoes collected. Information on the location, collection data, trap type and the total number of female mosquitoes will be recorded.
- Extra trapping will be conducted to collect day biting mosquitoes using BG sentinel traps and mosquito magnets.
- Adult mosquito trapping will be expanded in areas where WN virus is detected in mosquitoes and humans. This will help determine extent of viral activity and delineate spray zones.
- In the event that pesticides are applied for adult mosquito control, DOHMH will set traps more frequently to evaluate the efficacy of the control measures.
- The DEP will continue to use Mosquito Magnet™ traps to survey and control adult mosquitoes at parks and wastewater treatment plants. Additionally, DOHMH will place Mosquito Magnet™ traps to survey and control adult mosquitoes in the Rockaways.

## LARVAL MOSQUITO CONTROL

### Objective

To reduce the abundance of adult mosquitoes through the use of Integrated Mosquito Management (IMM) practices

### Background

*Culex pipiens*, a primary vector of WN virus, is the most common mosquito found in the New York City. This species breeds quickly and lays its eggs in standing or slow-moving water containing decaying organic materials. Important breeding sites include storm drains (catch basins), used tires, poorly maintained bird baths, clogged rain gutters, unused swimming and plastic wading pools, and puddles that last for a week or more. A single female *Cx pipiens* can lay between 100 to 300 eggs which can mature to adults within 10 days under ideal conditions. Eliminating breeding sites is the simplest and most effective way to reduce the number of mosquitoes. Every residential and commercial property owner should regularly inspect their property and buildings to determine if conditions are conducive to mosquito breeding and endeavor to eliminate those conditions. Mosquito breeding can be prevented by either eliminating the standing water (source reduction), or treating the water with larvicide to prevent mosquitoes from developing.

DOHMH's public education campaign emphasizes the need for New Yorkers to eliminate mosquito-breeding sites around their homes. From April to October 2015, DOHMH received 1,649 complaints of standing water through 311; on DOHMH web site; from elected officials and community groups; and through field surveys performed by inspectors and exterminators. The DOHMH investigated each of the complaints. Every report led to a letter being sent to the property owner regarding the need to eliminate mosquito-breeding sites and 2,122 sites were visited and checked for the presence of mosquito breeding. In order to respond to egregious conditions, the Board of Health adopted a resolution that made standing water a public health nuisance and allowed for the issuance of Notice of Violations to unresponsive property owners. In 2015, 667 Notice of Violations were issued to unresponsive landlords and homeowners.

DOHMH will conduct need-based larviciding in accordance with permits issued by NYS Department of Environmental Conservation (DEC) in catch basins (street corner storm drains), sewage treatment plants, and areas of permanent standing water. DOHMH works with the New York City Department of Environmental Protection (DEP), the New York City Housing Authority, and the New York City Department of Parks and Recreation to treat catch basins and other mosquito breeding sites. Approximately 150,000 catch basins across the City will be inspected and if justified, treated at least three times each season by hand application of larvicides. In areas that are inaccessible by ground vehicles, larvicide may be applied aurally.

Presently, DOHMH uses larvicides with the active ingredients *Bacillus sphaericus* and/or *Bacillus thuringiensis* var. *israelensis* (Bti)]. *B. sphaericus* and Bti are naturally occurring soil bacteria that produce toxins, which control mosquito larvae. These microbial larvicides are ideal for mosquito management because of their specificity to mosquitoes and their lack of

toxicity to humans and other non-target organisms. The bacteria produce asexual reproductive cells (spores) which enable them to survive in adverse conditions. Additionally, they produce unique crystalline bodies (endotoxins) when eaten, dissolve in the intestine of the larvae and paralyze the cells in the gut, thus interfering with normal digestion and triggering the larvae to stop feeding. The spores can then invade other tissues, multiplying in the larva's blood, until the insect dies. Death typically occurs within a few hours of ingestion.

### **Planned Activities**

DOHMH and other City agencies continuously identify areas of standing water associated with surface grading problems, road construction, clogged sewers and catch basins, obstructed waterways that are mosquito-breeding habitat. Through interagency collaborative efforts, these conditions will be remediated as they are identified.

DOHMH will inform large-property owners and managers of the need to eliminate mosquito-breeding sites on their property or to properly treat them with larvicides.

DOHMH will work with the New York City Department of Sanitation to prioritize and enhance the enforcement of lot cleaning and to ensure an aggressive tire disposal program. Abandoned lots are particularly conducive to mosquito breeding, and in areas where WN virus has already been detected these lots will be targeted for remediation.

DOHMH will work with the New York City Department of Buildings to develop and implement a protocol requiring all City's demolition and excavation contractors to larvicide when their activities result in significant sources of mosquito breeding.

The public will be asked to help eliminate mosquito-breeding sites and to report standing water using the City's toll-free Citizen Service Center Line (311) and the DOHMH Web site ((visit [nyc.gov/health](http://nyc.gov/health) and search **mosquitoes**)).

