

COMPREHENSIVE MOSQUITO SURVEILLANCE AND CONTROL PLAN

2023



The City of New York
DEPARTMENT OF HEALTH AND
MENTAL HYGIENE

Eric Adams
Mayor

Ashwin Vasani, MD, PhD
Commissioner

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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 is overseen by the New York City Health Department's Office of Vector Surveillance and Control.

At this time, West Nile (WN) virus is the only recognized locally-acquired mosquito-borne human disease in New York City. WN virus first appeared in the Western Hemisphere in 1999. The first cluster of human cases was identified in Queens, New York City (NYC, the City). Since then, the disease has spread throughout the continental United States. WN virus is spread by *Culex* mosquitoes primarily by *Culex pipiens*, *Cx. restuans* and *Cx. salinarius*. Most people infected with WN virus have no symptoms or they experience mild illness and recover on their own. In rare cases, the virus can be deadly and cause inflammation of the spinal cord and brain.

Each year, New Yorkers are diagnosed with travel associated mosquito-borne arboviral diseases, most notably dengue with occasional reports of chikungunya and over one thousand Zika virus infections in 2016 to 2017. These viruses are typically transmitted by *Aedes aegypti*, which is not found in NYC. A related mosquito species, *Aedes albopictus*, which is a less efficient vector of these viruses is found throughout NYC. Locally acquired cases of these infections have not been identified among NYC residents. Sustained mosquito control efforts are important to prevent outbreaks from all mosquito-borne diseases. Beginning 2016, *Aedes*-borne disease prevention efforts have been incorporated into the DOHMH West Nile Virus Control Plan.

To reduce the risk of WN virus and other potential mosquito-borne diseases, the DOHMH uses Integrated Pest Management (IPM). IPM is safer and more effective than other vector control approaches. IPM relies on surveillance, education, and habitat reduction to proactively reduce mosquito populations instead of relying primarily on pesticide use.

Each mosquito season, DOHMH takes the following mosquito control steps:

- Removing standing water where mosquitoes can breed
- Reducing mosquito larvae in mosquito season using environmentally safe agents
- Working with the public to reduce standing water through public outreach/education and by investigating standing water complaints reported to 311
- Surveillance of mosquito populations and disease

This document explains the technical steps of mosquito control. It is intended for vector control professionals. For general health guidance on mosquitoes and mosquito bite prevention, visit nyc.gov/health/mosquito.

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 area. Since 1999, WN virus has reappeared in NYC each year during the adult mosquito season. A total of 413 human cases of WN neuroinvasive disease, including 59 deaths, have occurred among NYC residents from 1999-2022. Human cases of WN fever (a less severe form of disease) have also been reported (n=89), although the number of undetected or unreported WN fever cases is estimated to be much higher. Over the past twenty-four years, 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 737 human cases of WN neuroinvasive disease, including 79 deaths, were identified nationwide.

Each year, other mosquito-borne viral diseases are diagnosed among New Yorkers who travel to affected areas. Dengue is reported most often and is associated primarily with travel to the Caribbean and Central and South America, and occasionally travel to Asia. Dengue virus is endemic in tropical and sub-tropical regions, with certain years being more severe than others. In 2019, the largest number of dengue cases ever recorded was reported, with over 3.1 million cases throughout the globe (most being in the Caribbean and Central and South America). In 2014, a large outbreak of chikungunya occurred in the Caribbean and Latin America, resulting in over 600 cases of travel-associated chikungunya among New Yorkers that year. In 2015, local transmission of Zika virus infection was first identified in the Western Hemisphere in Brazil. Zika virus was originally discovered in Uganda in 1947; like WN virus it had not been seen previously in the Americas. Zika virus can cause severe birth defects including microcephaly, and has also been linked to Guillain-Barre syndrome. A large outbreak in Latin America and the Caribbean in 2016 resulted in over 1,000 travel associated Zika infections among NYC residents who traveled to affected areas. That year, minor outbreaks of Zika virus also occurred in Florida and Texas. To date, no locally-acquired cases of chikungunya, dengue, or Zika virus infections have been identified among NYC residents. NYC does not have the *Aedes aegypti* species, which has been confirmed to spread chikungunya, dengue, and Zika virus, but it does have a related mosquito *Ae. albopictus*, the Asian tiger mosquito. This species has not been implicated in the recent Zika outbreak, however, there is laboratory evidence that *Ae. albopictus* may carry and spread Zika virus. Additionally, *Ae. albopictus* mosquitoes have been involved in chikungunya and dengue transmission in parts of Europe, Africa, and Asia.

The Department of Health and Mental Hygiene (DOHMH) routinely analyzes surveillance and control data from previous years to better prepare for the upcoming mosquito season. The 2022 Comprehensive Mosquito Surveillance and Control Plan is built on our extensive experience with West Nile virus prevention and control since 1999 and our current understanding of other mosquito-borne disease threats to NYC. 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 Emergency Management (NYCEM), 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).

DOHMH takes a proactive approach for the prevention of mosquito-borne diseases in the City. 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 disease transmission to humans, adult mosquito control (adulticiding) is considered.

Surveillance data collected from 2000-2022 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 re-emerging or newly emerging. 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.

Despite the fact that mosquitoes are active in New York City from April through October, our mosquito prevention, surveillance and control efforts are year-round. 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, Oregon State University, Corvallis, OR 97331]

The objective of the DOHMH Comprehensive Mosquito Control Program is “to prevent or reduce locally transmitted human cases of mosquito-borne illnesses in the City.” In the case of chikungunya, dengue and Zika virus, the Department seeks to reduce the risk that local transmission will occur, since only travel-related cases have been observed. IPM, especially for WN and aforementioned *Aedes*-borne viruses, involves using all the tools available for prevention and control of mosquitoes and these viruses. Key components of mosquito-borne disease IPM include community outreach and education, prevention of biting of humans by vectors (infected mosquitoes), surveillance and control (non-chemical methods are considered first and if a chemical pesticide is used that it be the lowest toxicity pesticide that is most

effective against mosquitoes).

