Special Report
Trends in West Nile Virus
Nevada

June 2017

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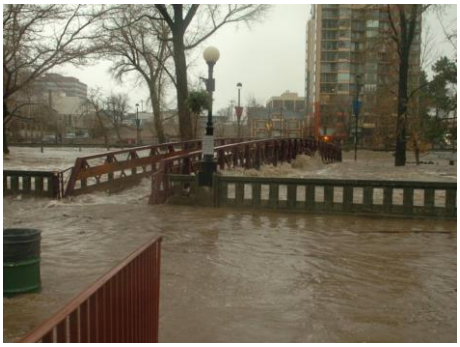
After an unusually wet winter and epic flooding in northern Nevada damaging many homes and industrial structure, it is expected and feared that a rapid *Spring Thaw* of record snow pack on the Sierras will have even more devastating short- and long-lasting impacts.

After flood waters start to retreat, streets, parking lots, backyards, swimming pools, buildings, and other structures, unusually continue to hold significant amounts of contaminated water. Stagnant water in overturned trash cans, jars, flower pots, cups and glasses in flooded homes can persist for weeks and even months after a flood. Even small pools of standing water can provide fertile grounds for mosquitos to grow and multiply; thus, increasing the risk for mosquito-borne illnesses among humans and livestock in Nevada.



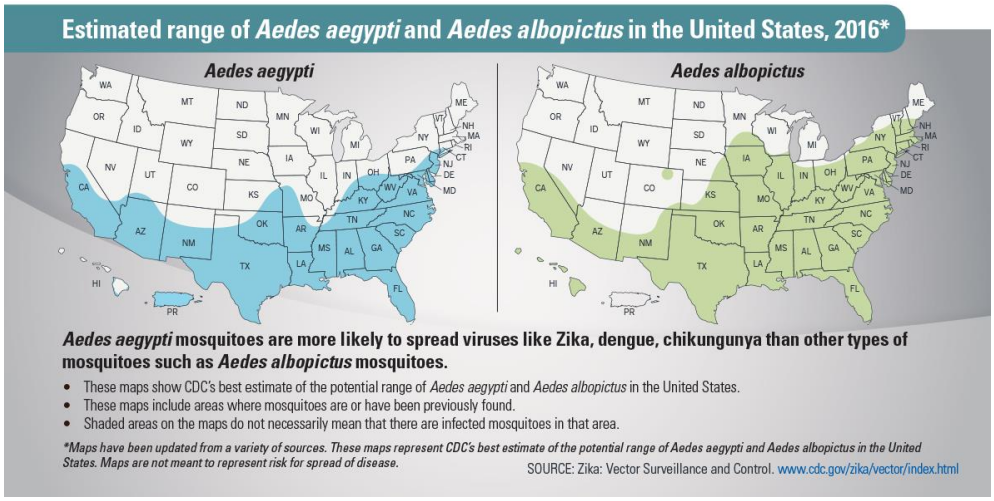
Images from the 2006 Massive Flood in Northern Nevada

Recent headlines have mostly focused on the mosquito-born Zika virus infections and the serious birth defects which could result if pregnant women contract the virus. Equally, or even more concerning in Northern Nevada will be the expected spread of West Nile Virus (WNV) just a few weeks after the flood - which will mostly coincide with the start of the regular WNV season.

Natural disasters in the United States (U.S.) have not been usually associated with outbreaks of vector-borne viral illnesses which are spread by mosquitoes. Swiftly moving flood water usually washes away existing mosquito larvae; reducing the mosquito population and rendering the vector (adult female *Culex* mosquito) less effective in actively transmitting and spreading WNV and other mosquito-borne illnesses in and around flooded areas. However, this can last only for a limited period of time, as a few weeks after flood waters recede, stagnant waters remaining in water-saturated areas start again to provide optimal conditions and fertile breeding grounds for newly arriving mosquitos. The rapid boom in the mosquito populations after a flood, will certainly increase health risks for humans and animals who will become more exposed to infected mosquito bites and subsequently more individuals and animals will contract mosquito-transmitted WNV infections.

