

# Evaluation of the Department of Defense Installation Mosquito Surveillance Program, United States 2012-2015

Master of Public Health Capstone Project and Field Experience Presentation

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# Presentation Overview

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# Field Experience Introduction

- Field Experience Overview
  - Performed at Kansas Department of Health and Environment (KDHE)
  - Preceptor was Dr. Ingrid Garrison, Kansas State Public Health Veterinarian
  - Observed the implementation of the recommendations from the new Compendium of Animal Rabies Prevention and Control
  - Observed and participated in the Zika virus summit webinar for state public health departments
  - Conducted Master's project



<http://www.kdheks.gov/employment/>



<http://www.cdc.gov/zap/>

# Project Overview

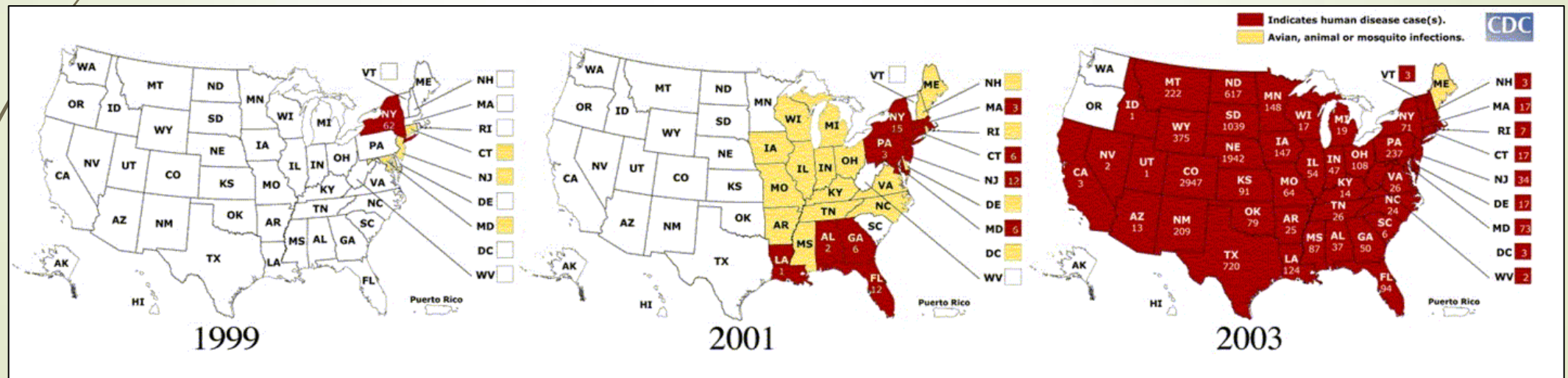
- Dr. Garrison oversees Kansas' mosquito surveillance program for West Nile virus (WNV)
- Project was developed from a question Dr. Garrison had regarding mosquito surveillance conducted on Department of Defense (DoD) installations within Kansas
- Learning Objectives
  - Describe the national arboviral disease surveillance system ArboNET
  - Describe how arboviral disease surveillance was conducted by the State of Kansas and how case investigation was performed
  - Describe the Department of Defense arboviral disease surveillance system(s)

# Project Objective

- ▶ The main objective of this project was to compare and evaluate the DoD WNV mosquito surveillance data to the ArboNET data to determine if the DoD installations had reported surveillance data to ArboNET

# Background

- West Nile virus (WNV)
  - First Introduced into the United States in the summer of 1999<sup>1</sup>
  - By the end of the 2002 mosquito season, WNV had spread to the West coast<sup>1</sup>

