

# Vector-Borne Diseases of Public Health Importance West Nile Virus



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## Definition of Vector-Borne:



- A biological association between an arthropod (*insect or arachnid*) and a pathogen acquired by feeding on the blood of an infected vertebrate host or through transovarial (*TOT*) or venereal transmission
- Arboviruses (*ARthropod-BORne Viruses*)



- **Mosquito** transmitted pathogens

- Viruses
- Malaria

- **Flea** transmitted pathogens

- Plague

- **Tick** transmitted pathogens

- Lyme Disease
- Rocky Mountain Spotted Fever
- Tularemia

- **Other** rare pathogens present in the US



## Mosquito Transmitted Pathogens

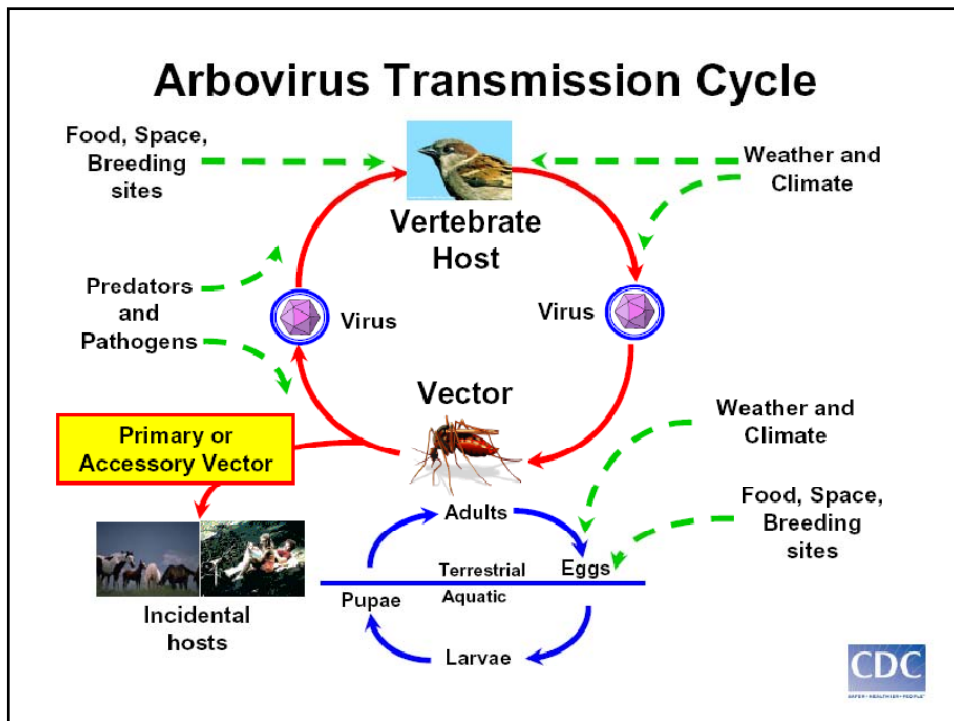
- West Nile virus (*WNV*)
- St. Louis encephalitis virus (*SLE*)
- California group viruses (*CE & LACV*)
- Western equine encephalitis virus (*WEE*)
- Eastern equine encephalitis virus (*EEE*)
- Dengue virus (*DEN*)
- Malaria



# Arboviruses



- Seasonal – typically occur in warm months
- Incidence varies with time and place because ecological factors are important
- For each of these viruses, the ratio of clinical to subclinical infection varies (*number of detected cases versus number actually infected*)
- With the exception of dengue virus, and yellow fever, humans are dead-end hosts.



