

Disease Carrying Insects Program

Developing a Sustainable Surveillance Program

- I. West Nile Virus 2007 Report and
Comprehensive Plan for 2008
- II. Tick Surveillance 2007 Report and
Comprehensive Plan for 2008

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Abbreviations

ASTHO - The Association of State and Territorial Health Officials
BOS - Fairfax County Board of Supervisors
CB(s) - Catch Basin(s)
CDC - Centers for Disease Control and Prevention
CDPH - Chicago Department of Public Health
CHS - Community Health and Safety
CO₂ - Carbon dioxide
CSF - Cerebrospinal Fluid
EHS - Environmental Health Specialist
DC - District of Columbia
DCIP - Disease Carrying Insect Program
DCLS - Division of Consolidated Laboratory Services (of Virginia)
DEET - N,N-diethyl-3methylbenzamide (an insect repellent)
DIT - Department of Information and Technology
DPWES - Department of Public Works and Environmental Services
EEE - Eastern Equine Encephalitis
ELISA - Enzyme-Linked Immunosorbent Assay
FCHD - Fairfax County Health Department
FDA - Food and Drug Administration
HMIS – Health Maintenance Information System
IgG-ELISA-IgG Enzyme-Linked Immunosorbent Assay (a test to detect antibodies in serum)
KAP - Knowledge, Attitude and Practice
LAC - LaCrosse Virus
MAC-ELISA - IgM Antibody Capture Enzyme-linked Immunosorbent Assay (a test to detect antibodies in serum)
MLE - Maximum Likelihood Estimation (a measure of infection rate of mosquitoes)
MWCOCG - Metropolitan Washington Council of Governments
MSMS - Mosquito Surveillance and Management Subcommittee
OPA - Office of Public Affairs
PRNT - Plaque Reduction Neutralization Test (a test to detect virus)
RT-PCR - Reverse Transcriptase Polymerase Chain Reaction (a test to detect virus)
SLE - St. Louis encephalitis
TTY - Text Telephone
ULV - Ultra Low Volume
URL - Uniform Resource Locator
VA - Virginia
VDH - Virginia Department of Health
VDOT - Virginia Department of Transportation
WN - West Nile
WNND - West Nile neuroinvasive disease
WNV - West Nile virus

Definition of Terms as Used in this Report

Active surveillance: Health care providers report notifiable diseases on a case-by-case basis or syndromic information in aggregate form on a regular schedule due to routine outreach from the local or state health agency.

Adulticide: An insecticide used to kill adult mosquitoes.

Antibody: A type of protein normally present in the body or produced in response to an antigen which it neutralizes, thus producing an immune response.

Antigen: A substance that stimulates an immune response (usually production of an antibody) when introduced into the body. Antigens include toxins, bacteria, viruses, and other foreign substances.

Arbovirus(es): A virus transmitted by an arthropod. The name is derived from the words: **AR**thropod **BO**rne **VIRUS**.

Asian tiger mosquito: Common name for the *Aedes albopictus* mosquito.

Borrelia burgdorferi: Scientific name of the bacteria that causes Lyme disease.

Breeding site: Larval mosquito habitat.

Catch basin: Roadside inlet that permits rainwater to flow off the roadways.

CDC miniature light trap: A mosquito trap that attracts mosquitoes with light and CO₂ (produced by dry ice). A fan located below the light source sucks the mosquitoes into a collecting receptacle on the trap. The light is powered by a battery and the mechanism is protected by a metal roof. This type of trap collects mosquitoes attracted to humans (humans exhale CO₂ when they breathe).

Common house mosquito: In our area, it is the common name given to *Culex pipiens* mosquito.

Container breeder: Mosquito that lay their eggs in artificial containers such as cans, bottles, tires, birdbaths and even catch basins.

Corvids: family of birds that includes the crows, blue jays and magpies.

Day degrees above 75°F: The daily cumulative number of degrees Fahrenheit above 75° during the year.

DCIP: Disease Carrying Insects Program.

DEET: Chemical product in certain insect repellents that keeps mosquitoes away.

Diapause: A physiological state of dormancy usually controlled by hormones and environmental triggers. Many insects use diapause as a way to survive the winter.

ELISA: A sensitive immunoassay that uses an enzyme linked to an antigen as a marker for the detection of a specific protein in a blood sample. It is often used as a diagnostic test to determine exposure to a particular infectious agent, such as a virus.

Encephalitis: Swelling of the brain (as can be caused by the West Nile virus).

EPI-Week: An EPI-Week is a period of time that comprises seven days and is used to compare data from place to place and year to year. In the United States, the first EPI week is defined as the first week of the year ending on a Saturday as long as four days of that year are included in that week.

Epizootic: An epizootic is the non-human equivalent of an epidemic, meaning that large numbers of animals are infected with a disease. An epizootic disease is one in which greater than normal numbers of animals are affected for a given place or time period.

Gravid traps: A mosquito trap baited with water and fermented grass that attracts female mosquitoes that seek this type of water to lay eggs.

HMIS: Health Maintenance Information System; a database to manage health information.

IgM antibodies: The first class of antibodies produced by the immune system in response to the presence of an antigen (e.g. West Nile virus). Presence of IgM antibodies usually indicates a primary or recent infection. Diagnostic laboratories test for the presence of WNV-specific IgM antibodies in human serum or cerebrospinal fluid in order to confirm a case of WNV.

IgG antibodies: The second class of antibodies produced by the immune system in response to the presence of an antigen (e.g. West Nile virus). Presence of IgG antibodies usually indicates a past infection. Diagnostic laboratories test for the presence of WNV-specific IgG antibodies in human serum or cerebrospinal fluid in order to confirm a case of WNV.

Larvicide: An insecticide used to kill mosquito larvae.

Lyme Disease: Lyme disease was first identified in 1975 in Lyme, Connecticut, and is a bacterial illness caused by *Borrelia burgdorferi*. The disease is transmitted through the bite of an infected black legged tick (*Ixodes scapularis*).

Medical community: Health care providers.

Meningitis: Swelling of the membrane covering the spinal cord or the membrane covering the brain (as can be caused by the West Nile virus).

Mosquito Dunks®: A readily-available, non-restricted microbial larvicide which contains the active ingredient *Bacillus thuringiensis israelensis*. This product specifically targets mosquito larvae.

Mosquito larva (larvae: plural): The aquatic stage of development in mosquitoes. This is the stage that hatches out of the mosquito eggs, lives in the water and is the best target of a mosquito management program.

Mosquito pools: A sample of mosquitoes that has been grouped together (pooled) to be tested for the presence of a virus.

MSMS: Mosquito Surveillance Management Subcommittee. This is a subcommittee of Fairfax County's Environmental Coordinating Committee. The MSMS is composed of representatives from various county agencies and departments as well as other jurisdictions that have activities associated with the county DCIP.

Neuroinvasive: Affecting the nervous system. Refers to West Nile virus meningitis, encephalitis or other serious neurological symptoms.

Oil of lemon eucalyptus: An insect repellent.

Overwinter: To pass the winter, like hibernation.

Ovitrap: Traps set out specifically to collect eggs of container breeding mosquitoes, commonly used to monitor species such as the Asian tiger mosquito, *Aedes albopictus*.

Parous: Refers to mosquito adults that have laid eggs. This means that they have taken a blood meal and can be infected with the virus if the source of the blood meal had the virus.

Passive surveillance: Medical care providers report notifiable diseases on a case-by-case basis to the local or state health agency, based upon a published list of conditions.

Permethrin: A contact insecticide that is used to combat adult mosquitoes.

PCR: Polymerase Chain Reaction; a biochemical process whose purpose is to make huge number of copies of a gene (such as that of the virus) so that it can be identified.

Permethrin: A contact insecticide that is used to combat adult mosquitoes.

Picaridin: An insect repellent.

Trap night: Period of time elapsed from when one trap is set in the evening to when it is collected in the morning. One trap set in one location for one night.

“Tip and Toss” campaign: Part of Fairfax County Disease Carrying Insects Program involving the community to remove standing water from their yards, thus reducing mosquito breeding habitats.

ULV: Ultra Low Volume. This is a method of applying insecticides against adult mosquitoes that produces very small droplets and is usually applied by a truck- or aircraft-mounted machine.

SLE: St. Louis encephalitis.

VecTest: A quick test to detect the West Nile virus in mosquitoes or birds. It is not as sensitive as PCR, but has a much faster turn-around time.

VectoLex®: A biological larvicide (*Bacillus sphaericus*) used in catch basins to proactively suppress mosquito populations.

West Nile fever: A febrile condition caused by the West Nile virus, very similar to the flu. The symptoms include fever, body aches, swollen glands, rash and headache.

West Nile virus: A virus transmitted by mosquitoes. The normal cycle is between mosquitoes and birds. It can be transmitted to and cause disease in other animals and people.

West Nile virus “off-season”: The period of time (usually October to May) marked by little or no mosquito activity and no West Nile virus transmission.

West Nile virus “season”: The period of time (usually May to October) marked by high mosquito activity and West Nile virus transmission.

Acknowledgments

Fairfax County Health Department (FCHD) would like to thank the members of the Mosquito Surveillance and Management Subcommittee (MSMS) of the county's Environmental Coordinating Committee for their guidance, participation and comments in the preparation of this document.

Parts of this plan are modeled after plans of the Centers for Disease Control and Prevention (CDC), the Virginia Department of Health (VDH), the Metropolitan Washington Council of Governments (MwCOG) and the Chicago Department of Public Health's (CDPH) 2003 WNV report. Recommendations and guidance were also obtained from a document issued by The Association of State and Territorial Health Officials (ASTHO).