Unlike Florida and Texas, Nevada did not have any locally-acquired Zika cases, and all 22 Zika virus infections identified to date in Nevada were travel-associated. Although it can be sexually transmitted, Zika virus infections are spread to people primarily through the bite of an infected Aedes mosquito species (Ae. aegypti and Ae. albopictus). These are the same

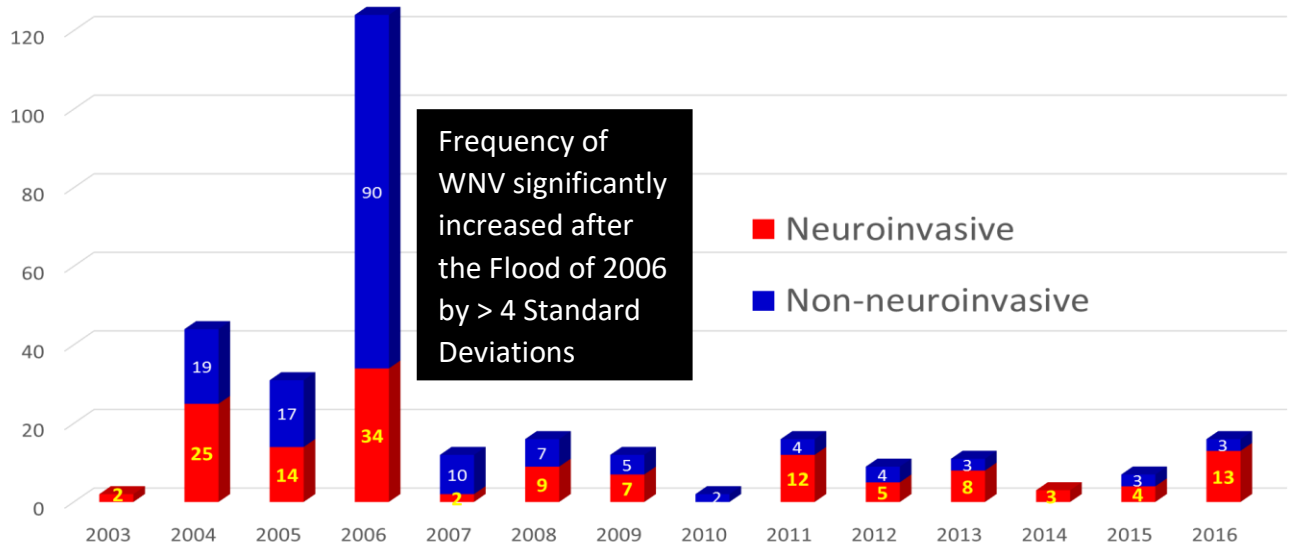
mosquito species that can transmit dengue fever and chikungunya viruses. Fortunately, Aedes mosquito species have not been found in parts of Nevada that were affected by the flood. However, the National Centers for Disease Control (CDC) and Prevention maps from 2016, estimating the range of Aedes mosquitoes showed that both Zika-carrying mosquitoes can reach some areas in Nevada; especially in the southern and eastern parts of the state as illustrated in the CDC Map (below). While, it is not expected to see an increase in Zika virus cases as a result of the 2017 flood in Northern Nevada, WNV will be a major concern.



WNV first emerged in North America in 1999, and reached the state of Nevada in 2003, causing regular annual/seasonal outbreaks in Nevada and every state around the nation. Fourteen years of data [2003 - 2016] on WNV infections among humans across the state of Nevada were examined. This review demonstrated that WNV outbreaks were significantly larger following years of flood in Northern Nevada. Stagnant water after a flood provides the most perfect environment for spreading WNV.

Since its emergence, 308 residents contracted WNV infections in Nevada; of those 138 cases (45%) were classified as "neuroinvasive diseases" including meningitis and encephalitis, and 170 cases (55%) were classified as "non-neuroinvasive disease," as illustrated in Figure 1. Since 2003, there had been significant variations in the size and severity of WNV outbreaks. Annual frequency of WNV cases in Nevada ranged from two cases in 2003 to 124 in 2006. About two thirds of all WNV cases in the state occurred among residents of Northern Nevada, while only one third occurred among residents of Clark County [most populated county in the state – about 73% of the Nevada's population reside in Clark County which is located in the southern part of the state].