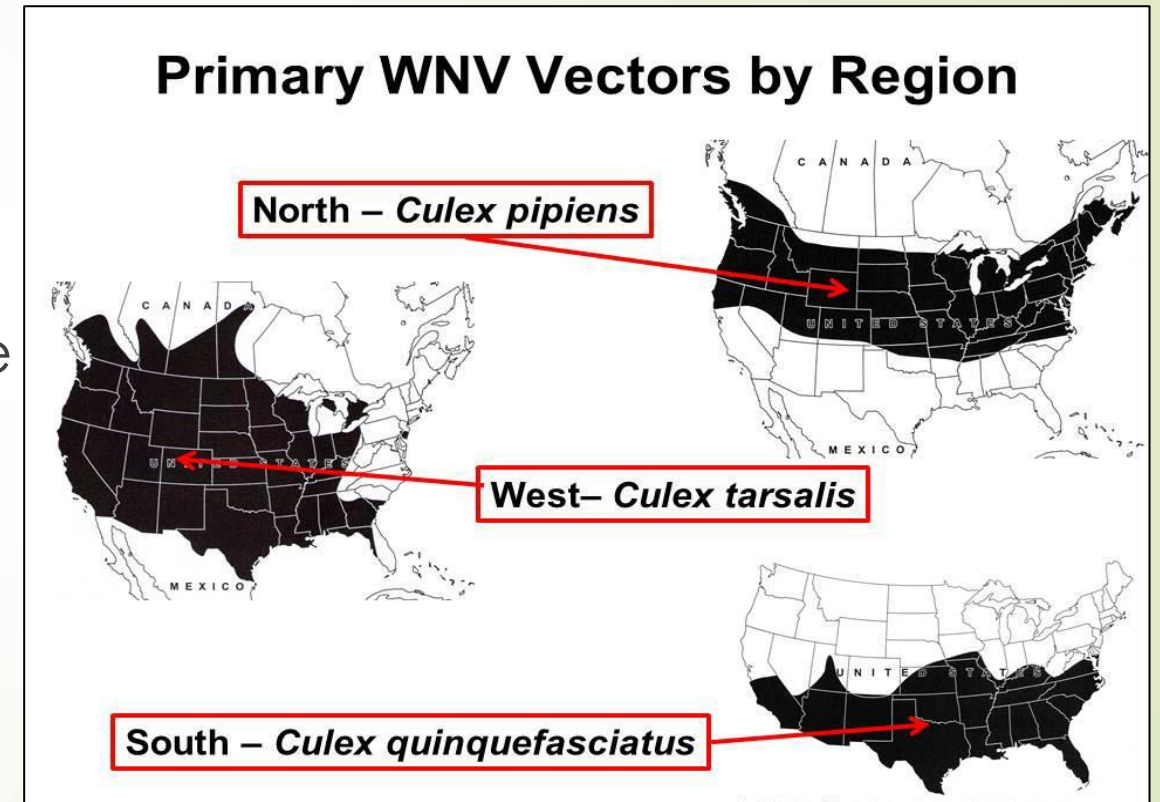


## WNV Background cont.

- As of 2016, the Centers for Disease Control and Prevention (CDC) reported that WNV had been reported in humans, animals, or mosquitos in all 48 states and the District of Columbia<sup>2</sup>
- WNV is considered an endemic disease in the United States

# Background cont.

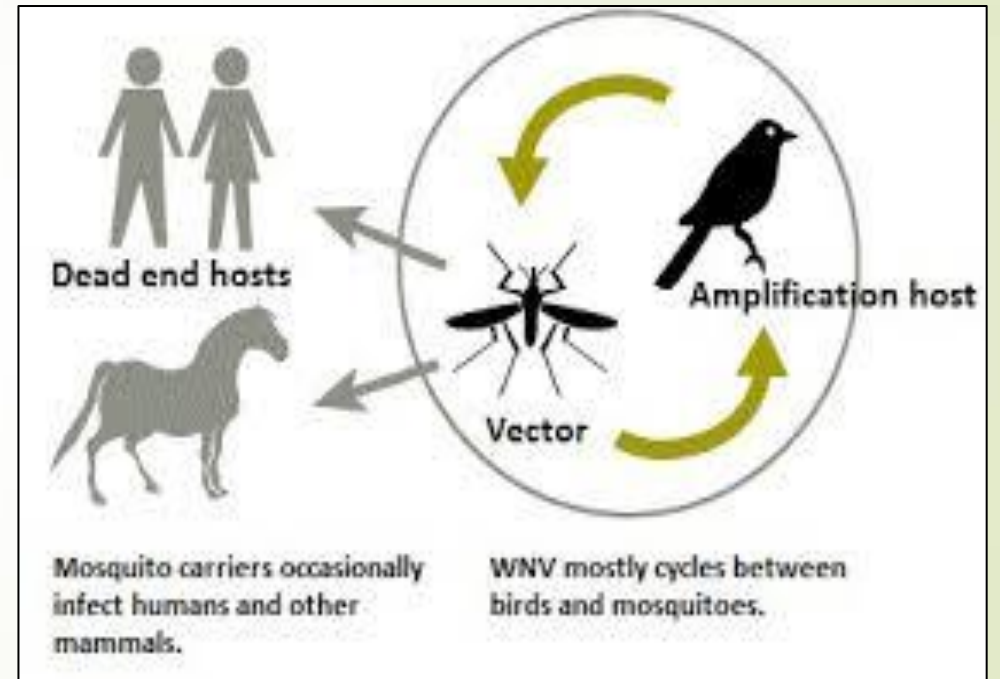
- ▶ WNV ecology
  - ▶ Transmitted by the bite of a mosquito
  - ▶ In the United States, the primary vector is the *Culex* species of mosquito<sup>4</sup>