Public Education and Community Outreach

The Office of Vector Surveillance and Control (OVSC) conducts public education and community outreach through the media, advertising, as well as collaboration with community boards and elected officials. Presentation to community group will be conducted virtually or in person where possible. During the mosquito season, NYC continually posts neighborhood level surveillance data and updates on mosquito Control activities (www.nyc.gov/health/mosquito). OVSC works in collaboration with the DOHMH Office of External Affairs to increase public awareness of mosquito-borne disease risk, mosquito and disease surveillance, personal protective measures against mosquito bites, and mosquito habitat reduction. 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 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 (BCD) makes ongoing efforts to educate New York City health care providers regarding diseases transmitted by mosquitoes, especially WN virus, 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 routine testing through commercial laboratories, they can also submit specimens directly to the New York State Department of Health for WN virus PCR and immunoassay testing as well as 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 that 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 throughout the City are regularly tested for WN virus during the spring, summer, and early fall.

Mosquito Surveillance

OVSC monitors mosquitoes citywide by collecting larval and adult mosquitoes to determine

mosquito distribution, density and species. DOHMH tests adult mosquitoes collected in the City for mosquito-borne viruses at the Public Health Laboratory (PHL). With testing taking place locally, the time required to receive results is minimized, allowing for increased public education, and more targeted control of larval and mosquitoes in areas with increased viral activity. Mosquito surveillance allows for targeted mosquito control activities.

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 which 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 which includes catch basins citywide and natural mosquito breeding habitats. When WN or another mosquito-borne virus is detected in an area, DOHMH will increase public education, breeding site reduction activities, 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 (EIS) on the pesticides used for adult mosquito control in 2001. The department filed a Technical Memo updating the EIS in 2017. This 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 WN virus or other diseases spread by mosquitoes. 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 monitors the adverse health effects associated with the application of pesticides for adult mosquito control through syndromic surveillance. Additional pesticide products have been approved for use in NYC

by state and federal agencies. DOHMH will continue to assess the health effects of these and any products considered for use for its mosquito control program.

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 diseases spread by mosquitoes are maintained in our environment. DOHMH evaluates surveillance indicators that signal a threat to human health and to assess the efficacy of larval and adult mosquito control activities.

INTRODUCTION

New York City experienced recurring outbreaks of yellow fever and malaria in the nineteenth century and early parts of the twentieth century, respectively. In present times, West Nile (WN) virus is the only mosquito-borne disease that has been transmitted by local mosquitoes in the City. WN virus is primarily transmitted by *Culex* mosquitoes. The City does not have the *Aedes aegypti* species, which has been demonstrated to spread chikungunya, dengue and Zika virus, but it does have related mosquitoes in the *Aedes* genus. *Ae. albopictus*, a known vector of chikungunya and dengue fever, is found in all boroughs of the City. There is laboratory evidence that this mosquito may also carry and spread Zika virus, however, it has not been implicated in the recent outbreak, nor has its competence as a vector been demonstrated.

In late August of 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 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 45 were NYC residents who were hospitalized. There were 4 fatalities resulting from WN virus infection.

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 413 neuroinvasive cases and 59 deaths. From 1999-2022, the number of neuroinvasive cases due to WN virus among New York City residents has ranged from 2 to 45 (median 15) per year.

In 2022, forty-six cases (36 neuroinvasive and 10 fever) of WN disease were detected among New York City residents, most of which were possibly or probably acquired in New York City.

Data from the CDC indicate that there were 1,035 human cases (737 neuroinvasive and 298 fever) and 79 human deaths reported in the United States in 2022. For more information, please refer to the CDC homepage (cdc.gov/westnile).

Since 2003, universal screening of donated blood products has been conducted in New York City by the New York Blood Center. Between 2003 and 2022, 23 presumptively infected donors have been identified in New York City. All implicated blood products were retrieved and removed from the blood supply.

The reoccurrence of human cases of WN virus every year and repeated identification of WN virus activity in mosquitoes provides ample evidence that this virus has established permanently in New York City and the United States. With the establishment of WN virus, having a routine, year-round, integrated pest management 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,

reintroduction of the virus into the area may occur 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 WN virus during the amplification cycle before it spills over to humans. Typically, infected mosquitoes signal the presence of local WN virus activity, and occur a month or more prior to human transmission. The goal of DOHMH’s vector surveillance program is to detect WN virus in local mosquito populations before sufficient amplification of the virus can occur. This allows for the execution of targeted IPM practices, 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), Agriculture and Markets; and New York City agencies, including the New York City Emergency Management Department 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 Mosquito-borne illnesses in Humans

Prevention is the key to the DOHMH mosquito IPM 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) with biorational pesticides. 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 can 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 and older or those with weakened immune systems, should take special care to prevent WN virus infection as they are more susceptible to severe WN virus disease.
- b) Avoid going outside at dusk or dawn. If you do, or if mosquitoes are biting during the day, wear long pants, long-sleeved shirts and socks.
- c) Use an EPA approved insect repellent containing: 2-undecanone, DEET, picaridin, IR3535, or oil of lemon eucalyptus according to the label's directions.
- d) Make sure doors and windows have tight-fitting screens. Repair or replace screens that have tears or holes.
- e) 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 this comprehensive mosquito control plan. The more people know about mosquitoes and WN virus and other diseases spread by mosquitoes, the better they can protect themselves and help in reducing breeding sources. The OVSC conducts community outreach and education through both in-person and virtual presentations and also provides information through its website (www.nyc.gov/health/mosquito) and with literature on the personal prevention of WN and other mosquito-borne viruses.