OVSC will monitor reported breeding sites; send letters to property owners asking them to address the problem; conduct on-site inspections of the more egregious conditions; make referrals to appropriate agencies for abatement; and, if necessary, issue notices of violation.

DOHMH will use VectoLex® (*Bacillus sphaericus*), VectoBac®/AquaBac®/Submit Bti Briquets® (*B. thuringiensis* var. *israelensis*, Bti), and VectoMax® larvicides (mixture of *B. sphaericus* and *Bti*). Pesticide resistant management is a core component of this comprehensive mosquito control plan. DOHMH will continue monitoring local mosquito populations for resistance development for all above mentioned larvicides. Use of methoprene (Altosid®) may be considered if microbial larvicides do not produce desired results. Methoprene is an insect growth regulator used to control many types of insects. This chemical quickly breaks down in water and sunlight and does not persist in the soil. The U.S. Environmental Protection Agency has placed methoprene into the category of "least toxic" with regard to humans. Additionally, DOHMH will continue to explore other registered products that may increase the effectiveness of the larviciding program.

Beginning in May, bacterial larvicides will be applied at wastewater treatment plants, parks, and other surface waters, if larval breeding is present. Applications will be made by hand,



backpack or aerially via helicopter and continue to be applied as needed throughout the mosquito-breeding season.

Beginning in June, bacterial larvicides will be applied to sewers and to more than 150,000 catch basins citywide. Applications will continue, based upon larval surveillance findings, as needed throughout the mosquito-breeding season.

OVSC staff will intensify larval surveillance and control once WN virus activity is identified in an area. Targeted neighborhoods will have an expanded public outreach regarding breeding site elimination and personal protection; also community-specific media materials will be distributed.

DOHMH will work with the Parks Department and other partners to provide mosquito control in green areas (e.g., parks, cemeteries, and golf courses), especially in areas where infected mosquitoes are found.

DOHMH will provide occupational safety and health training to all employees involved in mosquito surveillance and control operations. Additionally, DOHMH will require that all employees from contracted vendors be provided with similar training as well as appropriate personal protective equipment.

For residents conserving rainwater, OVSC will recommend covering the barrels or other water holding containers with a tight-fitting lid or very fine mesh screen. Also, bacterial larvicides containing *Bti* can safely be placed in the barrels for mosquito larvae control.

## **ADULT MOSQUITO CONTROL**

### **Objective**

To reduce the abundance of WN virus infected adult mosquitoes in targeted areas through the judicious use of pesticides

### **Background**

Comprehensive vector and human surveillance data collected during the last thirteen seasons have allowed DOHMH to develop a more sensitive protocol for determining and monitoring the level of WN virus activity and the risk for human disease throughout the City.

DOHMH practices Integrated Pest Management (IPM) for managing mosquito populations in the City. Adulticiding operations are only performed as a last resort when surveillance data indicate a significant risk of WN disease transmission to humans. During the last fifteen years, only Anvil 10+10 containing sumithrin (d-phenothrin) was used for adult mosquito control. This product is a synthetic pyrethroid that has been used for more than 40 years. It provides a rapid knockdown of adult mosquitoes. Sumithrin exhibits low mammalian toxicity, degrades rapidly in sunlight, provides little or no residual activity, and does not accumulate in the environment. This product is applied at very small quantities per acre (0.0034 pounds/acre) and is referred to as ultra-low volume (ULV) application. ULV-delivery techniques minimize environmental impacts while effectively managing adult mosquito populations. In addition, DOHMH adulticiding events are monitored by city, state and Federal officials to ensure compliance with applicable laws and regulations.

DOHMH performs adulticiding only as a last resort, when WN virus infected mosquitoes have been identified and meet established criteria for adulticiding. The decision to adulticide is based on data obtained from mosquito surveillance and testing, and established and successful algorithms/decision trees. OVSC uses two different algorithms depending on whether or not a human WN virus case is involved. The Positive Mosquito Pool Algorithm is driven by 1) the presence of WN virus in mosquitoes, 2) the persistence (ongoing activity) of WN virus in locations where positive mosquitoes were found, 3) the competency of infected mosquito species in transmitting WN virus, 4) the propensity of WN virus positive mosquito to bite humans and 5) the population density in areas where WN virus positive mosquitoes were trapped. The Positive Human Case Algorithm is driven by 1) the presence of human case(s) in an area and 2) the evidence of local transmission of the virus [presence of positive WN virus mosquito(es) in area near the human case].

DOHMH will utilize its surveillance data to assess the risk of an outbreak of human disease and the need to apply pesticides in a limited and targeted area to control adult mosquitoes by considering habitat; time of year; weather conditions; the intensity of viral activity; the distribution, density, species, age and infection rate of the vector population; and the density and proximity of human populations.