## WNV ecology cont.

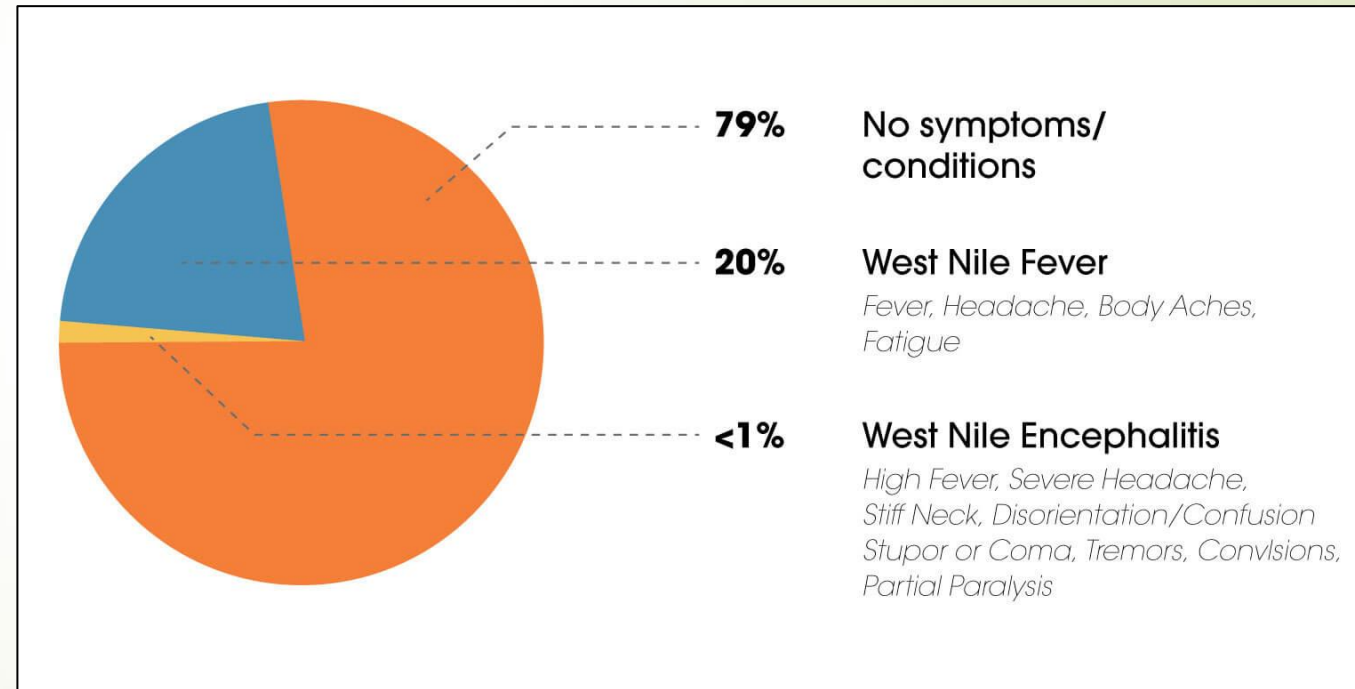
- WNV cycle is maintained in the environment between the mosquito and the avian host
- Some birds are considered amplifying hosts<sup>4</sup>
- Humans and horses are especially susceptible to the virus and are considered “dead-end” hosts<sup>4</sup>



[https://www.elpasotexas.gov/~media/files/coep/public%20health/epidemiology/new%20epi%20documents/wnv\\_2014.a](https://www.elpasotexas.gov/~media/files/coep/public%20health/epidemiology/new%20epi%20documents/wnv_2014.a)

# Background cont.

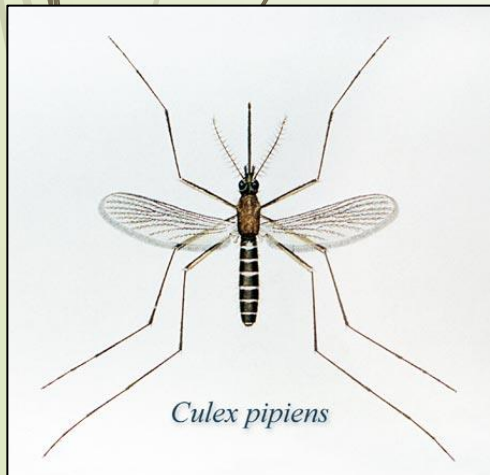
- WNV signs and symptoms
  - An estimated 70-80% of people infected with WNV do not develop any symptoms<sup>3</sup>
  - An estimated 20% develop symptoms
    - Most common clinical symptom is a fever and it is usually self-limiting
    - Less than 1% of those infected will develop more severe neurological symptoms such as meningitis or encephalitis (classified as neuroinvasive disease)
    - Of those that develop severe neurological disease, about 10% die of the infection<sup>3</sup>
    - For those that recover, neurological impairment may be permanent<sup>3</sup>



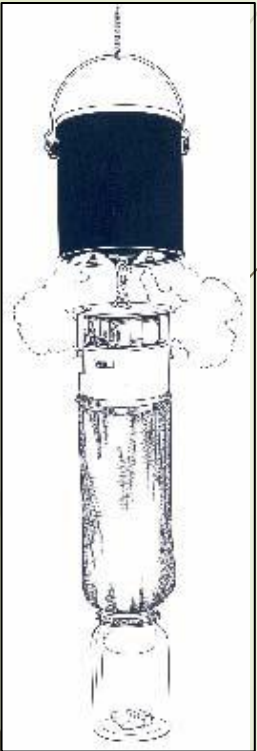
<https://off.com/en/education/diseases/west-nile-virus-what-you-need-to-know>