CDC

Epidemic/Epizootic West Nile virus in the United States: Revised guidelines for surveillance, prevention and control

www.cdc.gov/ncidod/dvbid/westnile/resources/wnv-guidelines-aug-2003.pdf

VDH

Virginia Arbovirus Surveillance & Response Plan, 2005

<http://www.vdh.virginia.gov/epidemiology/DEE/Vectorborne/responseplan/index.htm>

MwCOG

West Nile Virus Response Plan for the National Capital Region

www.mwcog.org/uploads/pub-documents/BFZd20040109135919.pdf

CDPH

West Nile Virus 2006 Interim Report and Comprehensive Prevention Plan for 2007

http://egov.cityofchicago.org/webportal/COCWebPortal/COC_EDITORIAL/WestNilePlan.pdf

ASTHO

Public Health Confronts the Mosquito: Developing Sustainable State and Local Mosquito Control Programs; Interim Recommendations of the National Mosquito Control Collaborative

www.astho.org/pubs/MosquitoControlInterim7804.pdf

Executive Summary

I. West Nile Virus 2007 Report and Comprehensive Plan for 2008

In 2007, North America continued to experience the effects of West Nile virus (WNV). Through Dec. 31, 2007, at least 3,404 human cases with 98 deaths were reported in the U.S.¹. There were three human cases of WNV recorded for 2007 in Virginia, one of which was from Fairfax County. From 2002 to present, there have been 22 human WNV cases, including two deaths, reported in Fairfax County.

This document reviews activities for 2007 and presents a surveillance plan for 2008 that will monitor mosquito populations to aid in minimizing the risk of WNV. The emphasis of the 2008 program will continue to be on community outreach and public education, surveillance and a proactive larviciding program.

Mosquito Surveillance

The program is anchored by a strong surveillance component that will monitor mosquito populations during the 2008 mosquito season for possible increases in vector density and viral activity. It is important to note that absolute high numbers of mosquitoes do not necessarily reflect high risk of human infection with WNV. There were 5,280 trap nights over the 2007 season from which 145,402 mosquitoes were collected. Of 4,995 mosquito samples tested (which included 145,154 mosquitoes), 469 were positive for WNV.

Risk Communication, Community Outreach and Public Education

Fairfax County will continue to emphasize personal protection, prevention and control through distribution of informational materials, media interviews, advertising, Web pages, presentations and collaborations with community groups and homeowners associations.

A third 18-month “Fight the Bite” calendar was produced in 2007. The calendar included colorful and creative graphics, captions, facts, figures, important dates and helpful hints for backyard mosquito and tick management as well as for personal protection from WNV and tick-borne diseases. Other national and international vector control programs and health departments continue to request authorization to use the calendar and its graphics and several of these have produced their own version giving credit to Fairfax County.

Human Case Surveillance

West Nile virus is one of 70 notifiable diseases and conditions in Virginia. The Fairfax County Health Department uses passive surveillance between November and June and active surveillance between July and October to monitor physician and laboratory reporting of WNV. The Health Department encourages physicians and laboratories to report cases of WNV by educating medical practitioners about the importance of reporting arboviral infections and by contacting key medical staff at hospital centers to inquire about the potential cases of WNV.

¹ Data from CDC on Jan. 22, 2007

Reported WNV cases are classified as either West Nile fever or neuroinvasive WNV according to the case definition. In 2007, there was one case of WNV neuroinvasive disease and one case of West Nile fever in Fairfax County.

Environmental Considerations

Air temperature, photoperiod and rainfall affect mosquito development. As in previous years, these factors were monitored in 2007 to better understand the relationship between climate and vector-borne diseases.

Avian Surveillance

The number of dead birds reported to the county decreased from the past two years with a total of 349 dead birds reported in 2007. About 15 percent of the dead birds were crows. Twelve of the reported dead birds were collected and tested for WNV. Of these, none were positive for WNV. In 2008, FCHD will continue to ask citizens to report dead birds and will continue to test selected birds for WNV.

Source Reduction

The FCHD continued to promote source reduction (elimination of mosquito breeding sites) in 2007 through the outreach campaign. During site visits and inspections, the DCIP educated property owners and managers about the benefits of eliminating breeding sites.

Larval Mosquito Control

Catch basins are located throughout the county and are typically constructed to ensure proper rainwater drainage. However, they still hold water and are important breeding sites for mosquitoes. Evidence presented by Dr. R. Nasci (CDC) and Dr. L.D. Haramis (Illinois Department of Health) concluded that programs with CB larviciding had proportionally fewer WNV cases. Dr. N. Walker (Michigan State University) indicated that the infection rate in mosquitoes was four per 1,000 in areas with CB control and 28 per 1,000 in areas without control activities. During the 2007 season, 107,280 CB's were treated in three cycles. Throughout the year, all the catch basins in the Huntington neighborhood of the Mount Vernon district, which was flooded on June 25, 2006, were treated on a monthly basis. In 2008, stormwater catch basins will continue to be treated in programmed cycles aimed at reducing *Culex pipiens* mosquito populations, as has been done in previous years. The first cycle will begin in May 2008, and the number and magnitude of each cycle will be dependent on climatic factors and mosquito surveillance results.

Operational research

Fairfax County Health Department conducts operational research and incorporates significant findings into routine actions. In 2007, FCHD looked into improved methods to collect mosquitoes, developed new strategies for treating specialized mosquito breeding sites and continued developing a computerized surveillance tool with industry. Trapping results with new traps that were tested in the past two years have been so promising that these two new mosquito traps will be incorporated into the routine surveillance in order to evaluate their performance on a larger scale.

Adult Mosquito Control

A timely response to surveillance findings can reduce the overall impact of WNV and prevent human disease. Consistent with CDC, VDH and MWCOG guidelines, FCHD will implement an appropriate level of response based on surveillance data. The response levels range from a basic response level to a much heightened response (details are in the 2008 plan of action). In 2007, surveillance data in the Masonville Park and Huntington areas indicated situations in which mosquito population densities and the presence of WNV posed a significant threat to human health. In response, one- and three-mile barriers (respectively) between the wooded area and the residences were sprayed with permethrin. In 2008, mosquito species, habitat, weather, time of year and the proximity of infected mosquitoes to human populations will be considered in determining the necessity for adult mosquito control. Any use of adulticides has been and will be under the direction of the County Executive and in coordination with any affected county, city or town within or adjacent to the treatment area.

II. Tick Surveillance 2007 Report and Comprehensive Plan for 2008

Fairfax County began tick and Lyme disease surveillance in 2005 with a small pilot program. In light of significant results from the first year of tick surveillance, the DCIP implemented an enhanced surveillance program in 2006 and 2007. In 2007, over 3,790 ticks (including 786 deer ticks) were collected in the spring and summer using standard trapping techniques and in the winter using host examination techniques. When deer ticks collected via standard trapping techniques were examined for *Borrelia burgdorferi*, an infection rate of 4.2 percent was seen. Deer ticks collected through host (deer) examination had a similar infection rate (4.1 percent).

Only the host (deer) examination technique will be used in 2008. As in 2007, this type of surveillance will be conducted by existing staff in the DCIP and will follow previously-established protocols. In 2008, the program will expand its outreach activities, as requested by the BOS in 2007, and will be directed by the results of a tick/Lyme disease KAP study that was carried out in 2007.

I. West Nile Virus 2007 Report and Comprehensive Plan for 2008

Background

Public Health Impact

Infection with West Nile virus causes illness in approximately one-fifth of people who are infected. The majority of those infected with the virus does not manifest any symptoms and may never know they were infected. Symptomatic individuals typically experience “West Nile fever,” which includes a relatively mild fever, muscle aches, rash and headache. These cases are often undiagnosed and go unreported. A small percentage of infected persons develop a more significant illness such as meningitis, usually manifesting fever, headache and stiff neck; or encephalitis, which is accompanied with fever, headache and confusion or muscle weakness. Encephalitis, meningitis and other WNV neuroinvasive illness require hospitalization and can be associated with prolonged recovery, disability and even death. Recent post-hospitalization follow-up studies of WNV patients (University of Texas) indicate prolonged effects of the disease for up to three years, which may include personality change, depression or subsequent episodes of encephalitis. Treatment of West Nile virus infections is supportive since there is no specific drug that acts against the virus and, at present, no human vaccine available.

Since WNV first appeared in the United States in New York City in 1999, it has expanded across the United States. To date, there have been about 27,379 cases of WNV human illness in the United States reported to CDC, including 1,060 deaths. Virginia has reported 69 human cases with four deaths.

In Fairfax County, WNV virus was first detected in 2000, when a single crow was found to be infected. In 2001, additional infected birds were detected and in 2002, the virus was found in birds, horses, mosquitoes and humans. Since 2002, there have been 21 human cases of WNV with two fatalities reported in Fairfax County. One neuroinvasive human case of WNV was reported in 2007 (Table 1).

Table 1. West Nile virus infections in birds, mosquitoes, horses and humans in Fairfax County, 1999 – 2007.

<u>Year</u>	<u>Bird</u>	<u>Mosquito</u>	<u>Human</u>	<u>Horse</u>
1999	0	0	0	0
2000	1	0	0	0
2001	54	0	0	0
2002	70*	26	13/1**	3/1**
2003	15*	148	3/0**	2/1**
2004	3 ^{&}	234	1/1**	0
2005	4 ^{&}	33	0	0
2006	0 ^{&}	167	3/0**	0
2007	0 ^{&}	469	1/0**	0

*Testing of birds was suspended after 70 positive birds were detected in 2002 and 15 in 2003.

** Cases / deaths.

[&]Limited (select) number of birds collected and tested.