## **Planned Activities**

### **Level 1 – No Pathogen Detection**

DOHMH *Responses*: Surveillance and control programs continue as outlined in the City's Mosquito Surveillance and Control Plan. Periodic reports or communications are made to the WN virus Steering Committee providing current status of the various surveillance programs. Periodic press releases are issued providing the public with current surveillance results.

### **Level 2 – Initial or Single Pathogen Detection**

Initial or a single detection of mosquito-borne viral pathogens in mosquito populations or avian populations in New York City will result in a move to Level 2 responses.

DOHMH *Responses*: OVSC recommendations will be communicated to the WN virus Steering Committee and the DOHMH Commissioner. Upon approval by the Commissioner, a press release will be drafted, notifying the public of the findings. Surveillance programs will continue with the following added activities:

- CDC Light Traps will be added to the area of concern if additional surveillance data are required.
- Larval surveillance and enhanced adult trapping will be conducted in affected areas if needed.
- Laboratory testing of mosquito pools will be given priority in primary vectors *Culex pipiens* and *Cx. restuans*, and bridge vector *Cx. salinarius*.
- Data from these additional traps and surveillance measures will aid in determining the extent of pathogen transmission and abundance of mosquito populations and be used to guide control measures, if applicable.

### **Level 3 – Continued or Multiple Pathogen Detections**

Persistent detection of mosquito-borne pathogens or detection in bridge vector mosquitoes or in non-avian vertebrate populations in New York City will result in a move to Level 3 responses.

DOHMH *Responses*: OVSC recommendations will be communicated to the WN virus Steering Committee and the DOHMH Commissioner. Upon approval by the Commissioner, a press release will be drafted, notifying the public of the recent findings. Surveillance programs will continue as noted above. Control measures will be implemented.

- CDC Light and/or gravid Traps will be added to the area of concern if additional surveillance data are required.
- Larval surveillance and enhanced adult trapping will be conducted in affected areas if needed.
- Laboratory testing of mosquito pools will be increased in primary and bridge vector

species.

- Control measures to be considered:
  - Application of larvicides (including aerial applications) to areas breeding large numbers of mosquitoes
  - Ground application of adulticides to immediate areas of concern
  - Aerial application of adulticides may be considered in the event of epidemic
  - Recommend the restriction and/or cancellation of outdoor evening activities
  - Recommend the closing of outdoor recreational areas
- Monitor the efficacy of the adulticiding activities.
- DOHMH will consider EPA and NYS DEC registered products for mosquito control that contain the following active ingredients: sumithrin, permethrin, or naled. The City will continually review the available information on the health impact of pesticides. Any products used will be applied in compliance with City, State, and Federal laws and regulations.
- The public will be notified of adulticide schedules in advance, which will allow sufficient time to take any necessary precautions to reduce pesticide exposure. (See Public Education and Community Outreach)
- Hospitals will be notified regarding the adulticiding schedule. Information on the pesticide to be used will be provided to the public, physicians and other health care providers.
- Adult mosquito control will be scheduled when mosquitoes are most active and when weather conditions are conducive to successful application.
- Information will be released at least 24 hours in advance of the scheduled spray event through the media, the DOHMH web site, West Nile virus Information Line, and pertinent City and community organizations.
- DOHMH will monitor and assess control activities for any potential environmental and health effects through several measures, including pre- and post-spray environmental sampling and addressing pesticide exposure complaints received by DOHMH.

Depending on surveillance findings and other criteria, DOHMH or its Contractor may apply targeted adulticides in response to community concerns about nuisance mosquitoes in the Rockaways.

# **SURVEILLANCE OF POTENTIAL ADVERSE HEALTH EFFECTS FROM PESTICIDE EXPOSURE**

## **Objective**

To perform passive and syndromic surveillance to monitor for possible exposure to pesticides used to control adult mosquitoes and the potential health sequelae due to such exposure

## **Background**

Since exposure to pesticides has the potential to cause adverse reactions, particularly among those with pesticide sensitivity or underlying health conditions, beginning in 2000, DOHMH took additional care to provide advance notification whenever adulticide applications occurred. Prior to conducting adult mosquito control activities, information on pesticides was sent to all hospital emergency departments, which included product information on pesticides, Material Safety Data Sheets, and other information relevant to identifying possible exposures to pesticides. Each year since 2000, calls to the New York City Poison Control Center (NYC PCC) were monitored during pesticide spraying and relevant exposures were forwarded to the New York State Pesticide Poisoning Registry (NYS PPR) for review and possible inclusion in the registry. In 2001, active surveillance for pesticide-related health complaints was performed. In this regard, chart review was conducted in emergency departments and physicians were randomly surveyed in the affected areas by telephone to determine if any individuals had sought care for symptoms related to possible exposure to adulticides. No cases of individuals reporting to emergency departments or seeking care from their physicians for health complaints related to adulticide exposure were found through these activities. Additional research was conducted to determine whether pesticide applications associated with WN virus mosquito control were associated with negative health outcomes. As a recent publication reported, no such associations were found.<sup>1</sup>

Beginning in 2002, syndromic surveillance was adopted as a surveillance tool to identify any possible respiratory symptom related cluster in areas in which a spray action occurred. If such a cluster is identified, DOHMH conducts further review of emergency department data to investigate the possible etiology of that cluster. In addition, the Poison Control Center monitors pesticide-related calls for number and severity that are geographically and temporally associated with spray events.

