2013 West Virginia Mosquito-borne Disease Surveillance Summary

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INTRODUCTION

Mosquito-borne diseases, the majority of which are viruses, are transmitted through the bite of infected mosquitoes. Surveillance for these diseases in West Virginia (WV) focuses on four arboviruses: La Crosse encephalitis virus (LAC), West Nile virus (WNV), St. Louis encephalitis virus (SLE), and Eastern equine encephalitis virus (EEE). Historically, LAC has been the mosquito-borne disease of most concern in WV, with up to 40 human cases reported in previous years. Other mosquito-borne diseases, such as malaria and Dengue fever, are not endemic to WV but a few travel-associated cases of these diseases have been reported. Maintaining mosquito-borne disease surveillance in WV is also important in detecting emerging diseases, such as chickungunya virus.

Most people who become infected with arboviral infections have no clinical symptoms; however encephalitis (inflammation of the brain) is a common and potentially life-threatening complication that is often reported among infected persons that do develop symptoms. Symptoms generally begin 1 to 2 weeks after a mosquito bite and include fever, headache, myalgia, meningitis, and neurologic dysfunction. There is no specific treatment available for arboviral infections.

Mosquito surveillance is important to understanding the distribution of these vectors and the diseases that they may transmit to humans. The WV state public health entomologist conducts mosquito surveillance across the state from late spring through early autumn. Certain species of birds (e.g. crows and jays) are more likely to become infected with WNV than other species and can die from infections. Reporting dead birds to local health departments (LHDs) is a great way to assist public health officials in arbovirus surveillance activities. Horses are also commonly infected with arboviruses. Mosquitoes, dead birds and horses help identify WNV and other arboviruses in an area.

This surveillance report summarizes the human cases of mosquito-borne disease and non-human surveillance—mosquito, dead bird, and horse surveillance—for arbovirus in WV in 2013.

METHODS

Human Surveillance

Patients with a positive laboratory test result for a mosquito-borne disease were entered into the West Virginia Electronic Disease Surveillance System (WVEDSS) for additional follow-up by the local health department, including an environmental assessment of case sites. All reported human cases were classified according to the national case definition for each mosquito-borne disease (http://wwwn.cdc.gov/nndss/script/casedefDefault.aspx). For Dengue fever and malaria cases, the 2010 case definition was used to ascertain the case status. For LAC cases, the 2011 case definition was used to ascertain the case status. For the WNV case, the 2014 case definition was used to ascertain the case status. Confirmed and probable arbovirus were reported to Centers for Disease Control and Prevention (CDC) through ArboNet. Surveillance reports were shared with public health partners bi-weekly to from June-December 2013 to provide data on vectorborne disease activity around the state. To obtain case counts and basic descriptive epidemiologic characteristics of cases, records were exported from WVEDSS for all mosquito-borne disease cases with a report date of MMWR Year 2013. Data were summarized using Microsoft Excel.

Enhanced passive surveillance methods were utilized to help detect human cases of mosquito-borne arbovirus infection. These methods included 1) a statewide health alert to physicians, 2) a hospital laboratory letter, 3) an email memo to local health departments with important arbovirus information, and 4) a webinar targeted for local health departments. During 2013, testing of human specimens occurred through hospital laboratories, the West Virginia

Office of Laboratory Services (WVOLS), the Virginia Department of Health Division of Consolidated Laboratory Services and CDC.

Horse Surveillance

Veterinarians suspecting arboviral infection in a horse patient submitted serum specimens to WVOLS. These specimens were forwarded by WVOLS to the National Veterinary Services Laboratory in Ames, Iowa for testing by IgM capture enzyme-linked immunosorbent assay (ELISA) for WNV and EEE. Equine specimens that test positive for arbovirus were reported to CDC through ArboNet.

Dead Bird Surveillance

Local health department personnel submitted oral swabs from dead birds to WVOLS for testing of WNV, SLE, and EEE to the Southeastern Cooperative Wildlife Disease Study at the University of Georgia. A report was submitted to CDC through ArboNet for any dead bird specimens testing positive for an arbovirus.