# Mosquito Surveillance Programs Overview

- Mosquito-based surveillance programs consist of the collection and testing of mosquitos for arboviruses<sup>5</sup>
- Considered an integral part of environmental surveillance for detection of WNV
- The objective is to identify the virus in vectors and other vertebrate hosts prior to the occurrence of any human cases<sup>5</sup>
- Focuses on the primary vectors of WNV (*Culex* species of mosquitos)
- Provides important information to public health officials
  - Used to determine mosquito control measures
  - Used to direct communication to the public
  - Used to identify species of mosquitos present in the area



# WNV Mosquito Surveillance Program: Kansas



[http://www.mosquitoscience.net/pdfs/Operational\\_Surveillance\\_Guide.pdf](http://www.mosquitoscience.net/pdfs/Operational_Surveillance_Guide.pdf)

- KDHE has overseen the WNV mosquito surveillance program since 2001<sup>6</sup>
  - Comprised of vector surveillance, human surveillance, and the sharing of results with key public health partners
- Current design has consolidated the program to Sedgwick County<sup>6</sup>
- The trapping, collection, and identification of mosquitos is contracted out to the Kansas Biological Survey (KBS)<sup>6</sup>
- During the mosquito season, surveillance is performed weekly
  - 9 Encephalitis Vector Survey traps are set in 9 various sites around the county
- Testing of *Culex* species for WNV is performed by Kansas Health and Environmental Laboratory using Polymerase Chain Reaction<sup>6</sup>

# WNV Mosquito Surveillance Program: Department of Defense

- Health Affairs policy (HA 02-014) published in July 2002, directed Army, Air Force, and Navy to “develop WNV surveillance and prevention plans appropriate for the region and installation in conjunction with local public health programs already in place.”<sup>7</sup>
- Spurred activities such as mosquito, bird, and nonhuman mammal surveillance on military installations, human surveillance within Military Treatment Facilities, and expanded the ability of DoD laboratories to perform diagnostic testing<sup>8</sup>
- DoD installations were then required WNV positive mosquito populations to state health departments

# WNV Mosquito Surveillance Program: Army Installations

- Each individual Army installation has standard operating procedures for conducting surveillance
  - At a minimum, vector surveillance is to identify medically important pests<sup>9</sup>
- Results of surveillance is to determine mosquito control measures



[https://en.wikipedia.org/wiki/United\\_States\\_Army](https://en.wikipedia.org/wiki/United_States_Army)



# WNV Mosquito Surveillance Program: Army Installations

Army Installation captures and collects mosquitoes

Mosquitos are identified to species depending upon expertise

Mosquitos are packaged and sent to regional Army laboratory

Mosquitos are identified to species and arbovirus testing is performed

Report is generated and sent back to submitting installation

# WNV Mosquito Surveillance Program: Air Force Installations

- Individual Air Force installations develop standard operating procedures based on their environment and their objectives
- Use guidelines from the Air Force's Guide to Operational Surveillance of Medically Important Vectors and Pests<sup>10</sup>
- Results of arbovirus surveillance is used to determine control measures



[https://commons.wikimedia.org/wiki/File:Seal\\_of\\_the\\_US\\_Air\\_Force.svg](https://commons.wikimedia.org/wiki/File:Seal_of_the_US_Air_Force.svg)



# WNV Mosquito Surveillance Program: Air Force Installations

Air Force installation captures and collects mosquitos

Mosquitos are packaged and sent to the Air Force Entomologist at the School of Aerospace Medicine

Mosquitos are identified down to species and tested for arboviruses

Reports are generated and sent back to submitting installation

# ArboNET

- A national surveillance database created in 2000 to consolidate all WNV surveillance data (human and nonhuman)<sup>4</sup>
- Collaboration between the CDC and state health departments
- In 2003, ArboNET was expanded to capture all arboviral diseases with public health significance<sup>4</sup>
- The CDC's Division of Vector-Borne Diseases consolidates data and reports cases according to county
- ArboNET data is displayed as a map on the US Geological Society's website: <http://diseasemaps.usgs.gov/>

# Project Objective

- To evaluate the DoD WNV mosquito surveillance data to determine if it was reported to the ArboNET surveillance system from 2012-2015
- The evaluation of the DoD WNV mosquito data and the ArboNET data could provide insight into the effectiveness of ArboNET as a national surveillance system

# Methods

- WNV mosquito surveillance data from 2011-2015 was requested from the Disease Epidemiology section of Army Public Health Center (Provisional)
- A Freedom of Information Act (FOIA) was submitted to the Wright Patterson Air Force Base FOIA office for the WNV mosquito surveillance data from 2011-2015
- The Navy Entomology Center of Excellence was contacted without success
- ArboNET nonhuman WNV surveillance data for 2011-2015 was requested from the Arboviral Diseases Branch of the Division of Vector-Borne Infectious Diseases within the CDC