## **Planned Activities**

Prior to conducting adult mosquito control activities, information on pesticides and their possible adverse health effects will be sent to all hospital emergency departments, including product information on pesticides, Material Safety Data Sheets, and other information relevant to identifying possible exposure to pesticides. Calls received by the New York City Poison Control Center (NYC PCC) will continue to be monitored during pesticide spraying for

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<sup>1</sup> Karpati AM, Perrin MC, Matte T, Leighton J, *et al.* Pesticide Spraying for West Nile Virus Control and Emergency Department Asthma Visits in New York City, 2000. *Environ. Health Perspect.* 2004 Aug; 112(11): 1183-7.

geographic and spatial associations with spray events. These data will continue to be forwarded to the NYS Pesticide Poisoning Registry for possible follow-up and inclusion in the Registry. Syndromic surveillance will also continue to be utilized to identify possible asthma clusters in the zip codes in which spraying occurs. Statistical and field investigation methods for evaluating spatial and temporal clustering are described in recent publications.<sup>2</sup> In the event that a possible respiratory symptom cluster is identified, emergency department chart review will be considered to investigate the possible etiology of that cluster at nearby hospitals.

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<sup>2</sup> See for example: Heffernan, R., F. Mostashari, D. Das, *et al.* New York City Syndromic Surveillance Systems MMWR September 24, 2004 / 53(Suppl);23-27; and Steiner-Sichel, L., J. Greenko, R. Heffernan, M. Layton, and D. Weiss. Field Investigations of Emergency Department Syndromic Surveillance Signals. New York City MMWR September 24, 2004 / 53 (Suppl.);184-189.

## **RESEARCH AND EVALUATION**

### **Objective**

To better understand the transmission and overwintering mechanism of mosquito-borne diseases and to assess the effectiveness of DOHMH surveillance, prevention and control methods

### **Background**

One of the most important roles for public health professionals is to assess the potential impact of a disease on a population and to devise safe and effective methods for reducing the risk of disease transmission. DOHMH, in collaboration with CDC and NYSDOH, has studied closely the risk factors for infection, morbidity and mortality from WN virus. However, many questions remain about how the virus circulates in nature.

Furthermore, some of the control methods used for managing mosquito populations, especially the application of pesticides for adult mosquitoes, are not without potential impact. However, alternative control measures lack sufficient efficacy or environmental impact data to allow their wholesale integration into this plan. The environmental impact statement and other research endeavors are important tools used to assess potential adverse health effects associated with pesticide exposure. Additional research is needed in this area as well as in assessing improved techniques for larval and adult mosquito control in New York City.

### **Planned Activities**

- DOHMH will continue to work closely with Federal, State, and Local partners to conduct research that will identify the most effective predictors of human illness from WN virus in New York City, including the analysis of overwintering mosquito populations and the use of predictive disease models.
- DOHMH will continue to refine the New York City-specific phased response for risk categories of mosquito-borne disease outbreaks based on the ongoing analyses of bird, mosquito, mammalian and human surveillance data.
- DOHMH will evaluate emerging methods of surveillance and control.
- DOHMH will research and evaluate the potential public health and environmental impact of the application of pesticides for adult mosquito control.
- DOHMH will research and evaluate the development of resistance in mosquitoes due to the application of pesticides (microbial larvicides and adulticides).
- DOHMH will test hibernating mosquitoes for WN virus infection to determine their role in the overwintering of WN virus from one season to the next.
- The host seeking activity patterns of mosquitoes will be determined by using collection

bottle rotator traps in various habitats such as marsh, urban areas and parks.

- Larval surveillance will be conducted before and after the control activities in the catch basins (storm drain) and natural breeding sites for determining larval control efficacy of the pesticides.



**QUESTIONS AND ANSWERS ABOUT WEST NILE VIRUS**

**Q: What Mosquito-Borne Diseases are present in New York City?**

**A:** West Nile virus is the only locally mosquito transmitted disease known to currently occur in the City.

**Q: Do all mosquitoes carry disease?**

**A:** While there are many different species of mosquitoes, only a small proportion can transmit diseases like West Nile virus.