Surveillance

The DOHMH mosquito-borne disease surveillance program includes 1) monitoring of human cases, 2) "in-season" surveillance of larval and adult mosquitoes, 3) "off-season" surveillance of overwintering adult mosquitoes, and 4) identification and characterization of breeding sites. Larval surveillance helps OVSC to 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 and gravid traps in about 257 (2022) locations strategically located throughout the City. Locations of these traps are based on current and past surveillance data. If WN or any other mosquito-borne virus is found in a location, supplemental traps are added to better define the distribution of WN virus activity 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 the lowest toxicity (and least persistent) pesticide that is most efficacious on mosquitoes will be used.

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.

For WN virus, 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.

For *Aedes*-borne viruses, adulticide will be applied only when there are high numbers of imported human cases in specific areas of the city where *Aedes albopictus* is also abundant and/or upon detection of these virus in *Ae. albopictus* mosquitoes, or if there are human cases that are locally acquired.

PUBLIC EDUCATION & COMMUNITY OUTREACH

Objective

To increase public awareness of mosquito-borne diseases and prevention.

Background

Each year, DOHMH launches a public education initiative, called “Fight the Bite” to increase awareness of mosquito bite prevention, standing water reduction, West Nile virus, and other diseases spread by mosquitoes.

Prior to mosquito season, DOHMH will reach out to previous recipients of standing water violations, cemeteries and large property owners at high risk for mosquito breeding habitats to remind them of the importance of eliminating standing water from their premises.

At the beginning of each season, DOHMH releases a Health Advisory to remind providers to consider West Nile virus disease in patients presenting with compatible illness and a press release to notify the public on the risk of WN virus and other diseases spread by mosquitoes and to educate them on personal protection strategies. DOHMH has developed educational fact sheets on mosquito bite and standing water prevention in seven languages for distribution to community-based organizations, community boards, elected officials, schools and the general public. This information can also be downloaded from the DOHMH’s website. The campaign also features presentations and other outreach activities from DOHMH staff to various community groups in the neighborhoods with higher risk of WN virus infection.

DOHMH promotes mosquito-borne disease prevention strategies and community participation in mosquito control program. OVSC’s community outreach activities include participating in community meetings, attending health fairs, and presentations targeting populations at highest risk for WN virus infection. The Press Office makes spray notifications and personal precaution announcements through the media and press releases relating to mosquito control events in the City. Through collaboration, educational materials are made widely available in hard copy and electronic form (through email and the Agency's website), in multiple languages. Information is also made available through 311.

In 2023, DOHMH will take standing water and mosquito infestation reports via New York City’s NYC311 and DOHMH’s Web site (nyc.gov/health/mosquito). 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 (www.nyc.gov/health/mosquitoes) in the form of fact sheets, press releases, larviciding, mosquito control 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 messaging and Department of Citywide Administrative Services (DCAS) on preventing the breeding of

mosquitoes on publicly owned property.

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.

To raise awareness of mosquito control events, the DOHMH uses the Notify NYC System to reach out to the public in areas at higher risk of disease transmission and during adulticiding events. This system allows residents of the City to receive alerts on many different communication devices such as cell phones, landlines, pagers, and email. 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. In addition, prior to each event, DOHMH places posters up in high trafficked areas of affected communities to alert them of the event.

Planned Activities

- 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 diseases spread by mosquitoes 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 NYC311 and via DOHMH's Website (www.nyc.gov/health/WNvirus). The public will be advised to eliminate standing water sites (tires, buckets, and other water-holding objects) 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 OVSC will conduct outreach on WN virus prevention and habitat reduction, focusing on populations at highest risk of disease transmission.
- The Office of Community Affairs will assist in increasing public awareness of the nature of mosquito-borne diseases
- 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.
- 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.
- NYC311 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.

- DOHMH's web site (nyc.gov/health/mosquito) 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 media's coverage.
- 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.
- 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, and NYC311, 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.
- Posters will be placed in public areas alerting residents of the upcoming spray event.
- 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 in order to reduce exposure to pesticides.

HUMAN SURVEILLANCE AND PROVIDER EDUCATION

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

From 1999-2022, 413 New York City residents were reported with neuroinvasive disease due to WN virus. Among these cases, 59 died as a result of West Nile infection. Most of the neuroinvasive cases have occurred in older New Yorkers (median: 65 years; range 1-95). Eighty-nine (89) cases of WN fever were also detected during this time period. In 2022, 36 New York City residents were diagnosed with WN neuroinvasive disease. Most of these cases of WN viral disease probably became infected locally. The tables below summarize WN virus disease by borough and syndrome.

West Nile Viral Disease by Borough, NYC, 1999-2022 (includes neuroinvasive and non-neuroinvasive cases)

Year	Bronx	Brooklyn	Manhattan	Queens	Staten Island	Total
2022	1	6	6	13	10	46
2021	4	3	4	9	1	21
2020	0	1	3	2	1	7
2019	0	3	0	4	3	10
2018	4	7	6	18	1	36
2017	0	9	4	8	0	21
2016	0	2	0	2	2	6
2015	2	12	1	17	6	38
2014	1	5	2	5	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	2	7	1	7	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	3	11	4	32
2002	9	2	2	12	4	29
2001	0	2	3	2	2	9
2000	0	2	1	1	10	14
1999	9	3	1	34	0	47
Total Cases	58	102	60	190	82	502

The table below summarizes morbidity and mortality due to WN virus in New York City from 1999-2022:

West Nile Viral Disease, NYC, 1999-2022

Year	Cases	Syndrome		Median Age*		Deaths	
		Neuroinvasive	WN Fever	Yrs	Range	#	Case Fatality Rate*
2022	46	36	10	65	(1-95)	2	6%
2021	21	18	3	65	(26-87)	0	-
2020	7	6	1	54	(39-87)	1	17%
2019	10	8	2	71	(33-89)	0	-
2018	36	30	6	60.5	(31-88)	2	7%
2017	21	20	1	62	(28-87)	2	10%
2016	6	6	0	49.5	(32-77)	0	-
2015	38	30	8	59	(22-89)	6	20%
2014	15	12	3	59	(36-81)	3	25%
2013	10	8	2	64	(45-81)	2	25%
2012	41	26	15	61.5	(1-88)	7	27%
2011	11	9	2	69	(41-82)	1	11%
2010	42	34	8	64	(19-87)	5	15%
2009	3	3	0	63	(60-73)	1	33%
2008	15	8	7	64	(33-86)	1	13%
2007	18	13	5	75	(41-90)	5	38%
2006	12	8	4	64.5	(44-80)	2	25%
2005	14	11	3	61	(27-84)	2	18%
2004	5	2	3	33.5	(1-66)	3	27%
2003	32	31	1	68	(8-93)	7	23%
2002	29	28	1	72	(22-86)	3	11%
2001	9	7	2	51	(44-75)	1	14%
2000	14	14	0	62	(36-87)	1	7%
1999	47	45	2	70	(5-90)	4	9%
Summary	502	413	89	65	(1-95)	59	14%

* 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, and an additional 30 cases of WN fever, occur for each case of neuroinvasive disease. Therefore, approximately 57,820 asymptomatic infections and 12,390 cases of WN fever have likely occurred among New York City residents from 1999-2022. 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 healthcare provider.

As part of a surveillance and provider education program, BCD 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 consider WN virus testing for any patients presenting with encephalitis, aseptic meningitis and acute flaccid paralysis from July through October. In July 2010, the DOHMH Public Health Laboratory discontinued routine serologic testing for WN virus. Providers are 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, several 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. Over the past five years from 2018 to 2022, NYC reported 242 cases of dengue. In 2014 a new outbreak of chikungunya virus in the Caribbean resulted in over 600 cases identified among NYC residents. The numbers declined with 24 cases reported from 2018 to 2022. Interviews with patients revealed that most had acquired their infection while traveling in the Caribbean and Central and South America, with a few cases more recently coming from areas with localized outbreaks. While no cases of Zika virus infection were identified among NYC residents in 2015, a large outbreak in Latin America, Mexico and the Caribbean that year resulted in 993 travel-associated Zika infections among NYC residents who traveled to affected areas in 2016. As the outbreak wound down in the affected areas, the number of cases in NYC declined. Between 2016 and 2020, 181 cases were reported; none were reported in 2022. We will continue to conduct human surveillance to identify travel associated mosquito-borne disease cases among NYC residents. DOHMH conducts passive surveillance for dengue virus, chikungunya virus and Zika virus infections, 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 WN virus 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.
- If possible, presentations will be made at local hospitals and to specialty societies as requested.
- BCD 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 providers who want to pursue mosquito borne infections other than WN virus, dengue, chikungunya or Zika.

MOSQUITO SURVEILLANCE

Objective

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

Background

The risk of mosquito-borne disease depends on 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.

For the 2023 mosquito season (April-October), DOHMH will conduct weekly surveillance at 53 permanent trap locations strategically placed throughout the five boroughs. To monitor adult mosquito populations, DOHMH uses light traps, gravid traps, and BG (Biogents®) sentinel traps. Light traps and gravid traps are placed as pairs at 53 sites to estimate risk of WN virus transmission to humans. Light traps attract female mosquitoes searching for blood meals and are used to estimate the size of mosquito populations, while gravid traps attract fertilized female *Culex* mosquitoes which already have had blood meals and are more likely to test positive for WN virus. In 2016, DOHMH began using BG sentinel traps at 60 additional locations. BG traps are more efficient in trapping *Aedes* mosquitoes which are potential vectors of chikungunya, dengue and Zika. Presently, these diseases are not transmitted locally in New York City. During the 2023 mosquito season, DOHMH will use BG sentinel traps at only 10 sites to monitor the density of *Aedes* mosquitoes in various boroughs of NYC. Due to the low risk of local transmission, *Aedes* mosquitoes will not be tested for chikungunya, dengue and Zika virus. Mosquitoes collected from BG sentinel traps will be tested only for WN virus. DOHMH will use resting boxes at 10 sites around the city for surveillance of *Culiseta melanura*, the main vector for Eastern Equine Encephalitis (EEE).

Field collected mosquitoes are sorted by species and grouped into pools of up to 50 mosquitoes for viral infection analysis. *Culex* and *Aedes* mosquitoes are tested for WN virus infection. In 2022, the DOHMH collected and identified a record number of 228,312 mosquitoes by species. Of the 5,117 mosquito pools (177,228 mosquitoes) analyzed, 1,555 tested positive for WN virus in eight different species (*Cx. pipiens*, *Cx. restuans*, *Cx. salinarius*, *Cx. erraticus*, *Ae. albopictus*, *Ae. sollicitans*, *Ae. taeniorhynchus*, and *Coquillettidia perturbans*). Results of our mosquito host feeding and preference study conducted in 2010 indicate that *Cx. pipiens* and *Cx. restuans* are the primary vectors and *Cx. pipiens* and *Cx. salinarius* are bridge vectors of WN virus in NYC.

In addition to conducting disease focused adult mosquito surveillance during mosquito season, DOHMH monitors adult mosquito populations in selected locations to monitor overwintering populations during the winter.

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 and need for treatment.
- Larval habitat information will be collected and updated throughout the season.
- In targeted urban areas, mosquito trapping will be conducted from sewer and adjacent buildings by using light traps in response to resident complaints.
- From April through October, DOHMH will conduct adult mosquito surveillance of at 53 permanent trap locations strategically placed throughout the five boroughs using three different types of traps. The trapping season may be lengthened or shortened depending on the weather.
- Mosquitoes will be collected on a weekly basis using light, gravid and sentinel 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.
- Adult mosquito trapping will be expanded in areas where traps indicate increased disease risk. This will help determine extent of risk and determine control methods.
- 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.
- Mosquito Magnet™ traps will be used 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

Mosquitoes breed in water. Eliminating their 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 to determine if conditions are conducive to mosquito breeding and attempt 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.