Mosquito surveillance

Active adult mosquito sampling occurred from May 22 – Sept. 25, 2013. The state public health entomologist and four summer interns conducted weekly mosquito trapping at three counties with historical human high case numbers from LAC (Nicholas, Fayette, Raleigh) and three counties with historical low human case numbers for LAC (Kanawha, Wood, Jackson) using CDC gravid traps and CO_2 dispersing light traps. BG Sentinel traps with octenol lures were used at different collecting sites in September. Semi-regular sampling was conducted in Mercer, Wyoming, Boone, Greenbrier, Harrison, Marion, and Monongalia counties. Daily mosquito samples were returned to WVOLS in the nets of the mosquito traps and placed in a -80°C freezer. Volunteers (sanitarians, public health nurses, local health department interns) around the state collected additional mosquito samples from Cabell, Wayne, Braxton, and Berkeley counties. All mosquito specimens were identified to species at WVOLS by the public health entomologist.

For arboviral testing, mosquitoes collected from the same locality and on the same date were pooled together based upon genus instead of species in an effort to conserve laboratory resources. Real time RT-PCR was used for arboviral detection. Only adult female mosquitoes were examined for arboviruses. Mosquito pools were tested for WNV, SLE, LAC, and EEE. Test results were reported to CDC through ArboNet. Pooled infection rates were examined for each genus each week. The minimum infection rate (MIR) is the ratio of the virus positive mosquito pools to the total number of mosquitoes in the sample

RESULTS

Human Surveillance

Table 1 provides a comparison of human cases of mosquito-borne diseases reported in WV during 2010-2013. During 2013, 16 cases of mosquito-borne diseases reported in WV: 11 LAC cases (8 probable and 3 confirmed cases), 2 travel-associated malaria cases (both confirmed cases), 2 travel-associated Dengue fever cases (one probable and one confirmed case), and one confirmed WNV case.

LAC cases

The median age of LAC cases was 6 years (mean 6.1 years, range 1-13 years). Six cases (54.5%) were male. Month of illness onset these cases ranged from June to September 2013 (Figure 1). LAC cases were reported from six counties: Boone, Greenbrier, Kanawha, Mercer, Nicholas, and Raleigh Counties. Figure 1 shows the geographic distribution of LAC cases and other human mosquito-borne disease cases in 2013. Nine (81.8%) of LAC cases had neuroinvasive disease.

WNV case

One case of neuroinvasive West Nile virus was reported in West Virginia. The case was a 40 year-old male from Monongalia County.

Table 1. Human cases of mosquito-borne disease in West Virginia from 2010 to 2013.

Mosquito-Borne Disease	No. (%) of Human Cases† - 2010	No. (%) of Human Cases† – 2011	No. (%) of Human Cases†- 2012	No. (%) of Human Cases†- 2013
LAC	8 (62)	26 (74)	14 (56)	11 (69)
WNV	0 (0)	2* (6)	9* (36)	1 (6)
Malaria	3 (23)	7 (20)	2 (8)	2 (12.5)
Dengue virus	2 (15)	0 (0)	0 (0)	2 (12.5)
EEE	0 (0)	0 (0)	0 (0)	0 (0)
SLE	0 (0)	0 (0)	0 (0)	0 (0)
Total	13 (100)	35 (100)	25 (100)	16 (100)

**Presumptive viremic blood donor not included in case count for West Nile virus*
†Includes only cases classified as confirmed or probable

Dengue fever and malaria cases

There were two travel-associated Dengue fever cases reported in 2013; one 23 year-old male from Kanawha County traveled to Haiti and one 66 year-old female from Monongalia County traveled to Costa Rica.

There were two-travel-associated malaria cased reported in 2013; one 7 year-old female with travel history to South Africa and one 49 year-old male with travel history to Côte d'Ivoire. Both cases were from Berkeley County. One case reported taking malaria chemoprophylaxis.