**Q: What is West Nile virus?**

**A:** West Nile virus is a mosquito-borne virus that can infect humans, birds, horses and other mammals. In most humans, West Nile virus infection causes a mild or moderate, short-lived flu-like illness, or causes no symptoms at all. However in some cases, particularly among persons 55 years of age and older, it can cause serious neurological diseases such as encephalitis, meningitis, or acute flaccid paralysis. West Nile virus first appeared in North America in New York City in 1999. Since then, the virus has spread across the continental United States. Visit [www.cdc.gov/westnile/](http://www.cdc.gov/westnile/) for more information on West Nile virus nationally.

**Q: What are the symptoms of West Nile virus?**

**A:** Most people who are infected with West Nile virus either have no symptoms or experience a mild or moderate illness with symptoms such as fever, headache, fatigue, or body aches before fully recovering. Some persons may also develop a rash or swollen lymph glands.

In some individuals, particularly persons 55 years of age and older, West Nile virus can cause serious disease that affects the brain and spinal tissue. Severe illness may include encephalitis (inflammation of the brain), meningitis (inflammation of the membrane around the brain and spinal cord), or acute flaccid paralysis (a polio-like syndrome in which muscles become very weak or paralyzed). Symptoms of more severe disease may include headache, high fever, stiff neck, nausea and vomiting, confusion, coma, tremors, convulsions, muscle weakness and/or paralysis.

At its most serious, West Nile virus can cause permanent neurological damage and death. Among those people who need to be hospitalized for West Nile virus, 10-15% die of their illness. People who do develop symptoms normally become ill 3-15 days following the bite of an infected mosquito.

**Q: How is West Nile virus spread?**

**A:** West Nile virus is predominantly spread to humans by the bite of an infected mosquito. Several other methods of human transmission have been discovered but appear to be rare. It has now been shown that West Nile virus can be transmitted to humans who receive transfusions of infected blood or blood products, or who receive infected organs through

transplantation. Also, there have been a few cases of transmission from a pregnant woman to her fetus, and a couple of probable cases of mother-to-baby transmission through breast milk. Additionally, a few laboratory workers were accidentally infected following injuries while handling infected birds. West Nile virus is NOT spread by casual contact such as touching, kissing, or caring for someone who is infected.

**Q: How is West Nile Virus encephalitis treated?**

**A:** There is no specific treatment for West Nile virus. Most people who become infected will get better on their own. In more severe cases, intensive supportive therapy is indicated, i.e., hospitalization, intravenous (IV) fluids and nutrition, airway management, ventilatory support (ventilator) if needed, prevention of secondary infections and proper nursing care.

Recently, some experimental treatments for West Nile virus have become available for people with severe disease. In New York City, two hospitals are participating in clinical trials of these experimental therapies. Not every patient with West Nile infection is eligible for these treatments.

Patients or their families who want more information about these experimental treatments should ask their medical providers about them. Medical providers may contact the Bureau of Communicable Disease at the New York City Department of Health and Mental Hygiene for more information.

**Q: Where did West Nile virus come from?**

**A:** Outbreaks of West Nile virus have occurred in Africa, Egypt, Israel, Asia, Romania, Russia and France. Before 1999, West Nile virus had not been found in the Western Hemisphere. The virus was most likely introduced by an infected bird or mosquito that was imported from a country where the virus is common.

**Q: Who is most at risk for getting severe West Nile virus disease from being bitten by an infected mosquito?**

**A:** Anyone who is infected can potentially develop severe West Nile virus disease (e.g. encephalitis, meningitis, or acute flaccid paralysis). However, persons older than 55 have the highest risk of becoming severely ill. There is also increasing evidence that immunocompromised persons (e.g., people who are taking immunosuppressive medications such as prednisone, or people who have received organ transplants) are at higher risk for severe West Nile virus disease.

**Q: How long does it take to get sick if bitten by an infected mosquito?**

**A:** Most people who are infected with West Nile virus have no symptoms or experience only mild illness. If illness does occur, symptoms generally appear between 3 to 15 days of being bitten by an infected mosquito.

**Q: Can you get West Nile virus directly from birds?**

**A:** In 2002, CDC reported two human cases of West Nile virus in laboratory workers who became infected after injuries while handling infected dead birds. It is unlikely that members of the general public would be exposed to West Nile virus in this manner.

However, as always, when handling a dead bird or animal for disposal, use gloves to carefully place the bird in double-plastic bags and then place in the outdoor trash.

**Q: Besides mosquitoes, can you get West Nile virus directly from other insects or ticks?**

**A:** Infected mosquitoes are the primary source of West Nile virus and caused the recent outbreaks in the United States. Although several types of ticks in Africa and Europe have been found to be infected with West Nile virus, there is no evidence that ticks or other insects in this country are able to transmit the virus.

**Q: Are children and infants at greater risk for severe West Nile virus disease?**

**A:** Although anyone who is infected can potentially develop severe West Nile virus disease (e.g. encephalitis, meningitis, or acute flaccid paralysis), persons older than 50 have the highest risk of becoming severely ill. Children and infants, however, can develop serious disease from West Nile virus. In 2002 and 2003, more than 200 children under age 19 years in the US were reported with West Nile encephalitis or meningitis.