Figure 1. Annual West Nile Virus Cases by Type in Nevada



Source: Nevada DPBH/OPHIE 2017

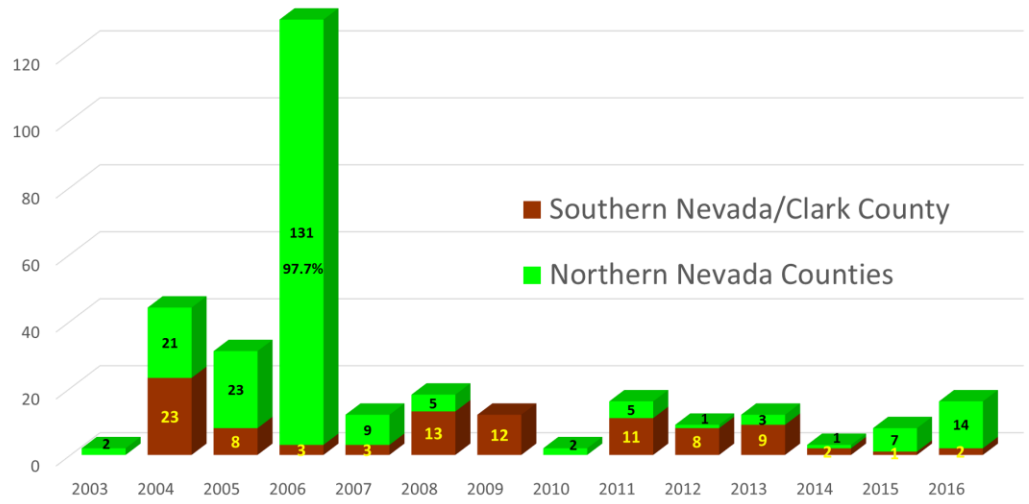
Following the 2006 Northern Nevada Flood, the state experienced the most severe and largest WNV Outbreak on record. More than 40% (124 cases) of all WNV cases ever reported in Nevada occurred during one WNV Season in 2006; specifically, after the flood of in Northern Nevada. 97.7% of WNV cases after the flood of 2006 were among residents of Northern Nevada, as illustrated in Figure 2. WNV cases were also more severe in flooded areas/counties in the north such as Lyon, Douglas and Churchill Counties which had not experienced such large outbreaks of this mosquito-borne viral infection before the 2006 Northern Nevada Flood.

Past national and state experiences demonstrate that flooding and exceptionally wet winters are always dominant weather-variables that can directly correlate with the size and severity of WNV outbreaks. It is not completely clear how floods seem to increase the severity, size and frequency of WNV outbreaks. However, it is speculated that it might increase the mosquito mass and bird's diversity and numbers in flooded areas which can synergize the transmission cycle of the virus [Mosquitos-Birds-Mosquitos]. Birds are the main "reservoir" of WNV in the environment, as explained in Figure 3. The more birds on large

areas impacted with the flood, the more mosquitos that can actively transit WNV; especially in the proximity of population centers. Current conditions in Northern Nevada can provide optimal circumstances for mosquitos to breed, multiply and spread WNV and probably other biological agents.

A Tulane University Study published in 2007 found that individuals were twice as likely to contract WNV in parts of Louisiana and Mississippi that were most affected by Hurricane Katrina. According to the study such a significant increase in WNV cases was not only because more mosquitos infested the area after the hurricane, but also because residents of areas hit hardest by the storm tended to be more frequently outdoors during the mosquito season, living and working close to stagnant water. Area residents had to spend longer hours working outside cleaning-up and repairing their homes after the hurricane, especially during the time of day when mosquitos are most active.