Primarily an infection of wild birds, WNV is transmitted by the bite of mosquitoes. The virus has been detected in 60 different mosquito species nationwide, to date, according to the CDC. The virus appears to be maintained in house sparrows (*Passer domesticus*). Infected mosquitoes can transmit WNV to birds, humans and other mammals while taking a blood meal. After the virus is ingested by the mosquito it passes through the stomach wall into the body cavity where it replicates and eventually invades the salivary glands. During blood feeding, the mosquito injects saliva into the host and in this manner the virus is passed to the animal or human, at times, infecting these hosts.

In Fairfax County, *Culex pipiens*, *Culex restuans*, *Culex erraticus*, *Aedes albopictus* and *Aedes vexans* are the species that would most likely transmit WNV to humans. *Culex pipiens*, also known as the northern house mosquito, has been identified as the principal vector by mosquito infection rates from 2002 through 2007. The vector status of *Culex pipiens* is supported by the recent findings of A.M. Kilpatrick et. al. (Consortium for Conservation Medicine) demonstrating that *Culex pipiens* shifts its feeding preferences from birds to humans by seven-fold during late summer and early fall, coinciding with the dispersal of its preferred host (American robins, *Turdus migratorius*) and the rise in human WNV infections. This mosquito species prefers to lay its eggs in stagnant water rich in organic matter, such as that found in some stormwater catch basins. Larvae will hatch from these eggs before turning into pupae and finally becoming adult mosquitoes.

During the 2007 mosquito season in Fairfax County, 145,154 mosquitoes were tested in 4,995 pools. Of those tested, 469 pools were positive for WNV. In 2006, 94,064 mosquitoes were tested in 3,407 pools (samples), of which 167 were positive for WNV. In 2007, six species of mosquitoes (*Culex pipiens*, *Culex restuans*, *Culex erraticus*, *Aedes vexans*, *Aedes albopictus* and *Anopheles punctipennis*) tested positive for West Nile virus. In previous years, one other species (*Culex salinarius*) was also found to be positive with the virus in the county.

Preparation and Planning for WNV in Fairfax County

In 2007, two human and 469 mosquito pools were positive in the county. Positive mosquitoes were found throughout the county. During the 2007 season, Fairfax County continued with the comprehensive mosquito surveillance program, including 69 routine collection sites and numerous response collection sites for a total of 5,280 trap nights.

The established, in-house surveillance system will continue to be the foundation of the Disease Carrying Insects Program. This will enable FCHD to detect circulating arboviruses (WNV, SLE and EEE) and respond in a timely fashion.

The county is undertaking a wide array of ongoing activities and new initiatives to enhance WNV prevention and mosquito control and better understand the transmission dynamics of the virus.

Effective July 1, 2003, the majority of funding for the Fairfax County WNV program was moved to Fund 116, the Integrated Pest Management Program fund, giving it the resources necessary for stability and effectiveness by including the program in a special tax district.

Working with a contractor, the FCHD has monitored mosquito breeding sites in Fairfax County for four years. These breeding sites will continue to be monitored and treated with the biological larvicide VectoLex® (*Bacillus sphaericus*) as necessary when mosquito breeding is detected.

To keep county residents informed, the FCHD constantly reviews and updates public information materials in English. In order to meet the needs of ethnic groups in the county, key elements of these materials have been translated into Chinese, Farsi, Korean, Spanish, Urdu and Vietnamese. Fact sheets, brochures and posters discussing actions Fairfax County residents can take to reduce mosquito populations (by eliminating sources of standing water), as well as personal protection from mosquito bites, have been widely disseminated from 2003 to present.

Interim Report and Action Plan, by Activity

1. Community Outreach and Public Education

Goal: To increase the public's knowledge about WNV, its consequences and mosquito control; to promote behavioral changes and to encourage the community to take an active role in reducing the risk of mosquito-borne diseases through preventive measures such as source reduction and personal protection.

Background and Report on 2007 Activities

In 2007, the county continued to aggressively disseminate public information materials to encourage Fairfax County residents to eliminate and/or treat standing water around their homes and to reduce their risk of infection by avoiding mosquito bites. Since most of the mosquitoes that bite around the house also breed around the house, removing breeding sites, using repellent, and treating the property with an adulticide will help reduce human-mosquito contact. Many news releases, news conferences and expert interviews with print and broadcast media in English and Spanish were used to deliver prevention messages. Documents and brochures with the slogan "Fight the Bite" have been distributed through Board of Supervisors' offices, libraries, fairs, presentations, by mail and in some schools during the last three mosquito seasons. Information was also provided regarding the clinical spectrum of illness and prevention of WNV infection. In all of the WNV public information messages, the Health Department underscored the elimination of standing water and personal protection against mosquito bites.

In early 2007, the program produced its third 18-month calendar full of bright, colorful and humorous graphics. The graphics were accompanied by captions, facts, figures, important dates and helpful reminders relating to West Nile virus, Lyme disease and preventive measures. Important behaviors such as cleaning gutters, emptying bird baths, filling depressions in the yard and wearing insect repellent were strategically stressed throughout the calendar. General facts, local figures and brief descriptions of the county's efforts were included to educate the public about basic mosquito biology and inform them specifically about mosquitoes and West Nile

virus in Fairfax County. These calendars were distributed at DCIP events and to all the fourth grades through a collaborative effort with the Fairfax County Public Schools. By the end of the summer, 22,000 calendars were distributed. Other jurisdictions, national and international, have requested permission to use the calendar graphics and materials. Another 18 month calendar for 2008-2009 is in preparation.

In the summer of 2007, the DCIP prepared and printed four new brochures: “Understanding Mosquitoes and West Nile Virus”, “The Asian Tiger Mosquito”, “Choosing the Right Repellent” and “Ticks and Tick-Borne Diseases in Fairfax County”. Several printings of these brochures have been made to date.

Many inquiries regarding WNV and mosquito breeding sites were received by the DCIP via direct telephone calls and two Web-submission forms available on the “Fight the Bite” Web page. Both of these Web submission forms routed messages directly to the “Fight the Bite” e-mail address, which is the Fairfax County Health Department’s dedicated WNV e-mail (fightthebite@fairfaxcounty.gov).

Planned Activities for Risk Communication, Public Education and Community Outreach

Public outreach, information and education are mainstays of the DCIP and will continue to be emphasized during the 2008 season. All materials will be reviewed, updated and new materials will be prepared to better reach county residents. Key materials will continue to be distributed in Spanish, Farsi, Korean, Vietnamese, Urdu and Chinese.

The FCHD, with assistance from the county’s Office of Public Affairs (OPA), will be the lead agency on content for WNV publications, posters, etc. and will make this information available to all interested county agencies and pertinent jurisdictions. The county will continue the “Fight the Bite” theme during 2008.

Key Communication, Education and Outreach activities:

- Revise and update the DCIP Web page.
- Prepare a 2008-2009 18-month calendar.
- Prepare and issue news releases as necessary.
- Promote Mosquito Awareness Week throughout the county.
- Distribute CDC literature on WNV and the outdoor worker.
- Evaluate media strategies used in other areas of the country and incorporate them into the program as feasible.
- Mass mail a brochure on WNV to the County residents.
- Beginning mid-April, key messages will be disseminated through news releases, interviews and public service announcements. Most will aim to elevate the population’s awareness of WNV and steps that individuals can take for personal protection. The multiple media outreach will include announcements in non-English language media as well.
- DCIP staff will work with OPA and the Board of Supervisors offices to reach the constituents in each of the districts.

- Fairfax County Print Shop will be contacted to produce outreach and educational material year-round, as needed.
- Posters and brochures will be distributed at, by or through:
 - Fairs.
 - Homeowners associations.
 - Civic associations.
 - Posters in public buildings.
 - Clinic room aides and public health nurses (Schools).
 - Farmers markets.
 - “Fight the Bite” Web page (www.fairfaxcounty.gov/fightthebite).
 - HD/Community Health and Safety staff.
 - Clinic and physician waiting rooms.
 - Other distribution methods as available.
- During special events and through the Board of Supervisors offices:
 - Information about the use of Mosquito Dunks® and other larvicides will be presented to the community as an option for larval reduction in areas where the “tip and toss” campaign cannot be implemented.
 - Information about the use of repellents containing DEET, picaridin or oil of lemon eucalyptus will be presented to the community as an option for personal protection against mosquito bites.
- If surveillance information demonstrates potential human risk of infection with WNV, media messages will:
 - Emphasize personal protection against mosquito bites using “Fight the Bite” recommendations.
 - Help Fairfax County residents ensure personal protection for themselves and family members.
 - Target traditional media outlets as well as community newspapers in multiple languages and in multiple neighborhoods.
- If the available surveillance information suggests imminent and substantial risk to human health and adult mosquito control is recommended, FCHD will enhance its efforts to provide complete, timely and accurate information on spray areas, spray schedule and measures people can take to reduce exposure.
- Timeline of Activities:
 - In April to May 2008, the county will prepare and provide WNV-related media stories.
 - From June to October 2008, as determined by mosquito and WNV activity detected, the “Fight the Bite” campaign to “reduce infection by reducing mosquito bites” will be intensified.
 - Throughout 2008, outreach activities will be implemented as the need demands.
 - New materials will be prepared or acquired to target specific issues or groups for WNV information and protection.
 - During winter months, FCHD will review and update all the outreach materials, prepare new material as needed. All material will be printed and prepared for distribution in targeted groups.

2. Human Case Surveillance

Goal: To promptly detect, investigate, and report cases of human WNV disease to enable timely implementation of prevention and control measures to prevent further cases; to assess and document the public health impact of WNV disease in Fairfax County.

Introduction and Report of Previous Activities

In 2007, Fairfax County Health Department (FCHD) used a system of enhanced passive surveillance to detect cases of WNV disease, and worked to improve the quality and timeliness of reporting. FCHD also continued its efforts to identify suspected WNV cases with higher risk of non-vector borne disease transmission, including individuals who had recently received or donated blood products or organs, and nursing or pregnant mothers.