Recent evidence suggests that babies born to mothers with West Nile virus infection during pregnancy may be infected with West Nile virus themselves. However, it is unknown how often this occurs, and what the effects of West Nile virus infection may be on the fetus and newborn infant. Also, there is one case of probable transmission of West Nile virus to a newborn via breast milk; in this one case, which occurred in 2002, the baby has remained completely healthy.

**Q: If a pregnant woman gets infected with West Nile virus, can it affect her fetus?**

**A:** Maybe. In 2002 there was one case of transmission of West Nile virus from mother to fetus during pregnancy. The newborn was infected with West Nile virus at birth and had severe neurological problems, including abnormalities of the brain and retinas. It is possible that West Nile virus caused these abnormalities in the baby; however, it is not proven.

More information is now being gathered about other babies born to mothers infected with West Nile virus during pregnancy in order to improve our understanding of the effects of West Nile virus on the fetus and newborn. Three other instances of maternal infection were investigated in 2002; babies born to these mothers appeared normal and had negative laboratory tests for West Nile virus.

**Q: Can West Nile Virus be transmitted through breast milk?**

**A:** Possibly. It appears that West Nile virus may be transmitted to infants through breast milk. In 2002, a woman developed encephalitis due to West Nile virus acquired through a blood transfusion she received shortly after giving birth. Laboratory analysis showed evidence of West Nile virus in breast milk collected from the mother soon after she became ill. She had been breastfeeding her infant and approximately 3-4 weeks after birth the infant tested positive for the West Nile virus. Because of the infant's minimal outdoor exposure, it is unlikely that the infection was transmitted by a mosquito. The infant had no symptoms of West Nile virus and remained healthy.

**Q: Is there a vaccine for West Nile virus?**

**A:** There is currently no human vaccine for West Nile virus, but several companies are working towards developing one. There is a West Nile virus vaccine that has been approved for use in horses.

**Q: What should I do if I think I have West Nile virus?**

**A:** People with mild or moderate symptoms should recover completely, and do not usually require any specific medication or laboratory testing. However, if you develop symptoms such as fever, headaches, stiff neck, confusion, muscle weakness, or your eyes become sensitive to light, you should consult your doctor and be tested for West Nile virus.

**Q: If I am bitten by a mosquito, should I be tested for West Nile virus?**

**A:** Most mosquitoes are not infected with West Nile virus and illnesses related to mosquito bites are uncommon. There is no need to be tested for West Nile virus unless you are ill and your symptoms suggest possible West Nile virus infection. If you develop symptoms such as fever, headaches, stiff neck, confusion, muscle weakness, or your eyes become sensitive to light, you should consult your doctor.

**Q: What can I do to prevent infection with West Nile virus?**

**A:** From June through October, when mosquitoes are most active, take the following precautions:

- Wear protective clothing such as long pants and long-sleeved shirts, particularly at dusk and dawn when most mosquitoes are searching for a blood meal.
- Avoid shaded, bushy areas where mosquitoes like to rest.
- Limit outdoor evening activity, especially at dusk and dawn when mosquitoes are most active.
- Use an insect repellent containing DEET, picaridin, oil of lemon eucalyptus, or IR3535 to help reduce exposure to mosquitoes. Always read the repellents label. For more information, see DOHMH's Insect Repellent Use & Safety Fact Sheet.

There have been no reported adverse reactions following the use of repellents containing DEET in pregnant or breastfeeding women. As a precaution, prior to handling infants, nursing mothers should wash repellents off their hands and areas of the breast that an infant may contact. (Please see the DOHMH fact sheet on Insect Repellent Use & Safety).

**Q: If I travel outside New York City, do I need to worry about West Nile virus?**

**A:** Yes. West Nile virus has spread throughout the United States and is present in other parts of the world as well. In some areas of the country, particularly the south and the west, the West Nile virus transmission season lasts longer. People can become infected with West Nile virus early in the spring or as late in the year as November or December. So when you travel, especially during the spring, summer and fall, you should check with the local health department wherever you go to see if West Nile virus is present. If it is, then you should take precautions to avoid mosquito bites, as described in the previous question.

**Q: What can I do around my home to help reduce exposure to mosquitoes?**

**A:** Mosquitoes lay their eggs in standing or slow moving water. Also weeds, tall grass, and bushes provide an outdoor resting place for mosquitoes. In residential areas, standing water can accumulate in unused tires, cans, unused pools and pool covers, and other receptacles that collect water. Mosquitoes can enter homes through unscreened windows or doors, or broken screens. Follow these general guidelines to help reduce mosquito populations in your area:

- Eliminate any standing water that collects on your property by:
  - Removing all discarded tires from your property.
  - Disposing of tin cans, plastic containers, ceramic pots, or similar water-collecting containers.
  - Making sure roof gutters drain properly and cleaning clogged gutters in the spring and fall.
  - Cleaning and chlorinating swimming pools, outdoor saunas and hot tubs. If not in use, keep empty and covered.
  - Draining water from pool covers.
  - Changing the water in bird baths at least every 3 or 4 days.
  - Turning over plastic wading pools and wheelbarrows when not in use.
- Repair or replace all screens in your home that have tears or holes.
- Remind or help neighbors to eliminate mosquito-breeding sites on their properties.