West Nile Virus

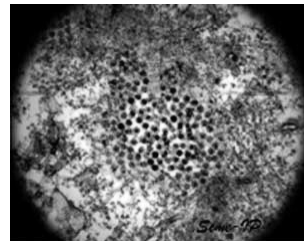
## West Nile Virus (WNV)

- Most recent mosquito transmitted arbovirus in the US
- Discovered in New York City in 1999 and has spread to every state in the continental US and most other countries south of Canada
- Basic cycle: bird to mosquito
- Bird deaths associated with infection



## West Nile Virus

- Most human infection occurs by mosquito bite, May– Oct. (*longer season further south*)
- Blood transfusion, infected tissue donation, placental, and accidental laboratory infections
- 80% of all human infections show no symptoms – of the symptomatic 20%, most go on to develop West Nile fever





## West Nile Virus

- After bite of infected mosquito, it takes 2-14 days for symptoms to occur
- Characteristics of WN Fever - fever, headache, fatigue, sometimes rash, swollen lymph glands and/or eye pain
- Severe disease occurs in up to 1% of infected individuals - meningitis and/or encephalitis and/or (*sometimes*) paralysis
- Approximately 10% of **severe** cases are fatal

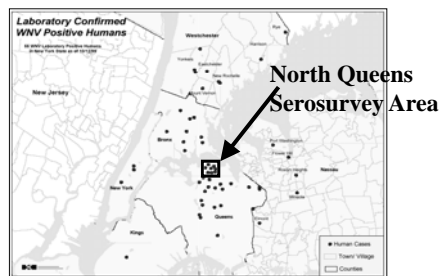
## West Nile Virus: Background

- First isolated in 1937 in Uganda from blood of a febrile woman
- Family: Flaviviridae
- All are transmissible by mosquitoes, many can cause febrile, sometimes fatal, illnesses in humans.



## WNV Outbreak in NE U.S. 1999

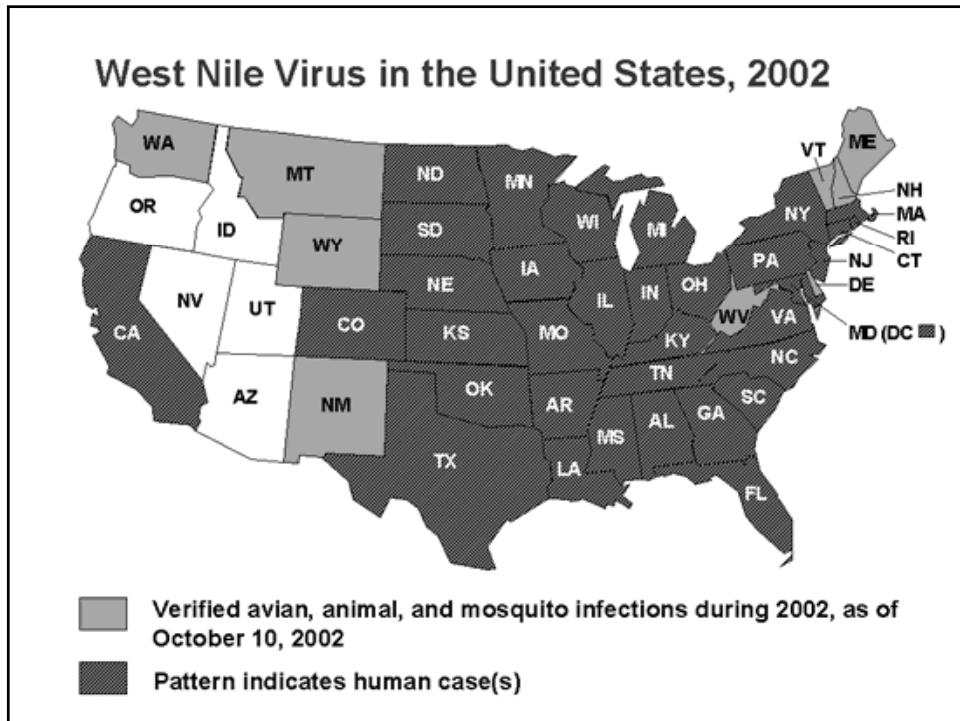
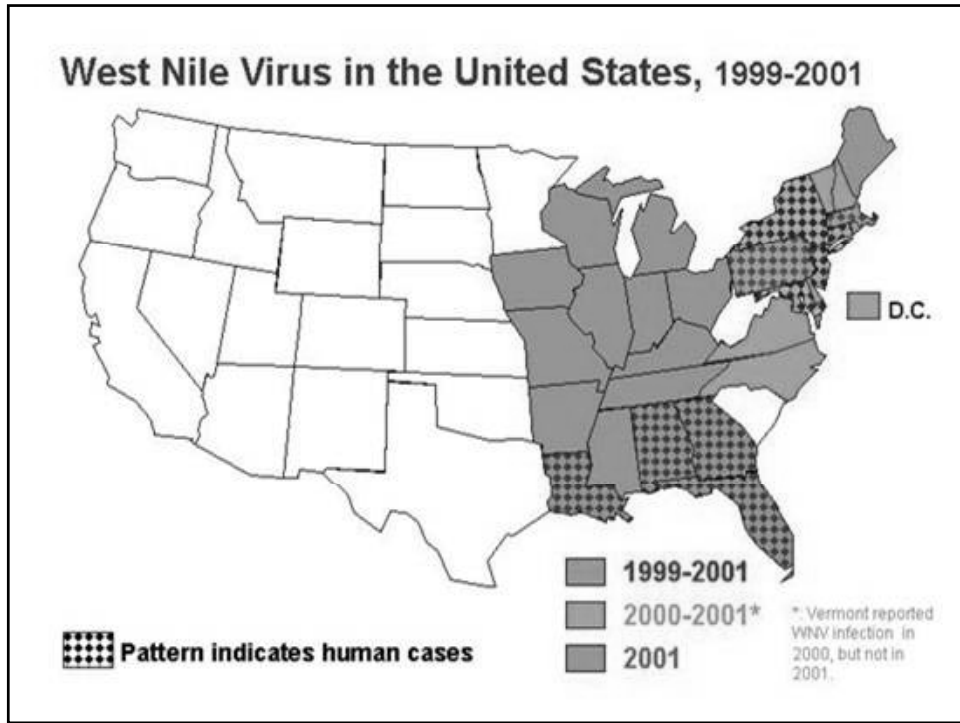
- 62 confirmed human clinical cases
- 7 deaths due to West Nile Virus
- first occurrence of disease in Western Hemisphere
- majority of clinical cases and deaths were among elderly
- 70% of human cases occurred within a 10km radius of Queens