Arboviral infection is one of more than 70 reportable diseases and conditions in Virginia and physicians are required to report all suspect cases to local health departments (including FCHD). In addition to physician reports, FCHD also receives reports of suspect cases of arboviral infection from commercial laboratories, hospitals, the Division of Consolidated Laboratory Services (DCLS), and the Virginia Department of Health Office of Epidemiology.

All suspect cases of arboviral disease reported to FCHD are investigated. Suspect cases meeting the clinical criteria for West Nile neuroinvasive disease or West Nile fever with laboratory evidence of recent infection (presence of IgM antibodies) are classified as “confirmed” or “probable,” depending on the strength of the supporting laboratory evidence. Cases of arboviral disease are classified either as neuroinvasive (WNND) or non-neuroinvasive (West Nile fever) according to the following criteria:

Neuroinvasive disease requires the presence of fever and at least one of the following, as documented by a physician, and in the absence of a more likely clinical explanation:

- Acutely altered mental status (e.g., disorientation, obtundation, stupor, or coma);
- Other acute signs of central or peripheral neurologic dysfunction (e.g., paresis or paralysis, nerve palsies, sensory deficits, abnormal reflexes, generalized convulsions, or abnormal movements); or
- Pleocytosis – increased white blood cell concentration in cerebrospinal fluid (CSF) associated with illness clinically compatible with meningitis (e.g., headaches or stiff neck).

Non-neuroinvasive disease (West Nile fever) requires, at minimum, the presence of documented fever (measured by the patient or clinician), the absence of neuroinvasive disease (above), and the absence of a more likely clinical explanation for the illness. Involvement of non-neurological organs (e.g., heart, pancreas, liver) should be documented using standard clinico-laboratorial criteria.

Whenever possible, serological and/or CSF specimens from suspect arboviral cases are sent to DCLS for laboratory confirmation. Serological specimens are evaluated by DCLS using a

highly-specific IgM Microsphere Immuno Assay (IgM MIA) to detect IgM antibodies specific to WNV and SLE. An IgM antibody capture enzyme-linked immunosorbent assay (MAC-ELISA) is used to detect IgM specific to Eastern Equine Encephalitis (EEE) and, for samples from individuals less than 20 years of age, Lacrosse virus (LAC). An IgG ELISA is used to identify WNV, SLE, EEE, and LAC-reactive antibody in IgM positive and convalescent samples. (Note: A negative IgM-MIA or MAC-ELISA on a specimen taken soon after illness onset (<10 days) does not rule out arboviral infection. Whenever possible, convalescent sera are collected to determine if WNV infection is present or absent in these cases.) Serological specimens from patients with detectable levels of WNV-specific IgM and IgG are tested for confirmation with a plaque reduction neutralization test (PRNT), as appropriate. CSF specimens are evaluated using IgM MIA and MAC-ELISA.

Patient information and laboratory data is shared between the VDH Office of Epidemiology and FCHD in person, via telephone or via fax to facilitate case surveillance and timely reporting of laboratory results to FCHD. Results reported to FCHD about residents of other districts are forwarded by fax or mail to the appropriate local health department (in VA and the DC metro area) or state health department (for out-of-state residents). When laboratory results are negative, a report is sent to the original collecting physician. When laboratory results are equivocal, the collecting physician is notified and a convalescent sample may be requested. When laboratory results are positive, the collecting physician is notified and a convalescent serum sample may be requested. Positive results are investigated and assigned a PIN number in AVATAR (an FCHD database). In addition, positive results are entered into the National Electronic Disease Surveillance System.

Cases of West Nile Virus Disease in Fairfax County in 2007

In 2007, two confirmed human cases of WNV disease were identified in Fairfax County. One case met the criteria for WNND. The second met the criteria for West Nile fever (non-neuroinvasive disease). Of note, the individual with West Nile fever had traveled to a part of the U.S. with higher rates of infection than recently documented in Virginia. The timing of this travel suggests that this individual may not have been infected locally. No probable cases were identified.

Planned Surveillance Activities for WNV

In 2008, FCHD will continue to implement a system of enhanced passive surveillance for arboviral infection, including WNV disease. Active surveillance will be instituted if necessary, based on the results of passive human case surveillance, mosquito surveillance, and any changes in the epidemiology of WNV disease in surrounding counties or in the state.

As in 2007, enhanced passive surveillance will have two main components:

- 1) *Alerting the medical community.* As with most other reportable diseases, physician reporting for WNV disease is not as reliable as laboratory-based reporting. FCHD will maximize physician reporting of WNV disease by: raising awareness within the medical community of the importance of reporting suspected infection; educating hospital infection control personnel and physicians on the criteria for reporting cases; and providing instructions for

submission of appropriate laboratory specimens.

Physicians will also be encouraged to: develop a high index of suspicion for arboviral infection in patients hospitalized with encephalitis of unknown etiology; rule out WNV in suspected cases of Guillain-Barre syndrome, botulism, and muscle weakness or flaccid paralysis; and determine if there is a history of donating or receiving blood or organs or if the patient is pregnant or breast-feeding.

As in 2007, testing for WNV will be performed by DCLS, including IgM MIA and MAC-ELISA on sera and CSF, IgG on IgM positive sera, and RT-PCR on post-mortem tissue. Health care providers will be reminded that the appropriate specimens for testing include:

- *Sera* - appropriately timed acute and convalescent sera for testing by IgM MIA (WNV and SLE), MAC-ELISA (EEE and LAC) and IgG ELISA;
- *CSF* - testing by IgM MIA or viral isolation;
- *IgM* - positive sera should be confirmed by convalescent sera (IgM MIA, MAC-ELISA and PRNT); and
- *Brain tissue* - real-time RT-PCR and viral isolation.

FCHD will intensify its efforts to alert and educate the medical community prior to and during the peak months of mosquito activity and viral amplification (July-October).

- 2) *Laboratory surveillance.* FCHD will continue to investigate reports of sero-positive cases of arboviral infection tested by commercial laboratories, hospitals, physicians, Division of Consolidated Laboratory Services (DCLS), and the Office of Epidemiology. As part of enhanced passive surveillance, FCHD will ensure that hospitals and laboratories are aware of the latest surveillance criteria, and have the information and materials necessary to submit diagnostic specimens for testing at DCLS.

To improve the efficiency of the passive surveillance system, FCHD will continue to encourage both physicians and laboratories to complete all essential information on the laboratory submission forms by contacting appropriate parties, including the patient or patient's family, if necessary. Accurate interpretation of serological findings requires knowledge of the patient's clinical history. For human specimens, it is important that the following data accompany specimens submitted for serology before results can be properly interpreted and reported:

- Symptom onset date;
- Date of sample collection;
- Unusual immunological status of patient (immunosuppression);
- Current address and travel history in flavivirus-endemic area;
- History of prior vaccination against a flavivirus disease (Yellow fever, Japanese Encephalitis or Central European Encephalitis); and
- Brief clinical summary including suspected diagnosis.

Additional Surveillance Activities for WNV

Given recent evidence suggesting the potential for non-vector borne WNV transmission, FCHD

will continue to determine if any human cases of probable or confirmed WNV infection:

- Received an organ transplantation or blood transfusion within the four weeks prior to illness onset, or acted as a blood donor during the two weeks prior to illness onset;
- Are pregnant or breast-feeding mothers; or
- Resulted from occupational exposure.

The VDH Office of Epidemiology will be notified in a timely fashion of any potential non-vector borne WNV transmissions. A trace-back investigation of transplant or transfusion cases would involve the CDC and the Food and Drug Administration (FDA).

Please note: The Human Case Surveillance Plan may be updated as needed to reflect local surveillance needs, resources or guidelines from the Virginia Department of Health, or the Centers for Disease Control and Prevention.

3. Mosquito Surveillance

Goal: *To maintain a sustainable surveillance program to monitor vector mosquito populations and their WNV infection rates as well as other associated factors that will allow the program to predict the risk of WNV transmission to humans.*

Background and Report on 2007 Activities

It is important to note that absolute high numbers of mosquitoes do not necessarily reflect high risk of human infection with WNV. High mosquito counts, even if the mosquito species involved may bite humans, are usually from large broods of floodwater “nuisance mosquitoes” such as *Aedes vexans*, which are less important than *Culex* mosquitoes, which transmit WNV. Fortunately, the Northern house mosquito, *Culex pipiens*, feeds much less frequently on humans than *Ae. vexans*.

In the 2007 season, a total of 174,250 mosquitoes were collected over 5,280 trap-nights. The FCHD submitted 4,995 samples (pools) (which included 145,402 mosquitoes) for WNV testing and 469 pools were found to be positive. From this information, the DCIP was able to determine that the Maximum Likelihood Estimation (MLE), or infection rate, of *Culex* mosquitoes ranged from zero to 20.6 per 1,000 mosquitoes during the season (Figure 1).