Some local hardware stores may carry a product called Mosquito Dunk® that contains a larvicide - *Bacillus thuringiensis israelensis* (Bti) - for use in areas of standing water around the home. The New York City Department of Health and Mental Hygiene recommends eliminating standing water around the home to reduce breeding sites for mosquitoes and warns that direct handling of larvicides may cause skin and eye irritation. Use these products only as directed by the manufacturer. If these products are purchased for home use, we recommend careful reading of the hazards label, directions, and details regarding storage and handling.

**Q: Should I report dead birds to the Department of Health and Mental Hygiene?**

**A:** No, unless you are reporting a group of 10 or more dead birds of any species, or a group of 3 or more dead waterbirds. The Health Department will no longer take reports of individual dead birds to monitor for West Nile virus. These tests had limited value as an early warning system for the virus. The Department will continue to take reports of groups of dead birds (10 or more of any species or 3 or more waterbirds). To report these clusters, **call 311**. If you need to dispose of a dead bird, use disposable rubber gloves to carefully place it in a double plastic bag, then put the bag in the outdoor trash. Wash your hands with warm soapy water afterwards.

**Q: What is the City doing to address the problem of West Nile virus?**

**A:** New York City is working to reduce the risk of West Nile virus infection. The main goal is to decrease the number of adult mosquitoes by eliminating breeding sites wherever possible and applying larvicides (to kill the immature larval form of the mosquito) to areas of standing water that cannot be drained completely. The City also regularly tests mosquitoes for West Nile virus throughout the spring and summer.

**Q: Is the City planning to spray pesticides?**

**A:** New York City may spray pesticides to target adult mosquitoes if there is a risk to human health from West Nile virus. Spraying will be concentrated in areas most at risk for disease occurrence and will be conducted by experienced and licensed applicators who are required to follow New York State Department of Environmental Conservation (NYSDEC) and EPA requirements. The City is hopeful that with an early and aggressive campaign against mosquito breeding areas, the need for the spraying of pesticides will be reduced.

**Q: Will the public be notified in advance about spraying activities?**

**A:** Residents can learn about adulticiding schedules in advance through public service announcements, the media, the City's website visit [nyc.gov/health](http://nyc.gov/health) and search **mosquitoes**, or by calling **311**, the City's Information Line. DOHMH will provide notification at least 24 hours prior to a spray event.

**Q: What health risks are posed to people and pets from pesticides for adult mosquitoes?**

**A:** In the amounts used, risks to people and pets are relatively low. However, some people may be more sensitive to pesticides and may want to reduce their chance of exposure by following the suggestions below. Anyone experiencing adverse reactions to pesticides should seek medical care or call **311** or the NYC Poison Control Center at **(212) POISONS (764-7667)**.

**Q: If the City sprays pesticides in an area where I am, what should I do during the spraying?**

**A:** If pesticide spraying occurs, DOH recommends that all individuals take the following precautions to avoid direct exposure to pesticides and reduce the risk of reactions:

Whenever possible, stay indoors during spraying.

Some individuals are sensitive to pesticides. Persons with asthma or other respiratory conditions are encouraged to stay inside during spraying since there is a possibility that spraying could worsen these conditions.

Air conditioners may remain on. But if you wish to reduce the possibility of indoor exposure to pesticides, set the air conditioner vent to the closed position, or choose the recirculate function.

Remove children's toys, outdoor equipment and clothes from outdoor areas during spraying. If outdoor equipment and toys are exposed to pesticides, wash with soap and water before using again.

Wash skin and clothing exposed to pesticides with soap and water.

Always wash your produce thoroughly with water before cooking or eating.

For more information about West Nile virus, call **311** or visit [nyc.gov/health](http://nyc.gov/health) and search **mosquitoes**.