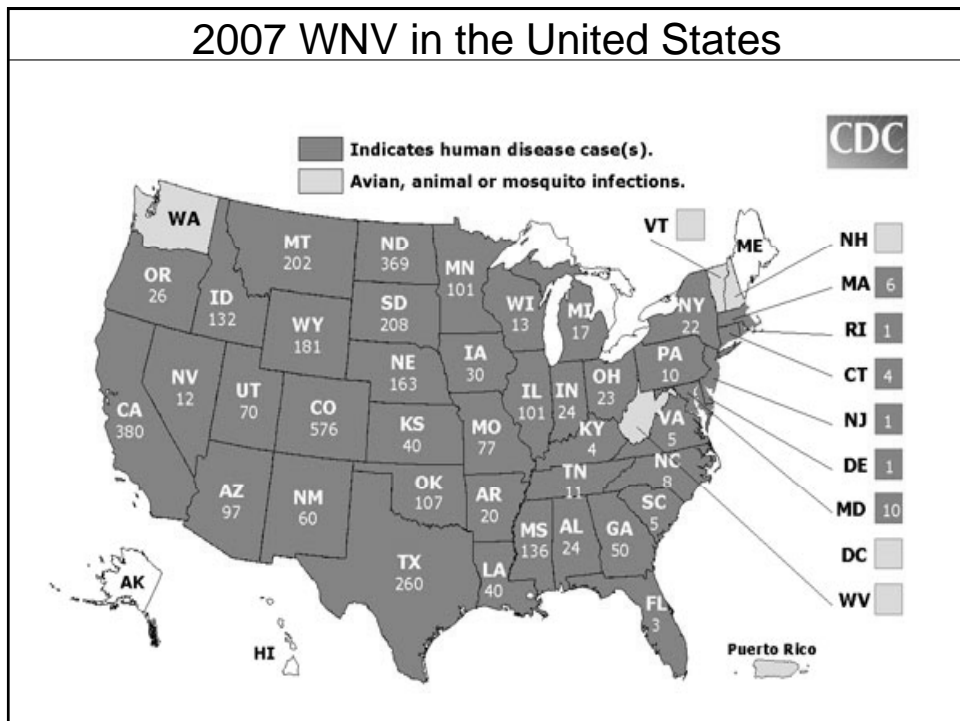
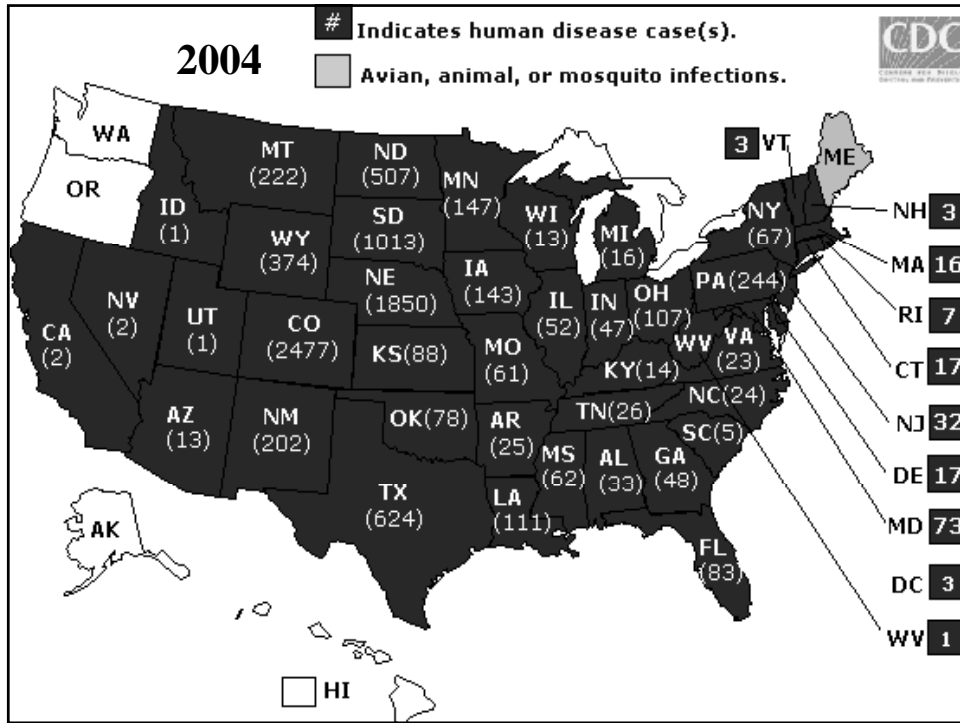