## Methods cont.

- Excel © spreadsheets of all active duty Army and Air Force installations, and their corresponding counties, were created
- Army and Air Force records were reviewed and positive mosquito pools were entered into the spreadsheets by year
- The data in these spreadsheets was cross-referenced with the ArboNET dataset to determine if WNV positive pools from DoD facilities were reported to ArboNET
- The proportion of installations with WNV positive mosquito pool(s) that had corresponding county and date within ArboNET were calculated by year
- The aggregated results were reported; individual installations were not named

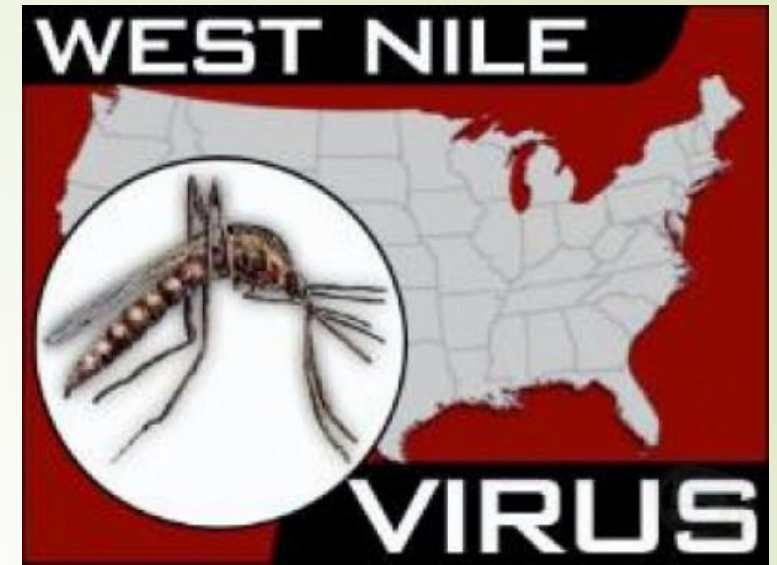
B	C	D	E	F	H	I
Installation name	County	Date	Stated in pdf that mosquitos were tested?	WNV pos?	Does ArboNET have positive for this county?	CDC FIPS #
Barksdale	LA, Bossier Parrish	3-Oct-14	Y	Y	N -not for this date (date was 8/14/14)	22015
Barksdale	LA, Bossier Parrish	25-Sep	Y	Y	N -not for this date (date was 8/14/14)	22015
Barksdale	LA, Bossier Parrish	10-Sep	Y	Y	N -not for this date (date was 8/14/14)	22015
Eglin	FL, Okaloosa	10-Oct-14	Y	Y	N	12091
Ellsworth	SD, Meade	21-Jul-14	Y	Y	Y	46093

Trap Site/Installation/Location	WNV Positive Pools	WNV Test Results	County of installation	ArboNET show positive?	Can you distinguish between pos for county or installation?	Date from raw data	ArboNET number
Armed Forces Retirement Home, DC	4	Pos	DC	Yes			11001
Bolling Air Force Base, DC	46	Pos	DC	Yes			11001
Marine Barracks, DC	1	Pos	DC	Yes			11001
Walter Reed National Military Medical Center, MD	1	Pos	Montgomery	Yes			24031
Walter Reed, Forest Glen, MD	6	Pos	Montgomery	Yes			24031
Walter Reed, Glen Haven, MD	1	Pos	Montgomery	Yes			24031

## Methods cont.

- State Arboviral Disease Report Review
  - Differentiation between Army installation surveillance results and state public health surveillance results was conducted by reviewing individual state's arbovirus surveillance reports for 2012-2015
  - A subset of state reports were selected for review based on the results of the Army data and ArboNET data evaluation