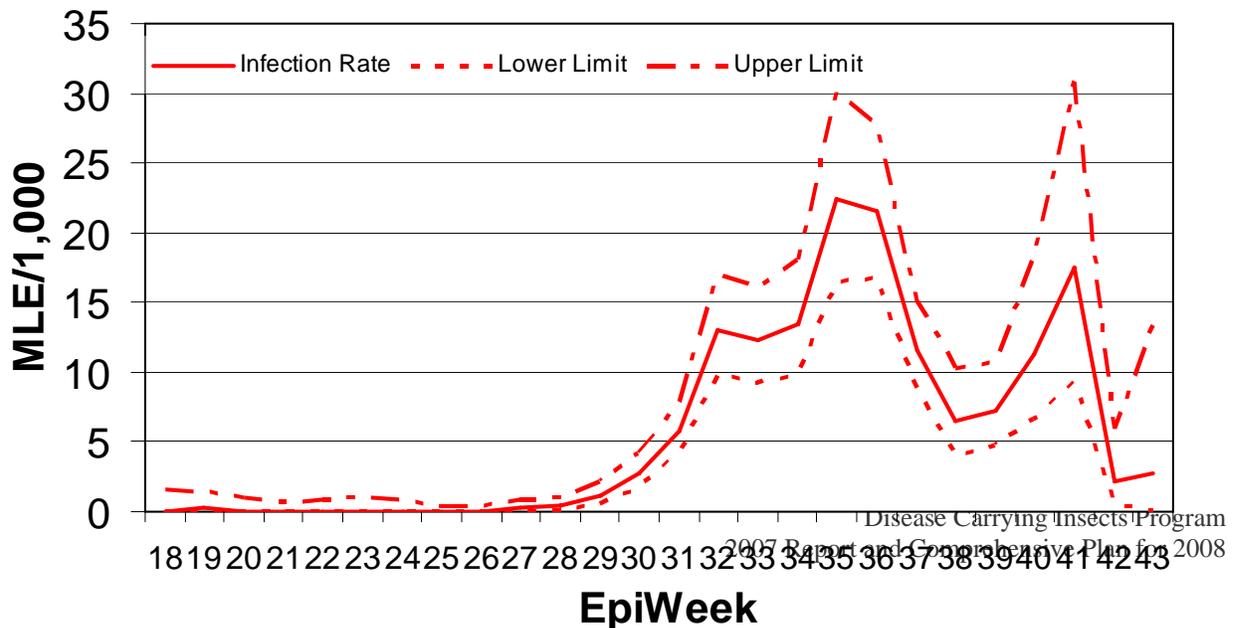


Figure 1. Maximum Likelihood Estimates of West Nile virus infection, per 1,000 mosquitoes, in *Culex* mosquitoes found in Fairfax County, 2007.

The first WNV positive mosquito in 2007 was collected in week 19 (May 8). This is early in the year and the lack of subsequent positive mosquitoes in the following weeks, strongly suggests that this was a mosquito that overwintered, infected from the previous season. The other positive pools began appearing in week 27 (early July) and peak infection rates occurred between weeks 33 and 36 (mid-August to early September). The observed infection rates were comparable to those found in 2004 and 2006.

Of the mosquitoes tested in 2007, six species were positive for WNV; *Aedes albopictus*, *Aedes vexans*, *Anopheles punctipennis*, *Culex erraticus*, *Culex pipiens* and *Culex restuans*. Both *Culex pipiens* and *Culex restuans* are the two species which are most frequently infected with WNV in the county and are mosquitoes that prefer to breed in stagnant water. In Fairfax County, catch basins and artificial containers appear to be the preferred breeding site for *Cx. pipiens*, while puddles of water above ground are the preferred breeding sites for *Cx. restuans*.

After the flood in the Huntington area of the county in 2006, we continued mosquito surveillance in the area in 2007. The results showed high mosquito densities with high infection rates in various mosquito species infected with WNV. Based on these findings, the DCIP found it necessary to apply a barrier spray of an adulticide (permethrin) to address the situation for a second year in a row. Catch basins in the Huntington area were treated weekly.

Again, one of the most common mosquito-related complaints received from citizens in 2007 was the presence of the Asian tiger mosquito (*Aedes albopictus*) in large numbers around residences. Several factors contributed to the presence of *Ae. albopictus* around these homes; however the presence of black corrugated pipes at the end of the downspouts from the roof gutters seemed to be the main source of the problem. Most of these corrugated pipes did not drain properly or adequately and they retained water throughout the season, thus providing great mosquito breeding habitat.

In 2007, FCHD continued to identify mosquito breeding sites throughout Fairfax County and treated all collections of water that contained mosquito larvae with a larvicide. This survey complemented the monitoring activities of *Culex* breeding sites in the county during the previous three years and allowed for the breeding site database to be updated. This data will serve as a guide to the breeding sites in the county that will be inspected and treated on a monthly basis during 2008.

Planned Activities for Mosquito Surveillance

FCHD mosquito surveillance activities for 2008 include:

- Continue to conduct mosquito surveillance with a minimum of 70 trapping stations throughout the county.
- Associate mosquito trap data with risk factors to assess how to predict human risk and refine “triggers” for mosquito control activities.
- Sort each trap collection by mosquito species and record information on location, collection data, trap type and the total number of female mosquitoes and send mosquito samples to DCLS for WNV detection.
- Prepare trap sites to be used during the 2008 season to ensure homogeneous coverage of the county.
- Conduct adult mosquito trapping in areas where conditions suggest a public health threat. This will help determine zones of potential local transmission and determine the extent of viral activity thus guiding interventions.
- Intensify mosquito trapping to evaluate the efficacy of control measures in the event that pesticides are applied for adult mosquito control.
- Deploy additional traps in areas where surveillance indicators suggest an increase in WNV activity.
- Introduce, into routine surveillance activities, new trapping techniques that have shown to be promising, particularly those that will enhance mosquito surveillance or capture species that are not readily collected by other trapping techniques.
- Continue to evaluate new trapping techniques (baits, traps, etc.), particularly those that will enhance mosquito surveillance, capture species that are not readily collected by other trapping methods (i.e. *Aedes albopictus*) or collect WNV vector species more efficiently.
- Ensure adequate routine inspection of suspected breeding sites to determine the presence of larvae.
- Collect and update larval habitat information throughout the season (May-October) and treat sites that produce mosquitoes.
- Respond to residents concerns regarding mosquitoes in a timely manner.
- Share information in a timely fashion with the contractor, county agencies and neighboring jurisdictions regarding sites needing larvicide, as appropriate.

4. Environmental Considerations

Goal: To monitor environmental factors (temperature, rainfall and photoperiod) to correlate with surveillance results and WNV circulation to determine those factors that may influence WNV transmission.

Background and Report on 2007 Activities

It is apparent that some of the factors associated with WNV transmission are temperature, rainfall and photoperiod (day length). Colder temperatures prolong the development of the virus in the mosquito, requiring a longer period for mosquitoes to become infective. Lower temperatures also prolong the larval development of mosquitoes, keeping them in breeding sites as immature larvae for longer periods of time. Frequent and abundant precipitation also creates a

flushing effect of catch basins and other breeding sites, washing out mosquito larvae that may be there.

While climatic factors can't be controlled or modified, monitoring them will help understand their effect on mosquito transmitted diseases. In 2008, FCHD will continue to monitor climatic factors in order to be able to correlate them with either disease or mosquito abundance.

Planned Activities for Environmental Considerations

- Continue to monitor climatic factors in 2008, and correlate them with both disease and mosquito abundance.
- Official (NOAA) weather data will be collected from weather stations at Ronald Reagan Washington National Airport and Washington Dulles International Airport on a daily basis and recorded electronically.
- Weather trends will be monitored and correlated with surveillance information to help predict mosquito population variation, viral activity and human infection.

5. Avian Surveillance

Goal: To use avian mortality records and WNV infection in birds as an additional indicator of WNV activity in Fairfax County to help predict the spread of the virus before the onset of human illness.

Background and Report on 2007 Activities

While many species of birds have tested positive for WNV, crows and blue jays have been particularly susceptible to the disease and are readily identified by the public.

In 2007, the number these dead birds reported was 350, about half the number reported the previous year (Figure 2). Twelve birds were tested for WNV in 2007 and all were negative for WNV; other birds that were collected were too decomposed to be tested.

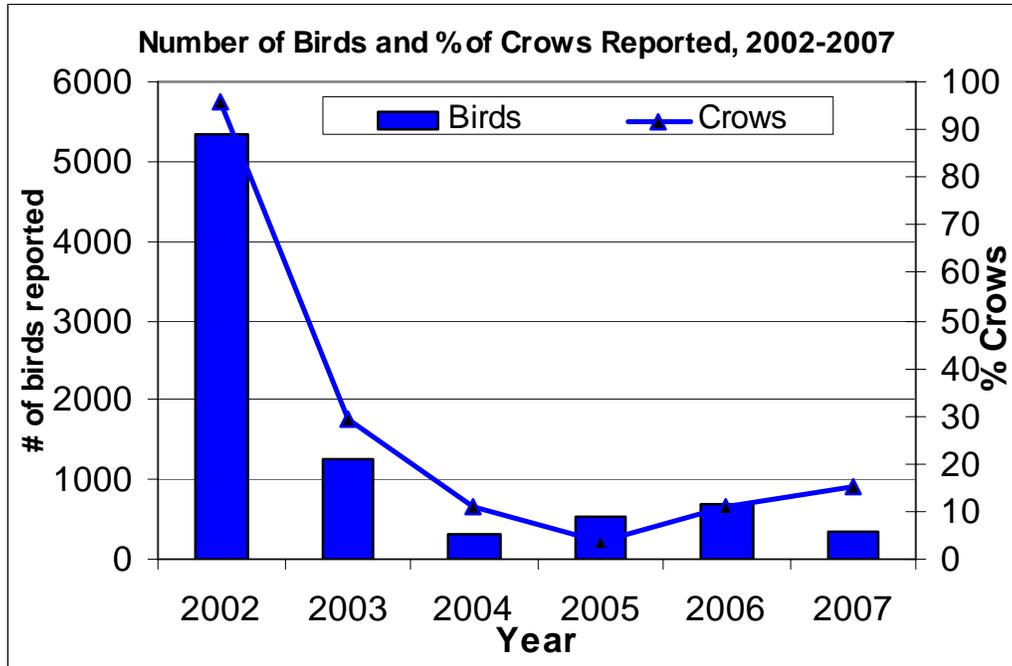


Figure 2. Number of dead birds reported and percentage of these that were crows from 2002 to 2007 in Fairfax County.