## West Nile Virus in the US - Some Possible Pathways of Introduction

- Human-transported vertebrate host (mammal or bird)
  - Legal
  - Illegal
- Human-transported vector (s)
- Storm-transported vertebrate host (bird)
- Migration of infected bird less likely (virus almost identical to Middle Eastern strain)
- Infected human host from endemic area overseas

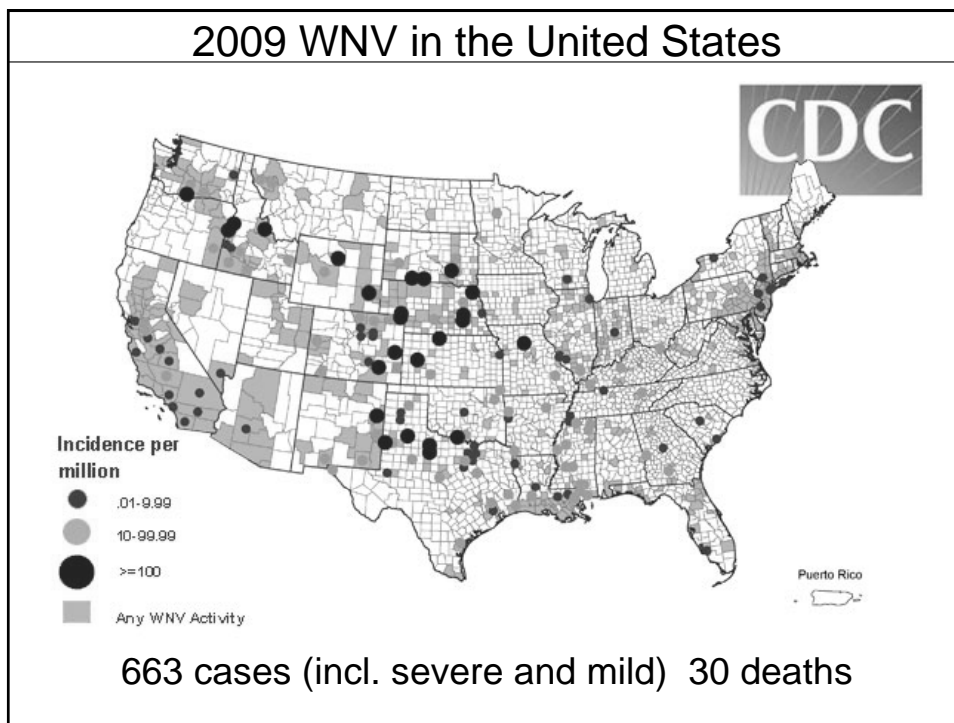
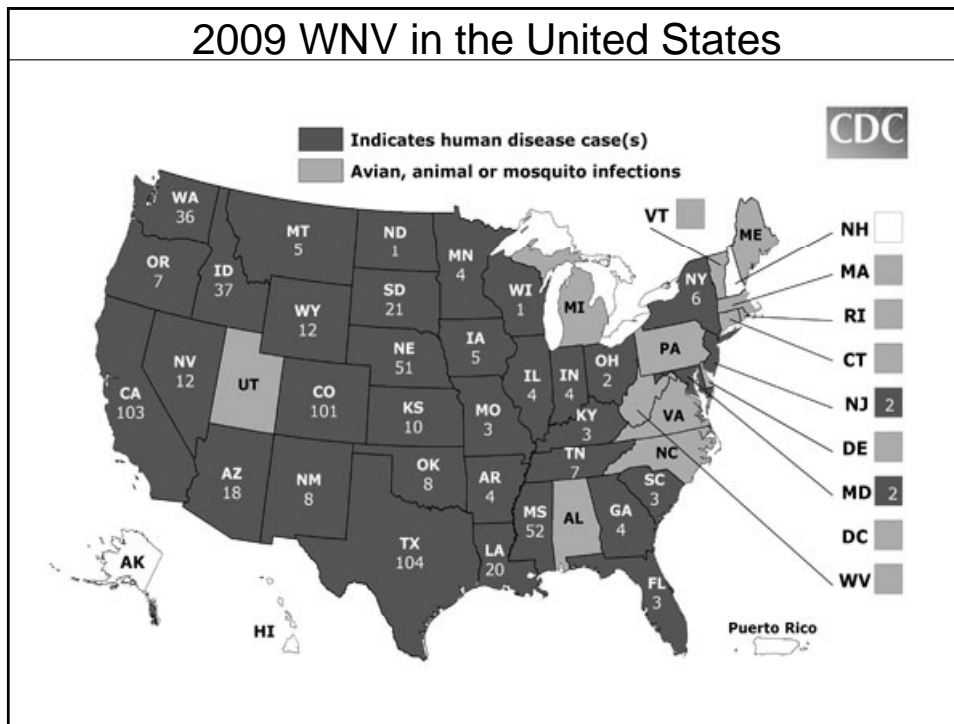