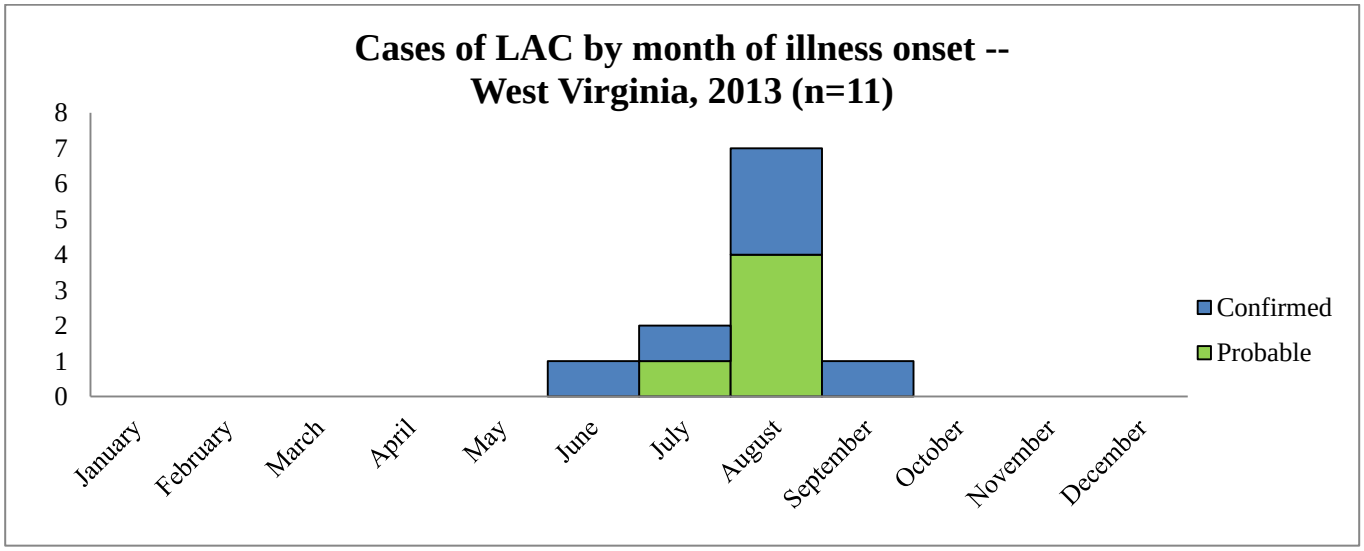
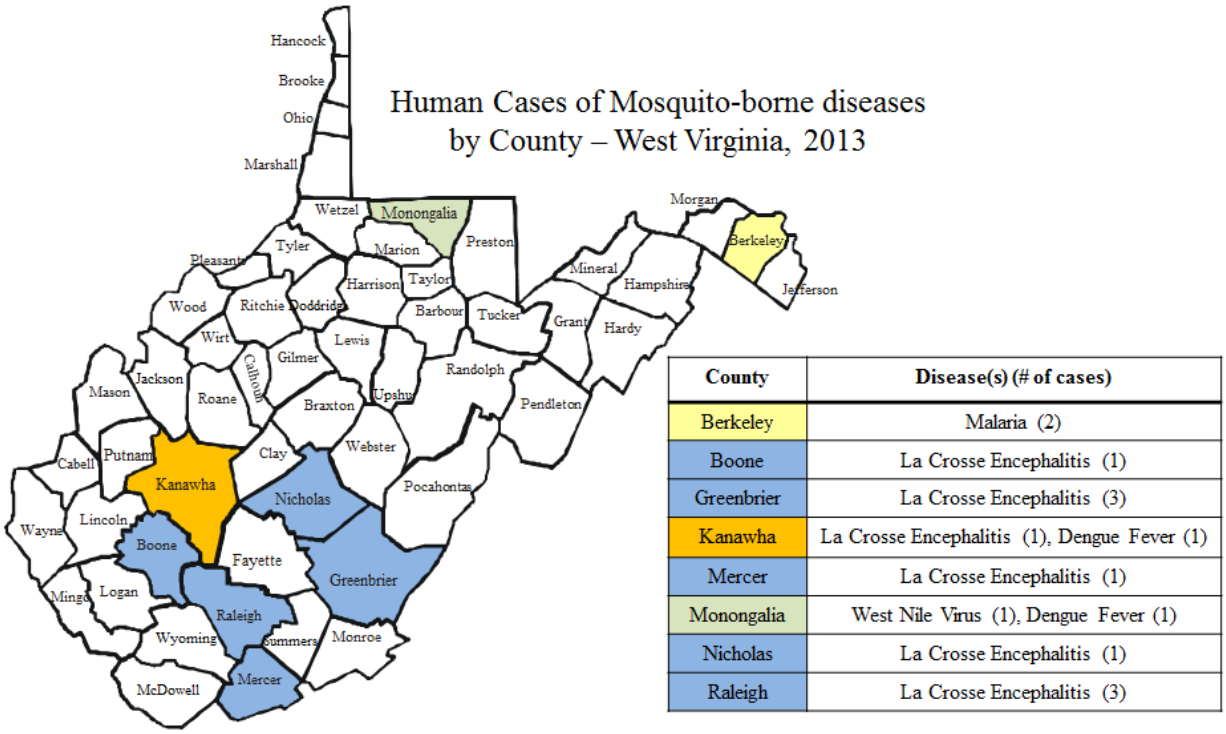