Culex pipiens, a primary vector of WN virus and one of the most common mosquitoes found in New York City, lays its eggs in standing or slow-moving water containing decaying organic materials. Important breeding sites for *Cx. pipiens* 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. These eggs can mature to adults within 10 days under ideal conditions. Larvae of *Ae. vexans*, *Cx. salinarius*, *Ae. sollicitans*, *Ae. taeniorhynchus*, and *Cq. perturbans*, can be found in either freshwater or saltwater marshes. *Ae. albopictus* and *Ae. japonicus*, are container breeding mosquitoes that require minimal amounts of water for egg and larval development. These species prefer to lay their eggs in natural and unnatural containers that are easily overlooked, such as tree holes and discarded trash. *Ae. albopictus* is a vicious day-biting mosquito that has the capability to transmit several mosquito-borne human illnesses. Public education on identifying and removing these larval habitats from residential properties is an integral component to reduce populations of these species.

DOHMH's public education campaign emphasizes the need for New Yorkers to eliminate mosquito-breeding sites around their homes. Standing water is a violation of the New York City Public Health Code and residents are encouraged to report standing water that can potentially breed mosquitoes to 311. Reports of standing water are investigated by DOHMH inspectors. When standing water is found in violation, the private property owner receives a Notice of Violation and is called for a hearing by the Environmental Control Board. Standing water may also be referred for extermination by the inspector or will be referred to the proper agency for evaluation and remediation if the water is identified on public property.

In 2022, DOHMH received 1,263 complaints of standing water through NYC311, on the DOHMH web site, from elected officials and community groups, and through field surveys performed by inspectors and exterminators. The DOHMH investigated each of these complaints. As a result of these inspections, 448 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 natural areas that are inaccessible by ground vehicles, larvicide may be applied aurally by helicopter periodically during mosquito season. DOHMH plans to continue to use all of these methods in 2023.

Presently, DOHMH uses larvicides with the active ingredients *Bacillus sphaericus*, *B. thuringiensis* var. *israelensis* (*Bti*) and/or methoprene. *B. sphaericus* and *Bti* are naturally occurring soil bacteria that produce toxins, which can be used to 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 unique crystalline bodies (endotoxins) that 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 NYC311 and the DOHMH Web site (www.nyc.gov/health/mosquito).
- From April 1st through October 31st, OVSC investigates all public complaints of standing water. OVSC will monitor the 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®) and Bti-methoprene combination products (VectoPrime®) may be used in specific situations. 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. Larvicides will continue to be applied as needed throughout the mosquito-breeding season.
- Beginning in May/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 or high abundance of *Ae. albopictus* (the vector of chikungunya and dengue virus, and a potential vector of Zika virus) is identified in an area. Targeted neighborhoods will have an expanded public outreach regarding breeding site elimination and personal protection; community-specific media materials will also 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.
- If local transmission of a vector-borne disease occurs, DOHMH will assist residential property owners in identifying and remediating standing water on their property.

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 seventeen seasons has 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 disease transmission to humans. During the first sixteen years (2000-2015), only Anvil 10+10™, containing sumithrin (d-phenothrin), was used for adult mosquito control. This product is a synthetic pyrethroid that has been in use for mosquito control for more than 40 years. During 2016 - 2018, DOHMH used Duet™ in addition to Anvil 10+10™. The main difference between Duet™ and Anvil 10+10™, is that Duet™ contains prallethrin, an agitating agent in addition to Sumithrin. Prallethrin is effective in targeting day biting mosquitoes like *Aedes albopictus*. DOHMH has also used a third pyrethroid product DeltaGard® and an organic pesticide Merus™ beginning 2018 and 2022, respectively. Active ingredient of Merus is a botanical insecticide that contains a mixture of six esters collectively called as pyrethrins. Pyrethrins are extracted from pyrethrum which is the compound found in the flowerhead of the chrysanthemum (also called as mum) plant. Anvil 10+10™, Duet™, DeltaGard® and Merus™ provide a rapid knockdown of adult mosquitoes.

Natural pyrethrins and synthetic pyrethroids exhibits low mammalian toxicity, degrades rapidly in sunlight, provides little or no residual activity, and does not accumulate in the environment. These products are applied at very small quantities per acre (0.00089-0.0036 pounds/acre) and are referred to as ultra-low volume (ULV) application. ULV-delivery techniques minimize environmental impacts while effectively managing adult mosquito populations. All 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 established criteria for adulticiding have been met. DOHMH uses pesticide only when it is necessary and only when a spray event can reduce the disease transmission risk. Mosquito density and distribution, mosquito species, persistence of West Nile virus, weather, time of year, and proximity to human populations are all carefully considered in determining the necessity for adult mosquito control in a particular area.

The decision to adulticide is based on data obtained from mosquito surveillance and testing, and established and successful algorithms/decision trees. OVSC uses different criteria based on disease risk. For WN virus there are 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. In the event that DOHMH identifies a chikungunya, dengue or Zika virus-positive mosquito pool or locally transmitted human case, adulticide will be applied in the affected area.

DOHMH will utilize its surveillance data to assess the risk of an outbreak of above mentioned mosquito borne diseases. DOHMH only applies pesticides in a limited and targeted area to control adult mosquitoes which is determined 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

DOHMH will conduct adulticiding activities when surveillance data implicate a serious risk for human disease

Outline of Control Activities Based on West Nile Virus Presence

Level 1 – No Pathogen Detection

DOHMH Response: 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 Response: 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 and 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 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 will 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 Response: OVSC recommendations will be communicated to 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 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 and truck mounted 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
- 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. For information on local pesticide laws, please visit Appendix B (page # 36).
- 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, 311, and pertinent City and community organizations.
- Spray event notification flyers will be distributed and posted at public places in the neighborhoods to be treated 24-72 hours in advance of pesticide application.
- 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 were to occur. Prior to conducting adult mosquito control activities, information on pesticides was sent to all hospital emergency departments, which included product information on pesticides, Safety Data Sheets (SDS), 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) has been 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 reviews were 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 mosquito control were associated with negative health outcomes. As a recent publication reported, no such associations were found.¹

Beginning in 2002, syndromic surveillance was adopted as a surveillance tool to identify any possible respiratory symptom related clusters 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 and other information relevant to identifying possible exposure to pesticides.