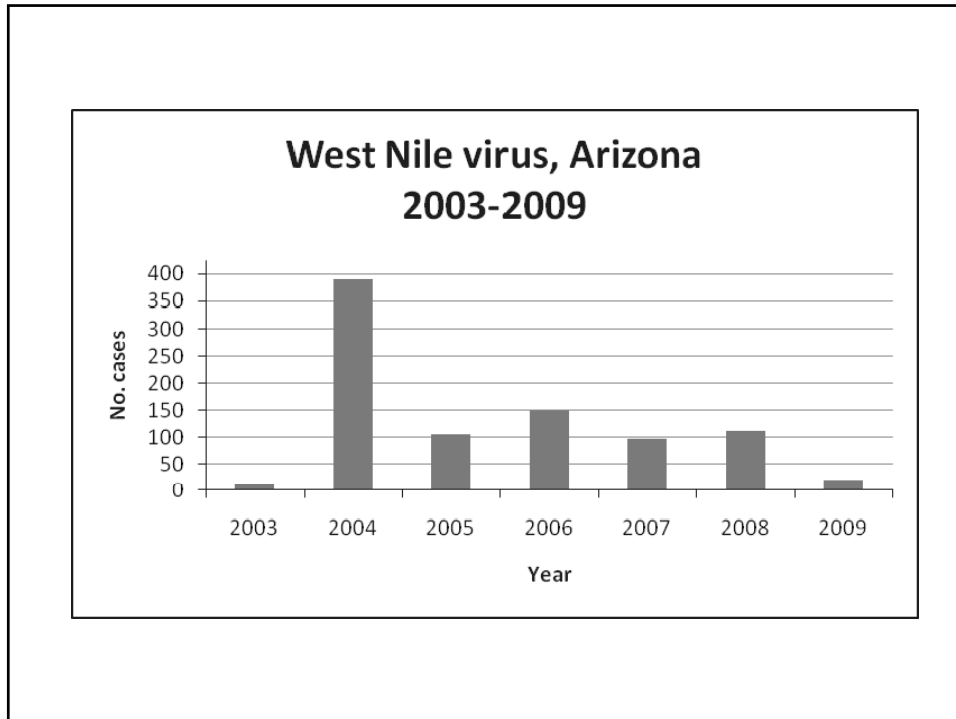


West Nile Virus









## WNV, AZ, 2009

- 2009: WNV lowest activity since 2003.
- 20 human cases (vs. 107 in 2008)
- 2009 – unusually cool summer – thru June.
- 2009 monsoon was a “Non-soon” – rains were late (late August) and scant.
- Don’t assume that WNV is declining!  
Mother nature is rarely predictable.