# Results

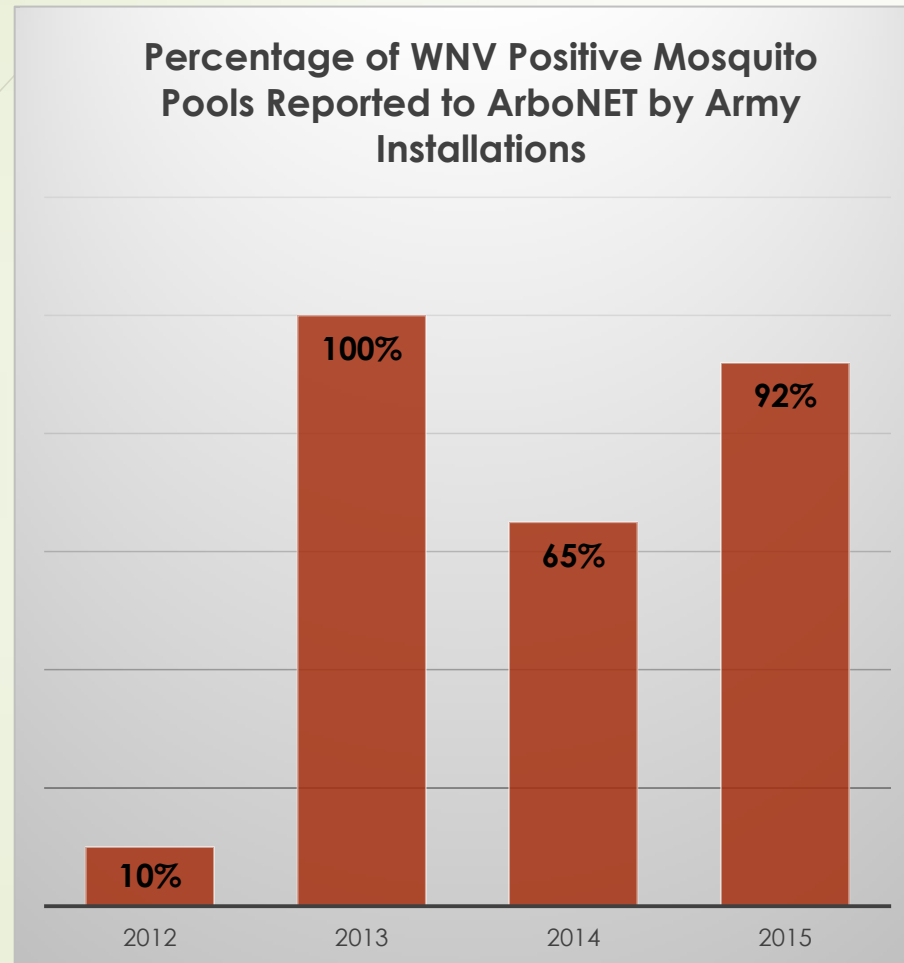


[naturalunseenhazards.wordpress.com](http://naturalunseenhazards.wordpress.com)

- Army WNV surveillance
  - Over the 4 year period (2012-2015), 191 positive mosquito pools were identified on active duty Army installations
  - 99 positive mosquito pools (52%) were reported to state health departments for inclusion into ArboNET



## Results cont.



- The data was further analyzed by year
  - 2012: 9 positive pools reported out of 87 positive pools identified (10%)
  - 2013: 35 positive pools reported out of 35 positive pools identified (100%)
  - 2014: 20 positive pools reported out of 31 positive pools identified (65%)
  - 2015: 35 positive pools reported out of 38 positive pools identified (92%)

## Results cont.

- State Arboviral Disease Report Review
  - For 2012, the annual arboviral surveillance reports for Maryland, Arizona, and the District of Columbia were reviewed
  - Maryland's 2012 annual arbovirus surveillance report confirmed 8 of the positive pools identified on Army installations were reported to the state public health department<sup>11</sup>
  - Arizona's 2012 annual arbovirus surveillance report identified 40 positive mosquito pools in La Paz County, whereas the Army installation only reported one<sup>12</sup>
  - The District of Columbia's 2012 West Nile mosquito surveillance report was reviewed, and it specifically listed the DoD installation's positive mosquito pools (5)<sup>13</sup>

## Results cont.

- State Arboviral Disease Report Review
  - For 2013, annual arboviral surveillance reports for the District of Columbia, Oklahoma, Maryland, and Texas were reviewed
  - The 2013 arboviral surveillance report for Oklahoma was not available
  - The DC annual arboviral surveillance report consisted only of a graphic representation of where positive pools were found<sup>14</sup>
  - The Maryland arboviral surveillance report confirmed the WNV positive mosquito pools on the Army installations were reported<sup>15</sup>
  - The Texas surveillance report reported 35 positive mosquito pools, whereas the Army installation in that county only identified 16 total<sup>16</sup>

## Results cont.

- State Arboviral Disease Report Review
  - For 2014, the annual arboviral disease surveillance reports for Maryland, DC, and Texas were reviewed
  - As in previous years, Maryland's report confirmed reporting of the Army installations WNV mosquito positive pools
  - Results for the 2014 WNV surveillance was not available for DC
  - The Texas arboviral surveillance report identified 4 positive mosquito pools for the county with the Army installation. The Army data only had 12 positive mosquito pools.
  - For 2015, the annual arboviral disease surveillance reports for Maryland, Texas, and Georgia was attempted
    - 2015 surveillance results were not available for any of the states

## Results cont.

- Air Force WNV surveillance results
  - Received 1227 reports
  - Over the four years, there were 57 WNV positive mosquito pools
  - 11 (19%) of those were reported to ArboNET