Figure 1. Cases of LAC by month of illness onset. The peak number of numbers occurred in August when 3 confirmed and 4 probable cases were reported. The temporal distribution of cases is consistent with when LAC-infected mosquitoes were active.



County	Disease(s) (# of cases)
Berkeley	Malaria (2)
Boone	La Crosse Encephalitis (1)
Greenbrier	La Crosse Encephalitis (3)
Kanawha	La Crosse Encephalitis (1), Dengue Fever (1)
Mercer	La Crosse Encephalitis (1)
Monongalia	West Nile Virus (1), Dengue Fever (1)
Nicholas	La Crosse Encephalitis (1)
Raleigh	La Crosse Encephalitis (3)

Figure 2. Map of human cases of mosquito-borne diseases by county in West Virginia. Eight counties reported mosquito-borne disease.

Horse Surveillance

Three horse specimens from Boone, Kanawha, and Roane Counties were submitted for testing during 2013. All specimens were negative for WNV and EEE.

Dead Bird Surveillance

Ten dead bird specimens were submitted for testing during 2013. Specimens were submitted between May 2013 and October 2013 from 3 counties: Hancock, Kanawha, and Wood Counties. Bird species submitted included a American Crow, an American Robin, a Blue Jay, two Common Grackles, a European Starling, a Gray Catbird, a House Sparrow, a Mourning Dove, a Red Cardinal, and a Wood Thrush. One specimen, a Red Cardinal found in September 2013 in Kanawha County, tested positive for WNV. Four samples were unable to be tested. No specimens tested positive for SLE or EEE.

Mosquito surveillance

A total of 20,930 mosquitoes were collected during mosquito surveillance season, of which 830 mosquito pools were tested for arboviruses. Table 2 shows the total number of mosquitoes collected by species.

Figure 3 shows a map of counties where mosquito surveillance occurred in the state. Positive WNV pools were found in nine of the 17 counties where mosquito surveillance occurred. The first WNV-positive pools were *Aedes vexans* and *Anopheles punctipennis* active in Nicholas County on May 29. The last WNV-positive mosquito pools were *Cx. pipiens/restuans/erraticus* from Cabell County on September 11.

Mosquitoes infected with LAC were active in seven of the 17 counties under active mosquito surveillance. This is the first record of LAC infected mosquitoes in Wayne, Cabell, Jackson, and Berkeley counties. The first LAC-positive

mosquitoes were *Aedes japonicus* from Fayette County on June 12. The last LAC positive mosquito pools were *Cx. pipiens/restuans/erraticus* from Kanawha County on September 18.

Table 2. Mosquito species collected and identified in 2013.