¹ 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.

- Calls received by the New York City Poison Control Center (NYC PCC) will continue to be monitored during pesticide spraying for 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 and respiratory illness 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.
- 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.

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 and to devise safe and effective methods for reducing the risk of such transmission. DOHMH, in collaboration with CDC and NYSDOH, has closely studied the risk factors for infection, morbidity, and mortality from WN virus. However, many questions still remain about how the virus circulates in nature.

In a successful IPM program, constant evaluation is needed to effectively and safely manage mosquitoes. Mosquitoes have a high propensity to develop resistance to pesticides, requiring continued evaluation of the efficacy of all mosquito control activities.

Additional pesticide products have been approved for mosquito control use in NYC by state and federal agencies. DOHMH will continue to assess the health effects of these and any products considered for use for its mosquito control program.

Furthermore, some of the control methods used for managing mosquito populations, especially the application of pesticides for adult mosquitoes, are not without potential negative impact. 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 in assessing novel control techniques is also an important aspect of an effective mosquito control program for 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 and other diseases that can be spread by mosquitoes 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.
- DOHMH will institute mosquito surveillance at or near ports of entry including airports, cargo shipping terminals, and cruise ship terminals to capture and identify invasive mosquito species at the earliest possible time. This will enable us to conduct emergency measures to prevent their spread and potential establishment in the City.
- DOHMH will collect fish mortality data from the Parks Department and take water samples from environmentally sensitive waterbodies before and after adulticiding events to measure the impact of spray events on the environment. The water samples will be tested at the Westchester Water Testing Laboratory. The results of these tests will be shared with NYS DEC and Federal EPA.
- DOHMH will continue to evaluate natural larval control agents, including the use of native larvivoracious species, such as fathead minnows and copepods, to promote sustainable mosquito control in the City and to reduce the need for pesticide applications.
- DOHMH will implement programs to monitor and assess the non-target effects of currently used mosquito control agents in order to select efficacious products with minimal impact on the environment.

APPENDIX A

FREQUENTLY ASKED QUESTIONS ABOUT WEST NILE VIRUS AND MOSQUITO SURVEILLANCE AND CONTROL

What is mosquito control, and why is it needed?

Mosquito control is the effort to protect public health by reducing mosquito populations. Mosquitoes can spread West Nile virus and other diseases.

What is West Nile virus?

West Nile virus is a virus spread by mosquitoes that can affect people and animals. Mosquitoes may become infected with the virus when they feed on infected birds. Infected mosquitoes can then spread the virus to humans and other animals.

West Nile virus may cause fever, headache, fatigue or body aches. People typically recover on their own. In rare cases, the virus may cause inflammation of the brain and spinal cord.

Is there a vaccine or treatment for West Nile virus?

No. Currently there is no vaccine or treatment for West Nile virus, but in many cases, medications may be used to relieve symptoms. In severe cases, patients may need to be hospitalized to receive treatment.

If I get bitten by a mosquito, should I be treated for West Nile virus?

Not all mosquitoes carry West Nile virus. However, if you are bitten by a mosquito and have symptoms such as fever, headaches, stiff neck, confusion, muscle weakness or sensitivity to light, contact your doctor.

Can my pet be infected by West Nile virus?

Pets may get West Nile virus from mosquito bites, but they don't usually get sick. Contact your veterinarian if you are concerned about your pet's health. There is no evidence that dogs and cats can transmit West Nile virus to humans.

What does the City do to control mosquito populations?

The City's Health Code requires property owners to eliminate standing water, where mosquitoes easily breed, on their property. The City also regularly tests mosquitoes for West Nile virus and destroys mosquito breeding sites wherever possible. When standing water cannot be drained, the City applies treatments called larvicides that kill mosquitoes before they mature and can spread disease. (Mosquitoes that have not yet matured into adults are called larva.)

Does the City spray for mosquito infestation?

If mosquito surveillance and testing show that there is a threat to human health, the City may spray pesticides to kill adult mosquitoes. Spraying is conducted in high-risk areas. The City follows the New York State Department of Environmental Conservation (NYSDEC) and Federal Environmental Protection Agency (EPA) requirements when spraying and only sprays for mosquito control in the evenings or early mornings. The City does not take requests from the public for mosquito spraying.

Do the pesticides used during spraying hurt people and pets?

The City conducts spraying carefully and follows all state and federal requirements. Most people and their pets do not have health effects during and after pesticide spraying. Some people who are sensitive to spray ingredients may have short-term eye or throat irritation, or a rash. If you have stronger reactions after spraying, contact your doctor.

How will I be notified about spraying in my neighborhood?

The Health Department alerts the public of spraying at least 24 to 48 hours before the event. It notifies local media and distributes fact sheets in several languages to community-based organizations, elected officials, senior care facilities, libraries and many citywide organizations. See below for information about how to register for spraying updates.

How can I avoid exposure to pesticides during spraying?

Whenever possible, stay indoors during spraying.

What can I do to protect myself and my family from mosquito bites and West Nile virus?

- Use insect repellents and wear long sleeves or pants in the evening during mosquito season (June through September). Mosquitoes are most active at these times. See below for more information about repellants.
- Empty standing water from containers such as flowerpots, gutters, buckets, pool covers, pet water dishes, discarded tires and birdbaths.
- Make sure backyard pools are properly maintained and chlorinated.
- Install or repair screens on windows and doors.
- Call 311 to report groups of dead birds. They may be a sign of West Nile virus in the area.