Data collected since 2002 indicates that there was a decline in the number of dead bird reports to the FCHD to 2004, and then the number stabilized and remained constant for the following years, varying slightly each year. The greater part of this decline is due to the decreased number of dead crows reported.

The percentage of dead crows reported in 2007 (15.43 percent) is higher than that reported since 2003, yet no trend in crow mortality has been observed for the past five years. Although crows initially served as first indicators of WNV in the county, they are not useful in this capacity at present but may be an indicator of the amount of virus circulating.

Planned Activities for Avian Surveillance

- As in 2007, FCHD will continue to monitor dead birds as reported by the public through the call-in phone line 703-246-2300, TTY 711, or by e-mail through the county's WNV Web page www.fairfaxcounty.gov/fighthtebite.
- Reported dead bird information will be used by the FCHD to enhance its disease surveillance program even if the bird is not picked up.
- Clear public messages regarding bird testing and disposal will continue to be disseminated by all possible means.
- Throughout the year, FCHD will geocode and map dead birds as they are reported. Mapping will be done for all birds and corvids as well as any WNV positive birds. These maps will

show geographical groupings of dead birds. This data will be compared to other WNV surveillance and control events.

- An appropriate sample of dead birds, especially crows and blue jays that have died within the previous 24 hours, may be tested for WNV.

6. Source Reduction (elimination of standing water)

Goal: *To reduce the number of adult mosquitoes by eliminating potential mosquito development sites.*

Background and Report on 2007 Activities

All mosquitoes begin their life in water. The Northern house mosquito (*Culex pipiens*) and *Culex restuans*, the primary vectors of WNV in Fairfax County, and the Asian tiger mosquito (*Aedes albopictus*) are three mosquitoes commonly found in urban areas. The *Culex* mosquitoes breed quickly and lay their eggs on standing water. The Asian tiger mosquito is the primary nuisance and main backyard mosquito in the county. It lays its eggs in artificial containers around the home. Prime sites for all these mosquitoes to develop around homes include discarded tires left outdoors, poorly maintained bird baths, clogged rain gutters, poorly maintained swimming and plastic wading pools, pots, black corrugated gutter drain pipes and puddles that last for a week or more. Eliminating these sites is the simplest and most effective way to reduce the number of mosquitoes. Every residential and commercial property owner should regularly inspect their property and buildings to determine if conditions are conducive to mosquito development and endeavor to eliminate those conditions. Mosquito development can be prevented by either eliminating the standing water (source reduction) or treating the water with larvicide to prevent mosquitoes from growing if source reduction is not possible.

The county's WNV community outreach, information and public education campaign highlights the need for residents to eliminate mosquito-breeding sites around their homes. Diagrams of potential sources around the home were described in multiple media events and languages as well as on the WNV Web page.

In 2008, DCIP will continue to receive complaints from residents regarding standing water and mosquito development sites throughout the county and take the appropriate action to abate them.

Planned Activities for Source Reduction

- The DCIP will work with homeowners associations to promote community participation and distribute printed information on the need to eliminate mosquito-breeding sites on their property or to properly treat them with larvicide.
- The telephone line (703-246-2300, TTY 711) will continue to receive complaints on mosquitoes.
- The public will be asked to eliminate standing water on private property or to report standing water to (703-246-2300, TTY 711) if it is on public property.
- FCHD will communicate with owners or managers of cemeteries, country clubs and other institutions of concern to develop a plan that addresses the abatement of standing water.

- FCHD will work closely with DPWES on mosquito problems in stormwater retention/detention ponds.
- FCHD will route mosquito issues in roadside canals and blocked catch basins to VDOT.
- In collaboration with Fairfax County Public Schools, mosquito populations will be monitored and controlled on the school campuses in the county.

7. Larviciding

Goal: To reduce the number of adult Culex mosquitoes by applying environmentally safe larvicides in breeding sites that cannot be drained.

Background

Catch basins, also called storm sewers or stormwater catch basins, are located throughout the county. Catch basins usually drain well and do not present an opportunity for mosquito breeding; however, some (particularly those in older communities in the county) may have structural problems or may be partially blocked, retain water and produce excellent breeding sites for *Culex* mosquitoes. The exact number of CBs in the county is unknown, but it is estimated there are 75,000 to 100,000. Based on WNV data from previous years, FCHD worked with a contractor and began treating CBs proactively, in predetermined areas of the county. The larvicide used, VectoLex[®] (*Bacillus sphaericus*), is a naturally-occurring soil bacterium that produces toxins that cause death in mosquito larvae. It is considered ideal for mosquito management because it will only affect mosquitoes and one other type of biting fly and because of its very low toxicity to other organisms. During the 2007 season, 107,118 CBs were treated in three treatment cycles. The number of cycles treated in a season is dependent on several factors, including weather, degree of viral activity, resources, etc. Other than the routine monthly CB treatments, all the catch basins in the flooded Huntington area were treated once a week to lower the *Culex* population.

Dr. Roger Nasci (CDC) has stated, “(WNV) programs with the most intensive larviciding had proportionally fewer human WNV cases.” Dr. Linn D. Haramis (Illinois Department of Health) indicated that Cook County programs with the most intense larviciding programs had proportionately fewer WNV cases. Dr. Ned Walker (Michigan State University) noted that in Michigan, the infection rate in mosquitoes was four per 1,000 in areas with catch basin control and 28 per 1,000 in areas without such control activities. Even though this data is not conclusive, it strongly supports CB larviciding at least until WNV transmission and factors affecting it are better understood.

Planned Activities for Larviciding

- At present the, DCIP is planning three larviciding cycles in 2008. If needed, an additional cycle will be conducted. The Huntington area will be monitored and treated at a more regular frequency.
- The first round of CB treatments will begin in mid-May and will follow the programmed CBs in the county tax map areas treated in 2007.
- The second and third rounds of treatment will follow the pre-established order.

- FCHD will purchase sufficient larvicide for FCHD and Fund 116 staff to treat larval development sites as necessary to abate immediate problems.
- FCHD will inspect and larvicide the previously identified larval development sites.
- FCHD will work in collaboration with DPWES in the surveillance and larviciding of stormwater detention/retention ponds.
- FCHD will verify WNV control and mosquito management plans of action through the regular meetings of the MSMS.
- FCHD will continue to monitor CBs outside the treatment area and treat them as necessary.

8. Operational Research

Goal: To carry out designed experiments in a scientific manner which will answer specific operational questions that will improve the ability to understand and predict West Nile virus activity, resulting in a more effective approach to WNV control and mosquito management.

Background and Report on 2007 Activities

Competition studies were continued to assess the potential impact of introduced species on native and resident species. The results show that *Oc. japonicus* appears to be more populous than we can determine in the traps that are presently being used to collect adults. Larvae of this species appear to be the predominant species in tires yet are infrequently collected in the traps for adults.

Following up on data collected in 2006, the two new traps and lures tested for their ability to collect mosquitoes we found that the BG-Sentinel trap with a lure and CO₂ was still more effective in collecting the Asian tiger mosquito, however the Zumba trap, baited with the BG-Lure and CO₂ proved to be a better trap for collecting WNV-infected host-seeking mosquitoes. This trap has shown to be as effective as all the other three traps combined that we are presently using (BG, CDC and Gravid). It is our belief that this trap could be the only trap necessary for surveillance if our preliminary data holds true in an operational setting. We will incorporate the BG-Sentinel and the Zumba traps into our routine surveillance system in order to fully evaluate them.

Planned Activities for Operational Research

- Continue to document the importance of catch basins in the production of *Culex pipiens* in Fairfax County.
- Continue to evaluate specialized mosquito surveillance tools that are being developed by the industry.
- Continue to evaluate new mosquito collection methods (attractants and traps) to increase surveillance capabilities.
- Study the importance of certain artificial containers as larval habitat for *Aedes albopictus* and *Oc. japonicus*.
- Try to better understand the distribution of *Oc. japonicus* in the county.

9. Adult Mosquito Control

Goal: To reduce the abundance of infected adult mosquitoes through the judicious use of pesticides in targeted areas when there is significant risk of mosquito-borne disease.

Background and Report on 2007 Activities

While source reduction and the application of larvicides are the principal and most effective interventions to reduce mosquito populations, situations may arise in which infected adult mosquitoes are present in significant numbers and pose a threat to human health. In these situations, judicious application of adulticides to control mosquito populations will be added to all other mosquito control activities as an additional measure to reduce risk of illness and death in humans. WNV guidelines from CDC state that adulticiding based on surveillance data is an extremely important part of any integrated mosquito management program and should be used when there is significant risk of human illness.

Some of the insecticides that are used against adult mosquitoes include synthetic pyrethroids and malathion (an organophosphate) that have been used for more than 30 years and are registered by the U.S. Environmental Protection Agency and the Virginia Department of Agriculture for adult mosquito control in residential areas. These insecticides provide a rapid knockdown, killing adult mosquitoes upon contact. They also have low toxicity to mammals and birds, degrade rapidly in sunlight and water, and provide little or no residual activity. Most of these products do not bioaccumulate in animals.

There are two principal strategies in adulticiding that can be employed in mosquito control. One is to produce tiny droplets of insecticide from a machine (frequently mounted on a truck or aircraft) in such a way that a cloud of insecticide is produced. In this method, called Ultra Low Volume (ULV), the effect of the insecticide lasts a very short period of time and will only kill those mosquitoes which come in contact with these tiny droplets. A second strategy is to lay down a thin coat of insecticide on the vegetation. In this case the insecticide will last for a longer period of time and will kill any mosquito that comes into contact with the insecticide during the time that it is active. This form of adulticiding is called barrier spraying.