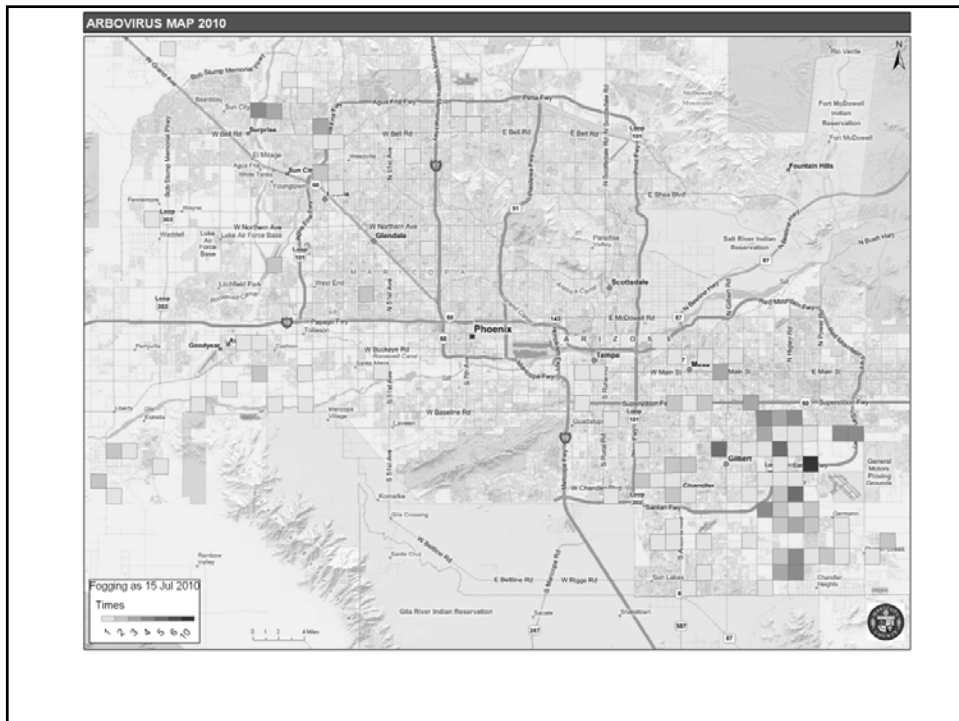
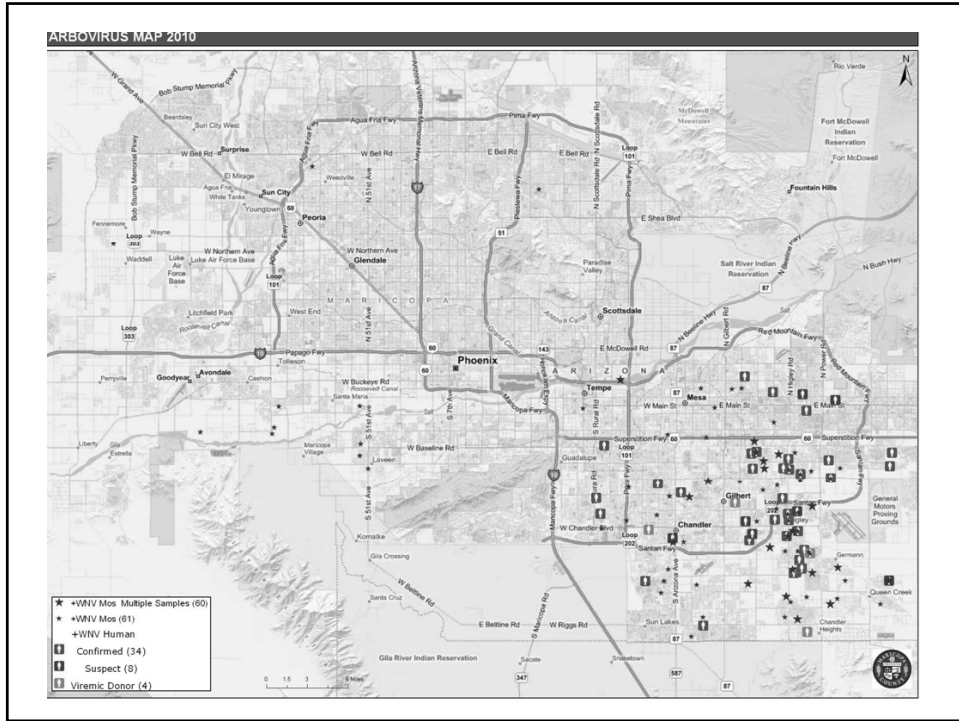
## WNV Infections, U.S., 2009

- For every case of neuroinvasive WNV, there 140 infections and 20%+ have sx (mostly “WNV fever”)
- CDC estimates for Year 2009:
  - - 54,000 infections
  - - 10,000 cases w/ clinical sx
- Surveillance only detects 3% of non-neuroinvasive clinical cases.
- Reduced case numbers can be deceiving.

## WNV, U.S. (Top Six States) - 2010

STATE	# HUMAN CASES	(#DEATHS)
ARIZONA	82	(6)
CALIFORNIA	38	
COLORADO	37	
NEBRASKA	19	(1)
NEW YORK	62	
TEXAS	24	(2)
<b>TOTAL – ALL STATES (31 States)</b>	<b>381</b>	<b>(12)</b>





West Nile Virus

## WNV Mosquito Surveillance, 2010

TOTAL : 264 WNV+\*

- MAR – 165
- NAVAJO - 3
- PINAL – 82
- YAVAPAI - 4
- YUMA – 10

### SPECIES

- Culex quinq. – 58%
- Cx. tarsalis – 32%
- Cx. sp. -4%
- Ae. vexans – 3%
- An. franc. – 0.5%
- Mixed –2%



## WNV: What lies ahead?

- We are still in peak season – July thru Sept.
- Cont. hot temps will keep WNV going.
- Cont. expansion of WNV activity = likely. Human #'s ↑
- Cuts in Federal Funding 2011 ?