How should I choose an insect repellant?

Always read the label carefully. Look for the repellant's Environmental Protection Agency (EPA) registration number, active ingredients and use instructions.

Active ingredients approved by the Environmental Protection Agency (EPA) and New York State include DEET and picaridin. DEET is the most common active ingredient proven to prevent mosquito bites. DEET-based repellents come in a wide range of percentages, but in New York City, you do not need a repellent with more than 30% DEET. Repellents with greater than 10% DEET should not be used on children.

Picaridin-based repellents ranging from 5 to 15% have shown similar protection times to DEET. Protection times vary for different people and depend on factors such as the species of mosquito in the area, how much a person sweats and how hot it is outside.

Are there any non-chemical, natural or botanical products that are effective in repelling mosquitoes?

Some products made with botanical oils provide protection from mosquito bites. However, studies suggest that these products work for much shorter periods of time.

If my neighbors don't take care of the standing water in their yards, should I report the issue to the Health Department?

Residents and business owners should take primary responsibility for emptying standing water from their property. If they do not, you may file a standing water complaint online or by calling 311. More information is below.

What happens after I report standing water complaints to the City?

The Health Department inspects properties for standing water. If an inspector notices conditions that attract mosquitoes, he or she will issue a violation to the property owner, which may result in fines of up to \$2,000.

Where can I get more information?

- For more information about mosquito control and West Nile Virus, call 311 or visit nyc.gov/health/wnv.
- To register for updates on mosquito spraying, sign up for NotifyNYC, follow the Health Department on Twitter at @nycHealthy or visit nyc.gov/health/wnv.
- For more information about mosquito repellent, go to nyc.gov and search “insect repellent.”
- To file a standing water complaint, go to nyc.gov and search “standing water” or call 311.

For more information about West Nile virus, call NYC311, 24 hours a day, seven days a week, by dialing 311 or check the DOHMH Website at <http://www.nyc.gov/health/westnile>

Appendix B

Useful Links

- [City of New York: 311 portal \(https://portal.311.nyc.gov/\)](https://portal.311.nyc.gov/)
- [City of New York: Notify NYC Information and Registration Page \(nyc.gov/notifynyc\)](https://nyc.gov/notifynyc)
- [City of New York: Local Law 37: Pesticides Used by City Agencies](#)
- [City of New York: Local Law 71 - Cleaning Park Playground Equipment](#)
- [NYC Department of Health and Mental Hygiene: Mosquito Control \(on.nyc.gov/MSE\)](https://on.nyc.gov/MSE)
- [NYC Department of Health and Mental Hygiene: Mosquito Information Page \(nyc.gov/health/mosquito\)](https://nyc.gov/health/mosquito)
- [NYC Department of Health and Mental Hygiene: West Nile Virus Information Page \(nyc.gov/health/wnv\)](https://nyc.gov/health/wnv)
- [NY State Department of Health: Mosquitoes and Disease \(health.ny.gov/diseases/west_nile_virus/\)](https://health.ny.gov/diseases/west_nile_virus/)
- [Center for Disease Control \(CDC\): West Nile Virus Information Page \(cdc.gov/westnile\)](https://cdc.gov/westnile)
- U.S. Environmental Protection Agency: [Protection against Mosquitoes, Ticks and Other Arthropods \(epa.gov/insect-repellents\)](https://epa.gov/insect-repellents)

Appendix C

Sample Public Facing Documents

Public Notice

The New York City Health Department will use the pesticide DeltaGard® and/or Anvil® 10 +10 to reduce mosquitoes in your neighborhood.

9/17/2020 (Or 9/21/2020 in case of inclement weather)

8:30 p.m. to 5:00 a.m.

Keep Yourself and Your Family Safe From Pesticides

The risks of pesticides applied by the Health Department for mosquito control to people and pets are low. Some people who are sensitive to spray ingredients may experience short-term eye or throat irritation, or a rash. People with asthma and other respiratory conditions may also be affected.

During spraying:

- Stay indoors, when possible. Air conditioning can remain on. When necessary, you may wish to close air conditioner vents, or change the recirculate function.

After spraying:

- Wash skin and clothing exposed to pesticides with soap and water.
- Always wash homegrown fruits and vegetables with water.

If you experience adverse reactions to a pesticide spraying, call your doctor or the NYC Pesticide Control Center at 1800.222.1222.

311 nyc.gov/health/mosquito NYC Health

Verizon LTE 8:29 AM 70%

Back Notify NYC

Mosquito Aerial Larviciding

Notified 7/15/19 at 1:22PM

Weather permitting, the NYC Department of Health and Mental Hygiene will conduct aerial-based application of mosquito larvicide to help prevent West Nile Virus between 6 AM and 7 PM on 7/17 - 7/19. The alternate time frame is between 6 AM and 7 PM on 7/19 and 7/22 - 7/23. The application will be conducted in parts of the following Brooklyn, Queens, Staten Island and Bronx ZIP codes: 10303, 10314, 10305, 10306, 10308,

GET RID OF STANDING WATER AROUND YOUR HOME

Prevent mosquitoes from breeding

NYC

Mosquitoes are more than an annoyance. They can spread disease. Mosquitoes need water to lay their eggs. Even very small amounts of water, in a space as small as a bottle cap, can serve as a breeding ground. Homeowners are required to remove all standing water from their property. Use this checklist to find and get rid of standing water around your home.