Mosquito Species	Number of mosquitoes collected (%)
Culex pipiens/restuans/erraticus	15,235 (72.8)
Aedes albopictus	2,799 (13.4)
Aedes vexans	919 (4.4)
Aedes japonicus	759 (3.6)
Aedes trivittatus	426 (2.0)
Aedes triseriatus	204 (1.0)
Anopheles punctipennis	186 (0.9)
Coquillettidia perturbans	122 (0.6)
Anopheles quadrimaculatus	104 (0.5)
Psorophora ferox	73 (0.3)
Anopheles crucians	30 (0.1)
Psorophora columbiae	28 (0.1)
Aedes spp.	19 (0.1)
Other (7 Orthopodoymia signifera, 4 *Aedes canadensis*, 4 *Psorophora spp.*, 3 *Uranotaenia sappharina*, 2 *Anopheles spp.*, 2 *Psorophora howardii*, 1 *Aedes cinereus*, 1 *Aedes atropalpus, 1 Psorophora ciliata*, and 1 *Culiseta inornata*	26 (0.2)
Total	**20,930 (100)**

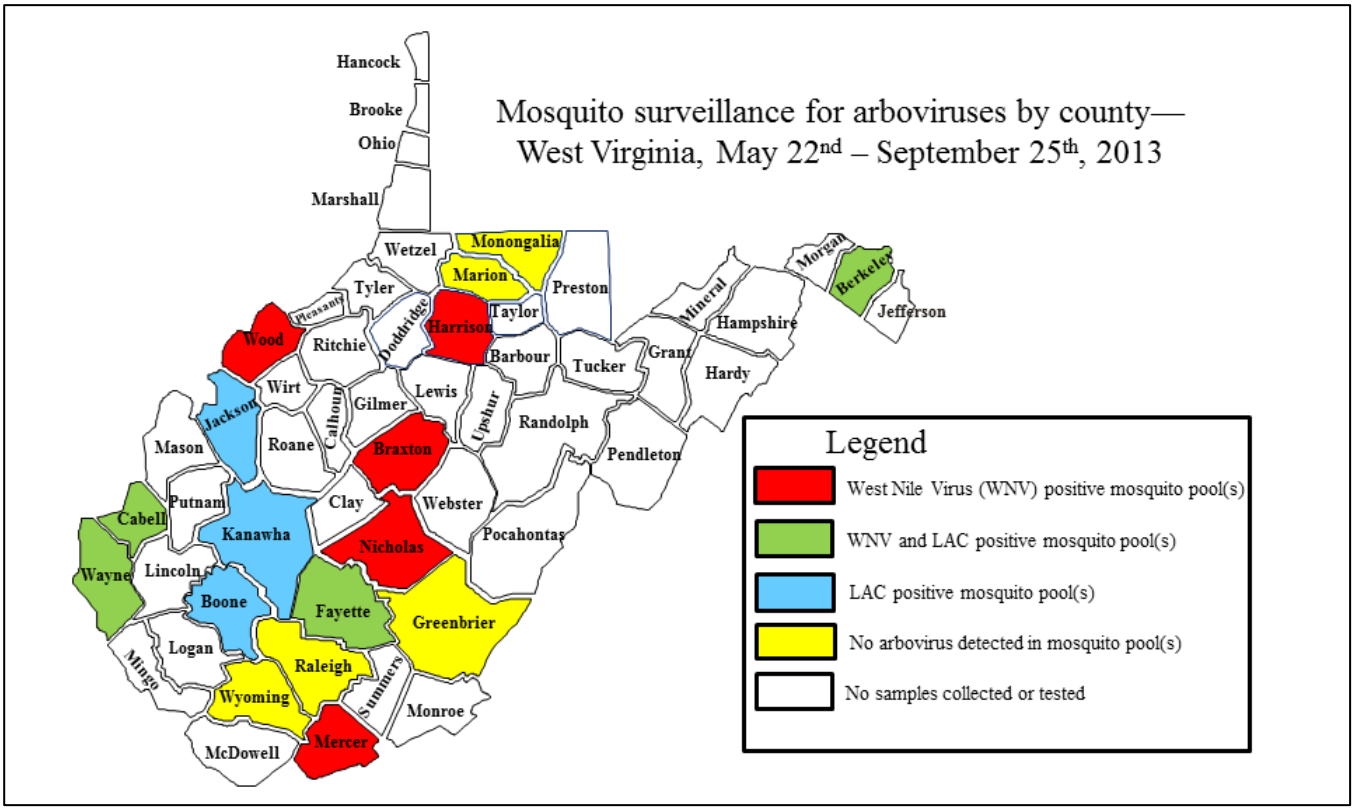


Figure 3. Counties in West Virginia where mosquito surveillance counties. Seventeen counties were under surveillance in 2013. Nine counties had positive mosquito pools for WNV. Seven counties had positive mosquito pools for LAC.