In the event that ULV adulticiding is necessary, the FCHD will define the areas in the county where risk of WNV infection to humans is highest and which requires such action. Drivers and trucks from the contractor will be escorted down streets and roadways by police and will apply adulticide to the defined areas.

All adulticiding activities will be conducted under the direction of the County Executive and in consultation with MWCOG and the VDH, and in coordination with any affected county, city or town within or adjacent to Fairfax County.

Mosquito species and habitat, weather, time of year, the presence of the virus and the proximity of infected mosquitoes to human populations will be considered in determining the necessity for adult mosquito control. If the application of adulticides becomes necessary, FCHD will provide advance notice to the public and health care providers in affected areas.

Prior to 2005, even in the years when there were human WNV cases, the use of insecticides against adult mosquitoes had not been indicated by the surveillance program. In 2005 and 2006 it was determined that it would be necessary to apply a barrier spray in an area where the surveillance program showed high WNV activity in the mosquitoes. Likewise, in 2007, the surveillance indicators in Masonville Park and the Huntington area indicated the need for an adulticide barrier spray and a permethrin barrier spray was applied at each site. Subsequent surveillance data showed that the barrier spray reduced the vector index, thus lowering the risk of WNV to humans in the area. All activities were conducted under the direction of the County Executive and all of the residents in the affected areas were notified before treatment by hand-delivered letters. None of the human cases reported in Fairfax County were from these areas.

At a minimum, the following factors will be considered when deciding the scope of the adulticiding effort:

- The general ecology of the area, e.g., key habitat types and the presence of natural barriers such as large rivers.
- The population composition, density, distribution, flight range and age structure (proportion of parous females) of the target mosquito species.
- The human population characteristics – spatial distribution and density relative to the positive locality (e.g. urban vs. rural), age demographics, etc.
- Evidence of persistent WNV activity detected by the surveillance program, season of the year and how long WNV activity can be expected to persist until the epizootic/epidemic vector(s) enter diapause.

Planned Activities for Adult Mosquito Control

The presence of mosquito-borne pathogens in Fairfax County will result in one or more responses or interventions recommended by FCHD. These interventions can range from continuing existing surveillance, education and outreach to the affected population to the targeted application of adulticides.

FCHD will utilize its surveillance data to assess the risk of an outbreak of human disease and the need to apply insecticides in a limited and targeted area to control adult mosquitoes. Vector considerations include level of documented virus, the distribution and the density, age and infection rate of the vector population. Other factors must also be considered before insecticide is used. Environmental considerations include habitat, time of year, weather conditions. The density and proximity of human populations are also considered before adulticide is used. Because these conditions can vary greatly and cannot be predicted, a consultation process with VHD, CDC and surrounding jurisdictions will be used to determine which, if any, responses are appropriate, on a case-by-case basis.

If adulticides are used to control mosquitoes, advance notification will be disseminated to surrounding residents indicating when and where the insecticides will be applied. This allows residents who wish to avoid exposure to take necessary actions and precautions. The Virginia Poison Control Center, area hospitals and health care providers will be provided information on

the pesticide being used. All insecticides considered for use are registered with the U.S. Environmental Protection Agency and the Virginia Department of Agriculture and will be used according to the label directions. When choosing pesticides for mosquito control, preference will be given to those insecticides that pose the least risk to humans and the environment.

In order to categorize the use of adulticides in Fairfax County, any responses initiated by the FCHD can be grouped into six broad categories or levels of risk. These levels are tailored after those of CDC, yet are modified to specifically reflect Fairfax County's position based on previous findings.

Level 0

Definition: Fall/winter; vector inactive, climate unsuitable for WNV transmission.

Response: Prepare material and equipment for the upcoming WNV season. Surveillance and control programs continue as outlined in the county's Surveillance and Control Plan. Identify locations where source reduction activities can be applied; secure surveillance and control resources necessary to enable response to WNV activity; initiate community outreach and public education programs; enhance communication with surrounding jurisdictions; recruit and train new staff; communicate with and educate large property owners of the importance of source reduction in areas such as cemeteries, golf courses, country clubs; communicate status of WNV activity to director of the Health Department, the Board of Supervisors and the public as the WNV season starts.

Level 1

Definition: Spring/summer/fall; anticipating WNV activity based on previous activity in region. No current surveillance findings indicating WNV activity in the area.

Response: Respond as in level 0, plus: continue and enhance source reduction; conduct larval control in identified breeding habitats where source reduction is not possible (emphasis will be placed on known *Culex* species breeding sites); continue community outreach and public education; begin monitoring avian mortality; work with other county departments on source reduction and mosquito control activities; initiate catch basin treatment rounds.

Level 2

Definition: Spring/summer/fall; initial, sporadic or limited WNV activity in birds and/or mosquitoes.

Response: Respond as in level 1, plus: increase larval control activities; continue source reduction in cooperation with other county departments; and increase public education, emphasizing personal protection measures, particularly the use of products containing DEET, picaridin or oil of lemon eucalyptus. Enhance human surveillance and activities to quantify epizootic activity (e.g. mosquito trapping and testing) in areas of concern. Consider recommending to the public that they decrease outdoor activities when mosquitoes are biting.

Level 3

Definition: Spring/summer/fall; initial confirmation of WNV in a human or a horse, or moderate WNV activity in birds and/or mosquitoes.

Response: Respond as in level 2, plus: expand public information programs (repellent use, personal protection, source reduction, risk communication about adult mosquito control program); prepare to implement adult mosquito control if surveillance findings indicate the likely potential for human risk to persist or increase.

Level 4

Definition: Spring/summer/fall; surveillance findings indicate high risk of human infection, (e.g. high or clusters of dead bird densities, high mosquito infection rates and vector index, multiple positive mosquito species, horse or other mammalian cases indicating increasing epizootic transmission, or a human case and high levels of epizootic activity) and abundant adult vectors.

Response: Respond as in level 3, plus: continue active surveillance for human cases; make final arrangements to implement adult mosquito control program in areas of potential human risk. The use of adulticides will be used in a limited manner as needed.

Level 5

Definition: Spring/summer/fall; marked increase of confirmed multiple WNV cases in humans and conditions favoring continued transmission to humans.

Response: Respond as in level 4, plus: implement or intensify emergency adult mosquito control program; monitor effectiveness of adulticiding on target mosquito populations; coordinate adult mosquito control activities with surrounding jurisdictions. FCHD activities related to adulticiding will include the following:

- CDC and gravid traps will be used in the treatment area if additional surveillance data are required.
- FCHD will work with state entomologist and/or CDC personnel as well as the contractor to design and implement feasible measures to monitor the efficacy of the adulticiding activities.
- The public will be notified of adulticide schedules in advance. This will allow residents with special health concerns sufficient time to take any precautions to reduce pesticide exposure (see Public Education and Community Outreach).
- Hospitals will be notified regarding the adulticiding schedule. Information on the pesticide used will be provided to the public, physicians and other health care providers.
- Adult mosquito control will be scheduled when mosquitoes are active and when weather conditions are conducive to its success.
- Information will be released in advance through the media, the FCHD WNV Web page and through news releases, the MSMS, as well as pertinent county and community organizations.

II. Tick and Tick-Borne Disease Surveillance 2007 Report and Comprehensive Plan for 2008

Background

Public Health Impact

Tick-borne diseases continue to impact public health causing serious acute illness, chronic long-term illness and, sometimes, death. The recent and widespread encroachment of suburban sprawl into areas that were once farmland and the large deer populations in these suburban communities have increased the prevalence of disease-carrying ticks and the exposure of the human population to the diseases they carry.

Ticks are excellent vectors for disease transmission, second only to mosquitoes as vectors of human disease worldwide. They can carry and transmit a remarkable array of pathogens, including bacteria, viruses, spirochetes, rickettsiae, protozoa, nematodes and toxins.

Furthermore, a single tick bite can transmit multiple pathogens—a phenomenon that has led to atypical presentations of some classic tick-borne diseases.

Ticks are among the most common disease vectors in the United States and are capable of transmitting Lyme disease, Rocky Mountain spotted fever, anaplasmosis, ehrlichiosis, babesiosis, relapsing fever, Colorado tick fever, tularemia, Q fever and tick paralysis.

Vector Biology

Knowledge of tick biology is important in understanding the tick's role in disease transmission and is equally important in the prevention of tick-borne diseases. There are four distinct life stages in a tick: egg, larva, nymph, and adult. The length of the life cycle and the number of hosts fed upon depends on the tick species. Most ticks have a two-year life cycle and will have from one to three hosts.

The essential characteristic of ticks in terms of disease transmission to humans is their need to ingest a blood meal to develop into the next stage of their life cycle. Ticks will take their requisite blood meal from all classes of vertebrates, with the exception of fish. Ticks find their host by questing, a behavior in which they perch in low vegetation and wait for a susceptible host to pass by, onto which they can attach and feed. Once on a host, the tick attaches its hypostome, a central piercing element with hooks, into the host's skin. Some ticks may secrete a cementing material to fasten themselves to the host, as well as anticoagulant, immunosuppressive and anti-inflammatory substances into the area of the bite. These prevent hosts from noticing feeding ticks and thus aid the tick in obtaining a blood meal. These same substances also help transmit any pathogens that the tick may be carrying.

Introduction to Vector Surveillance

In light of the findings obtained through the pilot program in 2006, the DCIP continued tick surveillance in 2007. An enhanced surveillance program was used during the first part of the year only. The surveillance program was halted in August of 2007.

Collecting ticks from dead deer during hunts was utilized in 2007 and will continue to be used in 2008. This remains to be the method of choice to collect blacklegged ticks in Fairfax County.