Potential Breeding Site	How to Fix
<input type="checkbox"/> Trash and garbage	Pick up all trash.
<input type="checkbox"/> Potted plants with saucers	Dump and clean saucers every three or four days. Do not overwater plants.
<input type="checkbox"/> Wading pools	Turn over wading pools when not in use.
<input type="checkbox"/> Bird baths	Clean and change bird bath water at least once a week.
<input type="checkbox"/> Flat roofs	Remove any standing water that collects on the roof.
<input type="checkbox"/> Rain gutters	Clean gutters in the spring and fall. Keep clear of debris and make sure water flows through.
<input type="checkbox"/> Air conditioner/HVAC runoff	Make sure runoff drains and does not collect beneath the unit.
<input type="checkbox"/> Pet dishes	Rinse twice a week.
<input type="checkbox"/> Ornamental ponds	Stock with fish, keep aerated or treat with Bti (<i>Bacillus thuringiensis israelensis</i>).

FIGHT THE BITE

Protect Yourself Against Diseases Spread By Mosquitoes

GLOSSARY

adulticide	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>
Altosid®	brand name of methoprene, a type of larvicide
arbovirus	shortened term for arthropod-borne virus, a virus that is carried by arthropods
arthropod	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> var. <i>israelensis</i> (Bti)	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®
biopesticides	naturally occurring substances that control mosquitoes and other pests by non-toxic mechanisms
bridge vector	an arthropod (in this case, a specific species of mosquito) that serves as a main transmission of virus between the reservoir (birds) and humans.
catch basins	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
DEET	DEET (chemical name, N,N-diethyl-meta-toluamide) is the active ingredient in many insect repellent products
DeltaGard®	a pyrethroid-based pesticide for adult mosquito control
Deltamethrin	an insecticide belonging to the pyrethroid family
Duet®	a pyrethroid-based pesticide for adult mosquito control
Eastern Equine Encephalitis (EEE)	mosquito-borne viral disease that causes inflammation of the brain; similar to West Nile
encephalitis	inflammation of the brain, which can be caused by numerous viruses and bacteria, including West Nile virus
Environmental Impact Statement (EIS)	a document that describes the impact on the environment from a proposed action (in this case, the application of

	pesticides to control adult mosquitoes).
fathead minnows	a species of temperate freshwater fish belonging to the genus <i>Pimephales</i> , commonly used as a baitfish in the USA.
gravid traps	mosquito traps designed to attract pregnant female mosquitoes
Guillain-Barré syndrome	an uncommon sickness of the nervous system in which a person's own immune system damages the nerve cells, causing muscle weakness, and sometimes, paralysis.
Interactive Voice System	an automated telephone system by which information can be accessed by choosing from a set of options
IR3535	IR3535 (3-[N-Butyl-N-acetyl]-aminopropionic acid, ethyl ester) is the active ingredient in many insect repellent products
larvae	immature mosquitoes that live in water; stage which hatches from the egg, prior to adult stage
larvicide	a type of pesticide used to control immature or larval mosquitoes
light traps	mosquito traps outfitted with a light to attract mosquitoes
meningitis	inflammation of the lining of the brain and spinal cord that can be caused by a virus or bacteria
methoprene	a type of (synthetic) insect growth regulator used to control larval mosquitoes; it prevents mosquito larvae from emerging and developing into adult mosquitoes
Merus™	a botanical pesticide based on the active ingredient pyrethrin
mosquito breeding site	a location where mosquitoes lay eggs, usually in stagnant water with organic material
mosquito pools	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
naled	an organophosphate pesticide used to control adult mosquitoes
neurology	the study of the nervous system and its disorders
<i>Ochlerotatus sollicitans</i>	species of mosquito that breeds in salt marshes
outbreak	an unexpected increase in frequency or distribution of a disease
permethrin	a synthetic pyrethroid pesticide used to control adult mosquitoes; active ingredient in the product Biomist®
pesticide	substance used to kill pests such as insects, mice and rats; an insecticide is a form of pesticide
picaridin	(chemical name, 1-Piperidinecarboxylic acid, 2-(2-hydroxyethyl)- 1-

	methylpropylester) is the active ingredient in many insect repellent products
piperyonyl butoxide	An additive to pyrethroid pesticides that improves the effectiveness of the active ingredient
salt marsh	areas of vegetation in bodies of saltwater that may support the breeding of certain types of mosquitoes such as <i>Ochlerotatus sollicitans</i> ; example of salt marshes is Jamaica Bay.
sentinel	an early warning system, in this case, for the presence of virus (e. g., sentinel chickens)
serologic	of, or relating to, serum
source reduction	the removal or reduction of larval mosquito habitats
St. Louis encephalitis (SLE)	mosquito-borne viral disease that causes inflammation of the brain; very similar to West Nile virus
sumithrin	a synthetic pyrethroid pesticide used to control adult mosquitoes; active ingredient in the product Anvil 10+10®
VectoBac	brand name for the larvicide <i>Bacillus thuringiensis</i> var. <i>israelensis</i> (<i>Bti</i>)
VectoLex	brand name for the larvicide <i>Bacillus sphaericus</i>
VectoMax	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>)
vector	an organism (an insect in most cases) capable of carrying and transmitting a disease-causing agent from one host to another
viral encephalitis Zika virus	inflammation of the brain caused by a virus, such as West Nile virus a mosquito-borne flavivirus that was first identified in Uganda in 1947. In October 2015, Brazil reported microcephaly in infants of pregnant women infected with Zika virus.

Contributing Authors

Waheed I. Bajwa, PhD, MPhil, FRES
Executive Director & Chief Medical Entomologist
Office of Vector surveillance and Control
Environmental Health Division

Sally Slavinski, DVM, MPH, Dipl ACVPM
Assistant Director Zoonotic, Influenza and Vector-borne Disease Unit
Bureau of Communicable Disease

Zahir Shah, MS
Director, Vector Surveillance and Medical Entomology Laboratory
Office of Vector surveillance and Control

Liyang Zhou, PhD
Senior Medical Entomologist
Office of Vector surveillance and Control

Vernon Herbert, BS
Director, Vector Control Operations
Office of Vector surveillance and Control

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