LAC human infection also did coincide temporally with LAC infection in mosquitoes. LAC infection in *Aedes* species (*Aedes triseriatus, Aedes albopictus, Aedes japonicus*) occurred throughout summer and early autumn (Fig. 4). Meanwhile, other mosquito species not traditionally associated with the LAC transmission cycle, such as *Culex* mosquitoes and *Anopheles punctipennis*, showed infection in late summer through early autumn. The first onset of

human LAC occurred on June 19, one week after collecting *Aedes japonicus* carrying LAC virus, and continued throughout summer and early autumn. The peak in human disease onset was August 19-25, one week before the peak in LAC infection in mosquitoes.

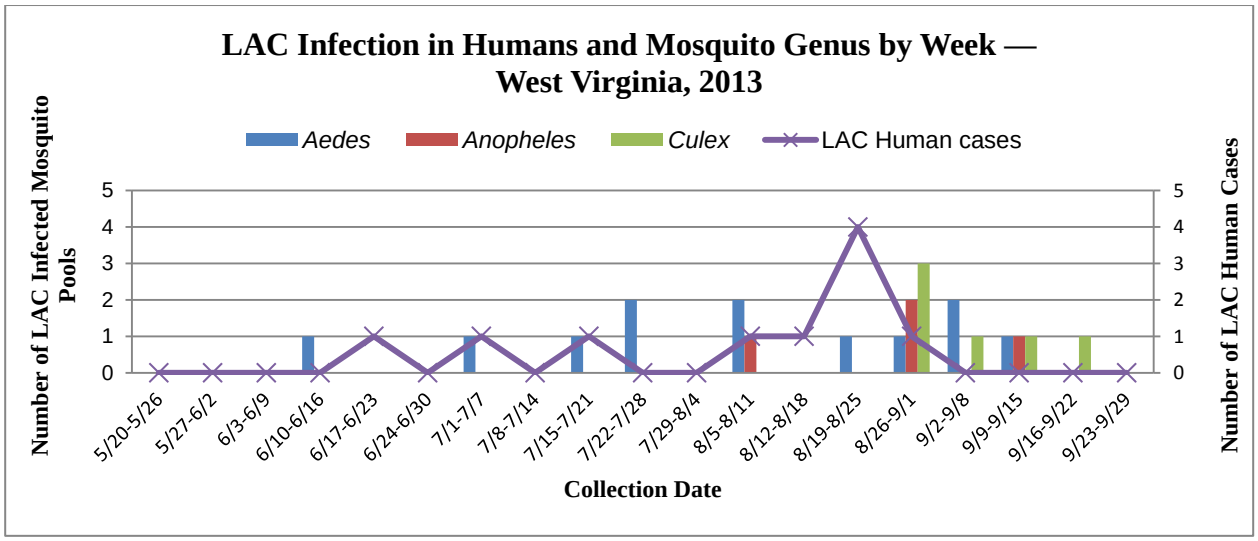


Fig. 4. LAC infection in humans and mosquito genus by week in West Virginia, 2013.

DISCUSSION

LAC continues to be the mosquito-borne disease of most concern in West Virginia. Analysis of human LAC cases verified epidemiologic trends that have been noted previously in WV. Children <15 years of age continue to be the age group at highest risk for infection, and most cases occur in the south-central portion of the state.