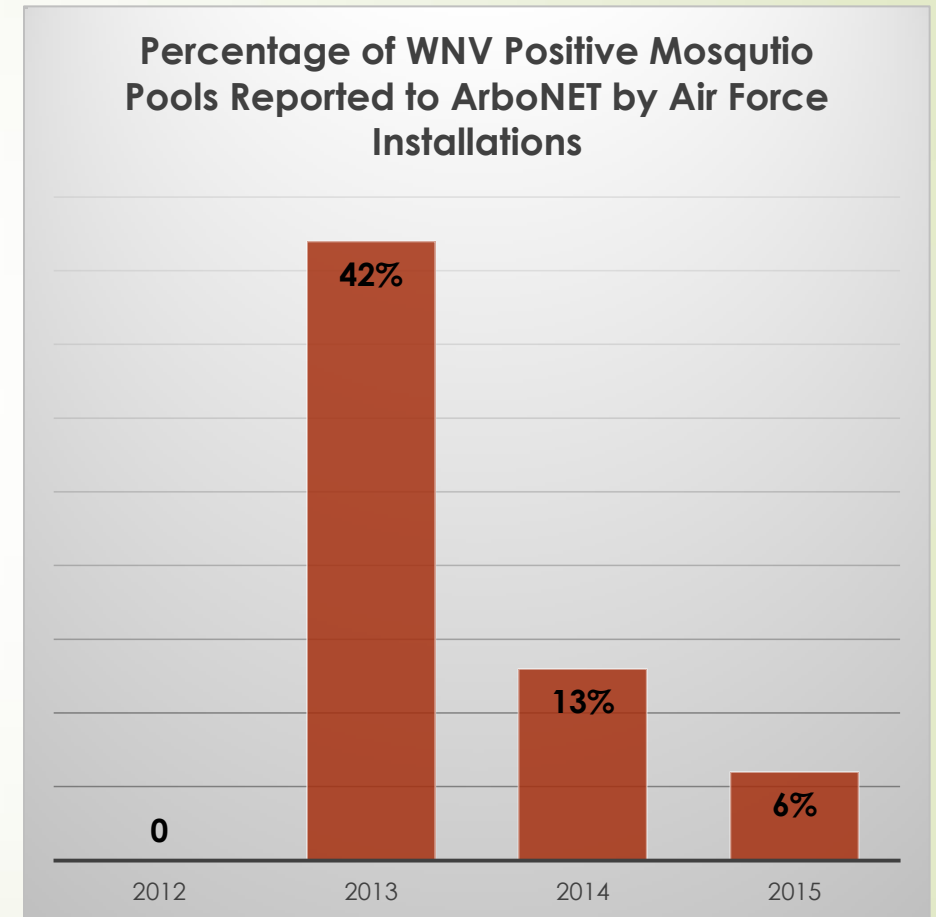
YEAR	NUMBER OF REPORTS
2012	244
2013	293
2014	341
2015	349
TOTAL	1227

## Results cont.

- Number of Air Force bases conducting mosquito surveillance
  - 2012: 56% (23/68) of Air Force Bases conducted arboviral surveillance within their installation in 2012
  - 2013: 63% (43/68) of AFB submitted mosquitos for speciation and arboviral testing
  - 2014: 68% (46/68) of AFB submitted mosquitos for speciation and arboviral testing to the Air Force Entomologist
  - 2015: 63% (43/68) of AFB submitted mosquitos for identification and arboviral testing to the Air Force Entomologist

## Results cont.

- The data was analyzed by year
  - 2012: 7 WNV positive mosquito pools were identified, none were reported to ArboNET
  - 2013: 19 WNV positive mosquito pools were identified, 8 were reported
  - 2014: 15 WNV positive mosquito pools were identified, 2 were reported
  - 2015: 16 WNV positive mosquito pools were identified, 1 was reported



# Discussion

- With the exception of the Army installations reporting 100% in 2013 and 92% in 2015, the reporting of positive mosquito pools to ArboNET needs significant improvement by both services
- The lack of reporting could be due to:
  - WNV is considered endemic and efforts are directed at mosquito control
  - Lack of public health resources available
  - Lack of qualified personnel to oversee the mosquito surveillance program
  - Other mission requirements taking priority
  - Installation public health personnel may not know it needs to be reported to the state public health department



## Discussion cont.

- Impact of mosquito surveillance
  - According to an article published in 2012, state and local health departments found the data contained within ArboNET to be useful<sup>17</sup>
  - Most of the nonhuman surveillance data was used by state health departments to determine when public health control measures should be implemented<sup>17</sup>
  - As state funding for arboviral surveillance was cut, many states had to decrease their nonhuman surveillance programs, including mosquito surveillance<sup>17</sup>


## Discussion cont.

- Importance of sharing results
  - As funding was cut to state health departments, the mosquito surveillance performed on military installations was an underutilized additional resource for state public health departments
  - Once WNV positive pools were identified, state public health departments could implement controls to mitigate the risk to the local population
  - Sharing enables public health departments, both military and civilian, to better defend against emerging and re-emerging diseases

# Mosquito Bite Prevention (United States)



Not all mosquitoes are the same. Different mosquitoes spread different viruses and bite at different times of the day.