## GLOSSARY

<b>adulticide</b>	a type of pesticide used to kill adult mosquitoes
<i>Aedes albopictus</i>	a day biting species of mosquitoes
<i>Aedes sollicitans</i>	<i>See Ochlerotatus sollicitans</i>
<b>Altosid</b>	brand name of methoprene, a type of larvicide
<b>arbovirus</b>	shortened term for <b>arthropod-borne virus</b> , a virus that is carried by arthropods
<b>arthropod</b>	a group of an animal that does not have a backbone and have jointed walking appendages, such as insects, spiders and lobsters
<i>Bacillus sphaericus</i>	a bacterium; type of biological pesticide used to control mosquito larvae in water (mosquito larvae die after ingesting this bacterium)
<i>Bacillus thuringiensis</i> <b>var. israelensis (Bti)</b>	a bacterium; type of biological pesticide used to control mosquito larvae in water (mosquito larvae die after ingesting this bacterium); bacteria found in Mosquito Dunks®
<b>bridge vector</b>	an arthropod (in this case, a specific species of mosquito) that serves as a main transmission of virus between the reservoir (birds) and humans.
<b>catch basins</b>	grates seen at street corners and in other properties for water runoff
<i>Culex pipiens</i>	a species of mosquito, the primary vector for West Nile virus, commonly found in urban areas; breeds in fresh, but stagnant water, such as backyard containers and storm drains
<b>DEET</b>	DEET (chemical name, N,N-diethyl-meta-toluamide) is the active ingredient in many insect repellent products
<b>Eastern Equine Encephalitis (EEE)</b>	mosquito-borne viral disease that causes inflammation of the brain; similar to West Nile
<b>encephalitis</b>	inflammation of the brain, which can be caused by numerous viruses and bacteria, including West Nile virus

<b>Environmental Impact Statement (EIS)</b>	A document that describes the impact on the environment from a proposed action (in this case, the application of pesticides to control adult mosquitoes).
<b>gravid traps</b>	mosquito traps designed to attract pregnant female mosquitoes
<b>Interactive Voice System</b>	an automated telephone system by which information can be accessed by choosing from a set of options
<b>IR3535</b>	IR3535 (3-[N-Butyl-N-acetyl]-aminopropionic acid, ethyl ester) is the active ingredient in many insect repellent products
<b>larvae</b>	immature mosquitoes that live in water; stage which hatches from the egg, prior to adult stage
<b>larvicide</b>	a type of pesticide used to control immature or larval mosquitoes
<b>light traps</b>	mosquito traps outfitted with a light to attract mosquitoes
<b>meningitis</b>	inflammation of the lining of the brain and spinal cord that can be caused by a virus or bacteria
<b>methoprene</b>	a type of (synthetic) insect growth regulator used to control larval mosquitoes; it prevents mosquito larvae from emerging and developing into adult mosquitoes
<b>mosquito breeding site</b>	a location where mosquitoes lay eggs, usually in stagnant water with organic material
<b>mosquito pools</b>	a group of mosquitoes of the same species, collected in given area and combined at the laboratory for testing for the presence of West Nile and related viruses
<b>naled</b>	an organophosphate pesticide used to control adult mosquitoes
<b>neurology</b>	the study of the nervous system and its disorders
<b><i>Ochlerotatus sollicitans</i></b>	species of mosquito that breeds in salt marshes
<b>outbreak</b>	an unexpected increase in frequency or distribution of a disease
<b>permethrin</b>	a synthetic pyrethroid pesticide used to control adult mosquitoes; active ingredient in the product Biomist®
<b>pesticide</b>	substance used to kill pests such as insects, mice and rats; an insecticide is a form of pesticide



<b>picaridin</b>	(chemical name, 1-Piperidinecarboxylic acid, 2-(2-hydroxyethyl)- 1-methylpropylester) is the active ingredient in many insect repellent products
<b>piperonyl butoxide</b>	An additive to pyrethroid pesticides that improves the effectiveness of the active ingredient
<b>salt marsh</b>	areas of vegetation in bodies of salt water that may support the breeding of certain types of mosquitoes such as <i>Ochlerotatus sollicitans</i> ; example of salt marshes is Jamaica Bay.
<b>sentinel</b>	an early warning system, in this case, for the presence of virus (e. g. , sentinel chickens)
<b>serologic</b>	of, or relating to, serum
<b>source reduction</b>	the removal or reduction of larval mosquito habitats
<b>St. Louis encephalitis (SLE)</b>	mosquito-borne viral disease that causes inflammation of the brain; very similar to West Nile virus
<b>sumithrin</b>	a synthetic pyrethroid pesticide used to control adult mosquitoes; active ingredient in the product Anvil 10+10 <sup>®</sup>
<b>VectoBac</b>	brand name for the larvicide <i>Bacillus thuringiensis</i> var. <i>israelensis</i> ( <i>Bti</i> )
<b>VectoLex</b>	brand name for the larvicide <i>Bacillus sphaericus</i>
<b>VectoMax</b>	brand name for the larvicide based on mixture of <i>Bacillus sphaericus</i> and <i>B. thuringiensis</i> var. <i>israelensis</i> ( <i>Bti</i> )
<b>vector</b>	an organism (an insect in most cases) capable of carrying and transmitting a disease-causing agent from one host to another
<b>viral</b>	of, or relating to, a virus
<b>viral encephalitis</b>	inflammation of the brain caused by a virus, such as West Nile virus