Special consideration was given to ascertain the single confirmed WNV case. According to the 2011 case definition for West Nile virus, a fever of ≥100.4 °F was required for clinical evidence of WNV infection .Without reported fever, the person would be considered "not a case." The WNV case definition was updated for 2014 with the fever requirement removed for neuroinvasive cases. The case had meningitis, but a fever was never reported. It is likely that due to the case's immunocompromised state, he was unable to mount an appropriate immune response to the infection that would be usually be detected by routine laboratory tests. Additional, more sensitive testing was done by CDC to confirm that the case was positive for WNV. After consultation with CDC, it was decided that 2014 case definition be used to ascertain this 2013 neuroinvasive WNV case due to the unique presentation of illness.

In 2012, there was an increase in human WNV cases nationally. West Virginia had its highest case count on record with 10 cases. Interestingly, in 2013 West Virginia had only one reported case and the number of WNV cases reported nationally decreased by more than half (see CDC's West Nile virus statistics page at http://www.cdc.gov/westnile/statsMaps/index.html). In West Virginia, high WNV infection among mosquitoes preceded infection in humans. The onset of the first 2012 WNV human case in West Virginia was July 19, two weeks after the initial peak in WNV activity in *Culex pipiens/restuans* and within the 2-14 day WNV incubation period in human patients. The high WNV infection rates in *Culex pipiens*/*restuans* (minimum infection rate > 5 per 1,000 mosquitoes) from late June through late September resulted in the high WNV human incidence in 2012. Except for the first few weeks in June, WNV infection rates in mosquitoes in 2013 were lower than mosquito WNV infection rates during 2012. The WNV infection rates in *Culex* spp. during the 2013 mosquito surveillance season were similar to low rates from other years when human incidence of West Nile encephalitis was low (2008-2011).

Two travel-associated cases of malaria were reported among WV residents in 2013. Both cases traveled to malaria-endemic areas (South Africa and Côte d'Ivoire). Additionally, two travel-associated cases of Dengue fever were reported among WV residents in 2013 who traveled to Dengue-endemic countries (Costa Rica and Haiti). Travelers should educate themselves about possible disease risks before leaving the United States. CDC's website for travelers' health is a good resource to help find this information (http://wwwnc.cdc.gov/travel/). Travelers can look up their travel destination and review important health information related to that country.

The best way to reduce the risk of mosquito-borne disease is to reduce the risk of being bitten by mosquitoes.

- Be aware of the times of day when mosquitoes are most active. Many mosquitoes peak hours are dusk and dawn. For some LAC-transmitting mosquitoes, peak hours are during the day.
- Wear protective clothing such as long sleeves, pants, and socks. Use insect repellant that contains DEET, picardin, IR3535 or oil of lemon eucalyptus on exposed skin and clothing when outdoors.
- Ensure that window and door screens are intact to keep mosquitoes outside of homes. Remove breeding sites around the home (e.g. any containers that can accumulate water).
- Check with your healthcare provider when traveling abroad to learn about mosquito-borne diseases found in that area of the world.

The low number of horse specimen submissions did not add useful arbovirus surveillance information. From dead bird surveillance, one WNV-positive Red Cardinal was reported late in the mosquito season. Increased surveillance among dead birds and horses may provide valuable supplemental information related to arboviral activity.

The Zoonotic Disease Group in the Division of Infectious Disease Epidemiology (DIDE) hopes to increase outreach efforts related to mosquito-borne diseases across the state in 2014. Several new pieces of public health literature have been created to share with public health partners and the general public. An updated LAC pamphlet was drafted in 2013 and is available for use (http://www.dhhr.wv.gov/oeps/disease/Zoonosis/Mosquito/Documents/arbovirus/lacrosseencephalitis/La-Crosse-Encephalitis-Pamphlet.pdf). An information sheet targeting equine practitioners was created to educate the veterinary community about free arbovirus testing for horses. An information sheet about dead bird surveillance was created to educate the public what to do when a dead bird is found. These and other important public health messages concerning mosquito-borne diseases can be found on the DIDE website at http://www.dhhr.wv.gov/oeps/disease/Zoonosis/Mosquito/Pages/default.aspx.

The Zoonotic Disease Group sincerely thanks the many public health partners who contributed to mosquito-borne disease surveillance across the state. Your efforts have provided us with important information presented in this report.

For questions about human mosquito-borne disease surveillance, email Miguella.P.Mark-Carew@wv.gov.
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