Type of Mosquito	Viruses spread	Biting habits
 <i>Aedes aegypti</i> , <i>Aedes albopictus</i>	Chikungunya, Dengue, Zika	Daytime
 <i>Culex</i> species	West Nile	Dusk (evening) to dawn (morning)

## Discussion cont.

### ■ Study Limitations

- Challenge to determine if the WNV positive mosquito pool(s) reported to ArboNET were the results of mosquito surveillance performed by the state, city, county, or Army installation
- Inability to determine the number of the military installations that had public health assets (staff and equipment) to perform mosquito surveillance
- There may be some instances in which positive mosquito pools were reported to local or state health departments, but state health departments did not report the positive pools to ArboNET

## Discussion cont.

- Study Recommendations
  - Creation of centralized database for nonhuman arboviral surveillance data for the DoD
  - Standardization of data fields collected during mosquito surveillance
    - At a minimum, data fields collected should include those required for input to ArboNET
  - Arboviral reports should include a reminder to the submitting installation to report WNV positive findings to their state health department

# Conclusions

- This paper presented results from the first evaluation of WNV positive mosquito data from military installation surveillance programs into ArboNET
- The reported number of WNV positive mosquito pools to ArboNET varied by year and service, however, it was as low as zero by the Air Force installations (2012) and 10% by the Army installations (2012)
- The lack of reported WNV mosquito pools represented a gap in the national arboviral surveillance system
- If reported, the data from Department of Defense installations could enable state health departments to determine mosquito control measures, direct public education campaigns, and determine the mosquito species present in the area

# Core Competencies

- Biostatistics
  - Analysis of mosquito surveillance data
- Environmental Health
  - Understand the influence insect vectors have on disease transmission
  - Understand the role avian hosts have in the disease process
- Epidemiology
  - Review of epidemiologic data collected for WNV surveillance
- Health Service Administration
  - Observe relationships required between stakeholders to conduct WNV surveillance
  - Observe the role(s) of State Public Health Veterinarian
- Social and Behavioral Sciences
  - Observe some of the social factors that affect people's health

# Acknowledgements

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- MAJ Elisabeth Hesse
- Dr. Bill Irwin

- CDC

- Dr. Jennifer Lehman

- Air Force

- Mr. Will Reeves

- My husband and my son





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

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# Questions?



[www.rover.com](http://www.rover.com)

C21070		:				47157		
	A	B	C	D	E	F		
11521	2012	MA	25027	8/31/2012	West Nile	Culex sp.		
11522	2012	MA	25027	8/31/2012	West Nile	Culex sp.		
11523	2012	MA	25027	9/5/2012	West Nile	Culex sp.		
11524	2012	MA	25027	9/12/2012	West Nile	Culex sp.		
11525	2012	MA	25027	9/14/2012	West Nile	Culex sp.		
11526	2012	MA	25027	9/18/2012	West Nile	Culex sp.		
11527	2012	MD	24031	7/13/2012	West Nile	Culex pipiens		
11528	2012	MD	24031	8/8/2012	West Nile	Culex pipiens		
11529	2012	MD	24031	8/15/2012	West Nile	Culex sp.		
11530	2012	MD	24031	8/15/2012	West Nile	Culex sp.		
11531	2012	MD	24031	8/15/2012	West Nile	Culex pipiens-restuans (Mixed)		
11532	2012	MD	24031	8/21/2012	West Nile	Culex sp.		
11533	2012	MD	24031	8/29/2012	West Nile	Culex sp.		
11534	2012	MD	24031	8/29/2012	West Nile	Culex pipiens		
11535	2012	MD	24031	8/31/2012	West Nile	Culex sp.		
11536	2012	MD	24031	9/13/2012	West Nile	Culex sp.		
11537	2012	MD	24047	8/7/2012	West Nile	Culex salinarius		
11538	2012	ME	23005	8/1/2012	West Nile	Culex pipiens-restuans (Mixed)		
11539	2012	ME	23005	8/23/2012	West Nile	Culiseta melanura		
11540	2012	ME	23005	8/23/2012	West Nile	Culiseta melanura		
11541	2012	ME	23005	8/30/2012	West Nile	Culiseta melanura		
11542	2012	ME	23005	8/31/2012	West Nile	Culiseta melanura		
11543	2012	ME	23031	8/1/2012	West Nile	Culiseta melanura		
11544	2012	ME	23031	9/6/2012	West Nile	Culex pipiens-restuans (Mixed)		
11545	2012	MI	26017	7/25/2012	West Nile	Culex pipiens-restuans (Mixed)		
11546	2012	MI	26017	8/1/2012	West Nile	Culex pipiens-restuans (Mixed)		
11547	2012	MI	26017	8/17/2012	West Nile	Culex pipiens-restuans (Mixed)		
11548	2012	MI	26017	8/22/2012	West Nile	Culex pipiens-restuans (Mixed)		
		2011	2012	2013	2014	2015	FIPS	

# Army Vector-Borne Disease Reports

- <https://phc.amedd.army.mil/Periodical%20Library/Vector-borneDisease08JUL2016.pdf>
- <https://phc.amedd.army.mil/whatsnew/Pages/PublicationDetails.aspx?type=Army%20Vector-borne%20Disease%20Report>