Figure 2. Annual West Nile Virus Cases by Location in Nevada



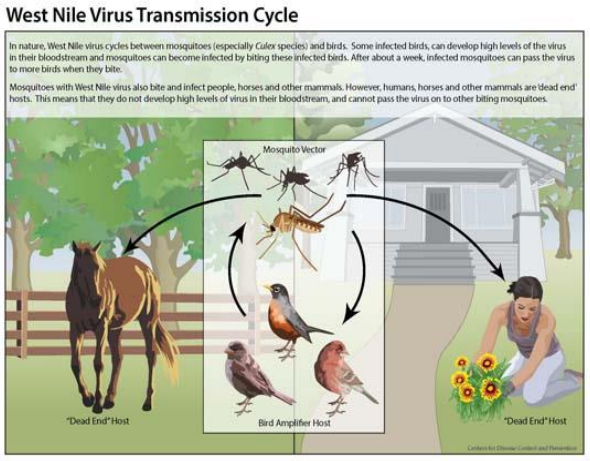
Source: Nevada DPBH/OPHIE 2017

Based on the observations gathered after the 2006 WNV season in Nevada and the study findings from the University of Tulane, it is expected that similar scenarios could occur

for the survivors of the most destructive flood in the state history. It is expected that the *Culex* mosquito, the vector that transmits WNV, will rapidly and excessively breed and multiply in communities affected by the flood, feeding on large animals such as horses and cattle, and travelling several miles to reach rural and urban populations of Northern Nevada.

Mosquitos become infected with WNV virus when they feed on infected birds. Infected mosquitos can then spread the virus to humans and other animals. WNV cycles between mosquitos (especially Culex species) and birds. Some infected birds can develop high levels of the virus in their bloodstream and mosquitos can carry the virus after biting infected birds. After about a week, infected mosquitos can pass the virus to more birds when they bite. Infected mosquitos with WNV also bite and infect humans, horses and other mammals, as illustrated in Figure 3. However humans, horses and other mammals are terminal dead-end "hosts," as they do not develop high levels of WNV in their bloodstreams and cannot pass the virus on to other biting mosquitos.

Figure 3. Adopted from CDC.gov



Findings from this review can help guide public health resources to regions most likely to experience future severe WNV outbreaks such as Northern Nevada. The State Public Health Preparedness (PHP) Program and the Office of Public Health Informatics and Epidemiology (OPHIE) are closely collaborating with state partners and stakeholders, local health authorities and community leaders to track WNV during every phase of the *Transmission Cycle* in order to prevent or reduce the burden of WNV infections among humans during this upcoming 2017 WNV season. Interventions should focus on the ***Vector*** (*Culex* mosquito species), the ***Reservoir*** (birds) and the ***Host*** (e.g., human behavior and environment).

Recommended activities include:

- Ongoing mosquito pools' testing.

West Nile virus (WNV) is spread by the bite of infected mosquitos and carries the threat of fatal inflammation of the brain in humans, horses and birds. It is almost certain that few weeks after a flood the mosquito population will flare-up and most probably many will carry WNV especially during the WNV season.

  - Mosquito sentinel sites distributed throughout the state are regularly monitored. Trapped mosquitos are tested to determine if they are infected with WNV and/or other biological agents. Mosquito species/types identified and rates of infected mosquitos are determined.
  - All mosquito pools are or should be tested for WNV. However, selected pools from particular sentinel sites should also - or can be tested for other mosquito-borne viruses, such as Western Equine- (WEE) and St. Louis encephalitis (SLE) viruses.
  - Testing results should be compared during high and low transmission seasons and from one year to another in order to detect trend changes.
  - Positive results should be communicated to the health authorities, the Department of Agriculture and other community partners.

- Increasing the efforts of Vector Control Authorities.
- Testing unexplainably dead birds.
- Ongoing public education and increasing the general awareness in order to reduce individual risks for exposure to mosquito (e.g., using mosquito repellents, wearing long sleeves and covering body while outdoors).
- Increasing public health messaging on the web and through frequent mass media (e.g., TV/radio) primetime and written public announcements before and during the WNV season.
- Listing/publishing updated mosquito test results by location on the web helps refocus the efforts and activities of public education especially in densely populated centers.
- Environment remediation (e.g., cleaning pools and vulnerable areas with contaminated stagnant water).
- Protecting mammals through vaccinations (i.e., WNV Vaccine provides the best protection for horses).

Conducting ongoing surveillance for vector-borne illnesses, providing timely public education, easy access for horse vaccination and adequate resources for vector control authorities have proven effective in reducing the burden of WNV infections among animals and humans.