Interim Report and Action Plan, by Activity

1. Risk Communication, Community Outreach and Public Education

Goal: To increase the public's knowledge about Lyme disease and other tick-borne diseases; to promote behavioral change; and to encourage the community to take an active role in reducing their risk of tick-borne diseases through preventive measures.

Background and Report on 2007 Activities

There has been an increased demand for information about ticks and tick-borne diseases (particularly Lyme disease) over the last year, and the Board of Supervisors has requested that efforts be increased in this area.

In 2007, we prepared a brochure on ticks and Lyme disease that was very welcomed by the community. Several thousand of these have been distributed to date. We also gave various presentations to homeowners and were present at many outreach events where we disseminated information regarding ticks and Lyme disease. We obtained a brochure from the VDH and distributed it at every event in which we participated. Tick and Lyme disease information and graphics were also incorporated into the DCIP 18-month calendar that was distributed through Fairfax County schools.

Planned activities for Risk Communication, Community Outreach and Public Education

The following activities will be carried out in 2008:

- Prepare educational materials on ticks and Lyme disease.
- Distribute educational material at all relevant venues.
- Inform residents about personal protection and the actions they can take to keep their property free from ticks.
- Emphasize the importance of personal protection, the use of FDA registered insect repellents, and proper dress when spending time outdoors.
- Design and implement a Lyme Disease Protection Program for county employees that work outdoors.
- Stress the importance of tick checks on self, children and pets.
- Give presentations to community groups as requested.
- Prepare media alerts when necessary.

2. Human Case Surveillance

Goal: To monitor the burden of tick-borne diseases (particularly Lyme disease) in Fairfax County through laboratory and physician case reporting.

Background and Report on 2007 Activities

In 2007, FCHD implemented a system of passive surveillance for Lyme disease and other tick-borne diseases, and worked with local physicians and laboratories to improve the quality and timeliness of reporting. In addition, FCHD actively participated in a regional Lyme disease forum held in July 2007 at FCHD. During this forum, issues and interventions surrounding disease reporting and surveillance were discussed.

Virginia state law requires that physicians (and/or laboratory directors) report cases of ehrlichiosis, Rocky Mountain spotted fever, Lyme disease, and Q fever within one to three days of diagnosis (depending on the disease). Anaplasmosis and babesiosis are not included in the Virginia list of reportable diseases.

In 2007, VHD and FCHD used the 1996 CDC case definition for Lyme disease. (NOTE: this definition has been revised for 2008, see below for details.) This case definition stated that, for a suspect case of Lyme disease to be considered confirmed, a patient must have erythema migrans (an expanding bulls-eye rash that is the best clinical marker of the disease), or the patient must have one late-stage manifestation (involvement of the musculoskeletal, nervous and cardiovascular systems without an alternate explanation) and be laboratory confirmed. Of note, a probable case classification for Lyme disease was not established under this definition.

Virginia DCLS criteria for a laboratory confirmation for 2007 were as follows:

- Isolation of *Borrelia burgdorferi* from a clinical specimen (tissue or body fluid); or
- Diagnostic levels of IgM or IgG antibodies to *B. burgdorferi* in serum or cerebrospinal fluid (CSF). A two-test approach was recommended, using a sensitive enzyme immunoassay (EIA) or immunofluorescence antibody (IFA), with positive or equivocal results confirmed by Western blot.

Cases of Lyme Disease in Fairfax County in 2007

Using the case criteria outlined above, FCHD detected and reported 192 confirmed cases of Lyme disease in Fairfax County in 2007 (as of January 17, 2008). This figure may continue to rise as data from 2007 is finalized in the first quarter of 2008. By comparison, 102 confirmed cases were reported in 2006.

Planned activities for Human Case Surveillance

In 2008, FCHD will:

- Intensify outreach efforts to educate physicians and laboratories regarding the diagnostic criteria, reporting requirements, and appropriate laboratory testing for Lyme disease and other tick-borne illnesses;
- Continue passive surveillance for human Lyme disease cases. Of note, surveillance activities will likely be modified to account for recent changes in the CDC case definition for Lyme disease and other tick borne illnesses. Pending VDH adoption of the CDC case definition, cases of Lyme disease will be defined as follows:
 - Lyme disease – Categories of confirmed, probable, and suspect will now be used with the following definitions:
 - *Confirmed*: a) a case of erythema migrans with a known exposure, b) a case of erythema migrans with laboratory evidence of infection and without a known

exposure, and c) a case with at least one late manifestation (as defined above) and laboratory evidence of infection.

- *Probable*: any other case of physician diagnosed Lyme disease that has laboratory evidence of infection.
- *Suspected*: a) a case of EM with no known exposure and no laboratory evidence of infection, or b) a case with laboratory evidence of infection but no clinical information available.

Lyme disease reports will not be considered cases if the medical provider specifically states that this is not a case of Lyme disease, or the only symptom listed is “tick bite” or “insect bite”.

Exposure will be defined as having been (less than or equal to 30 days before the onset of EM) in wooded, brushy, or grassy areas (i.e., potential tick habitats) in a county in which Lyme disease is endemic. A history of tick bite is not required.

For the purposes of surveillance, the definition of a qualified laboratory assay is: 1) a positive culture for *B. burgdorferi*; 2) two-tier testing interpreted using established criteria; or 3) single-tier IgG immunoblot seropositivity interpreted using established criteria.

Please note: The Human Case Surveillance Plan Lyme disease may be updated as needed to reflect local surveillance needs, resources or guidelines from the Virginia Department of Health, or the Centers for Disease Control and Prevention.

3. Routine Tick Surveillance

Goal: *To determine the density and distribution of tick vector species (Ixodes scapularis, Dermacentor variabilis, and Amblyomma americanum) to estimate the prevalence of infectious agents in tick population.*

Background and Report on 2007 Activities

The American dog tick (*Dermacentor variabilis*), the blacklegged tick (*Ixodes scapularis*) and the lone star tick (*Amblyomma americanum*) are the most important vectors of disease in Virginia and the primary focus of the DCIP’s surveillance efforts.

The 2007 tick surveillance program was modified mid-way through the year to include only tick removal from deer during hunts.

In 2007, a total of 3,805 ticks were collected, of which the majority were lone star ticks (*Am. americanum*) (1,996), followed by deer ticks (*Ix. scapularis*) (786) and American dog ticks (*De. variabilis*) (23). All ticks were sent to DCLS for pathogen testing in pools ranging in size from one to five ticks. Protocols were in place for testing deer ticks for the presence of the Lyme disease causing bacteria (*B. burgdorferi*), and *Anaplasma* but not for other pathogens. Mid-year, the lone star ticks and dog ticks were recovered from DCLS in light that Johns Hopkins School of Public Health offered to test these for other pathogens.

The percent of *B. burgdorferi* infected blacklegged ticks (the infection prevalence) was 4.4 percent in 2007.

Planned activities for Routine Tick Surveillance

The following activities will be carried out in 2008:

- Sort collected ticks by species, date and collection location, and record data in spreadsheets for analysis.
- Send ticks to DCLS (Division of Consolidated Laboratory Services) for Lyme disease, pathogen detection.
- Participate in controlled deer hunts to obtain ticks from county, state and national parks and wildlife refuges located within Fairfax County.
- Seek out new deer hunts and opportunities for tick collection.

III. Resources

In 2008, the Fairfax County Disease Carrying Insects Program will be supported by the following resources:

Fund 116

One Entomologist (Program Supervisor)
Two Merit Biologists
One Limited term Biologist
Six Limited term seasonal staff (May through October)
One Limited term Administrative Assistant

General Fund (Health Department)

One Environmental Health Specialists (EHS III) – Outreach support
One (10 percent) Environmental Health Specialists (EHS III) – GIS specialist
One (10 percent) Senior Administrative coordination

Other departments, agencies and jurisdictions

Mosquito Surveillance and Management Subcommittee (MSMS)

MSMS Members

City of Fairfax
City of Falls Church
Fairfax County Department of Public Works and Environmental Services (DPWES)
 Maintenance and Storm Water Management Division
 Forest Pest Management Program
Fairfax County Department of Management and Budget
Fairfax County Department of Information Technology
Fairfax County Park Authority
Fairfax Public Schools
Fairfax County Health Department
Fairfax County Office of the County Attorney
Fairfax County Office of Public Affairs
Fairfax County Police Department, Animal Control
Town of Herndon
Town of Vienna
Virginia Department of Transportation

IV. Mosquito Control References and Links

Association of State and Territorial Health Officials (ASTHO)
www.astho.org/

Centers for Disease Control and Prevention (CDC)
Pesticides and Public Health: Integrated Methods of Mosquito Management
www.cdc.gov/ncidod/eid/vol7no1/rose.htm

Centers for Disease Control and Prevention (CDC) and Environmental Protection Agency (EPA)
CDC/USEPA Joint Statement on Mosquito Control
www.epa.gov/pesticides/citizens/mosquitojoint.htm

Environmental Protection Agency (EPA)
Using Insect Repellents Safely
www.epa.gov/pesticides/citizens/insectrp.htm
Larvicides for Mosquito Control
www.epa.gov/pesticides/citizens/larvicides4mosquitos.htm
Synthetic Pyrethroids for Mosquito Control
www.epa.gov/pesticides/citizens/pyrethroids4mosquitos.htm
Pesticides and Mosquito Control
www.epa.gov/pesticides/factsheets/skeeters.htm

Fairfax County Health Department (FCHD)
West Nile Virus Web Page
www.fairfaxcountny.gov/fightthebite

U. S. Geological Survey (USGS)
<http://westnilemaps.usgs.gov/>

Virginia Department of Health (VDH)
West Nile Virus Web page
www.vdh.state.va.us/epi/wnvsrplan/AvianPlan.asp