## Primary WNV Vectors



- Northeastern and northcentral US – *Culex p. pipiens*
- Southeastern US – *Culex p. quinquefasciatus* and *Cx. nigripalpus*
- Southcentral US - *Culex p. quinquefasciatus* and *Cx. salinarius*
- Mountain west and western US – *Culex tarsalis* and *Cx. p. quinquefasciatus*

## West Nile Virus Severe Disease Risk Factors

- Exposure to infected mosquitoes when > 50 years of age (*most fatalities > 75 years*)
- *Culex* spp. mosquitoes - but over 60 mosquito spp. have been found naturally infected
- Recreational and/or occupational exposure in urban or rural setting
- Primary and secondary vectors can vary locally and regionally, so understanding local transmission is crucial

## West Nile Virus

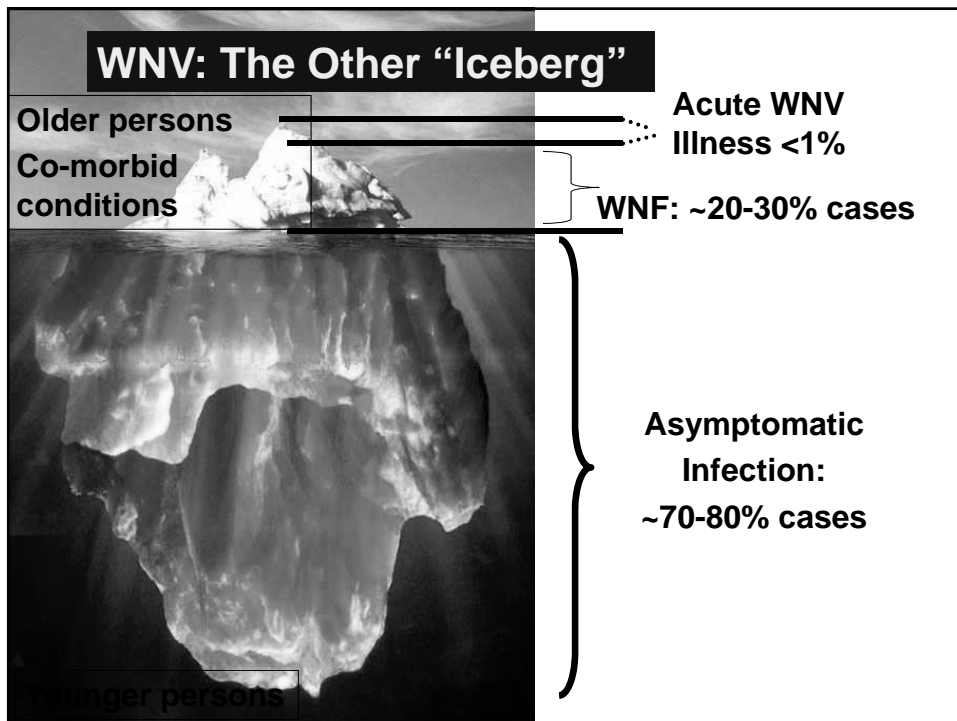
### Modes of Transmission in Perspective

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- Organ transplants
- **Blood transfusion**
- Intrauterine transmission
- Breast milk
- Exposure to infected bird carcasses

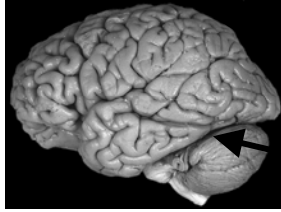
  

# ■ Mosquito bites

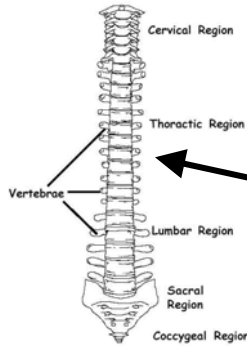




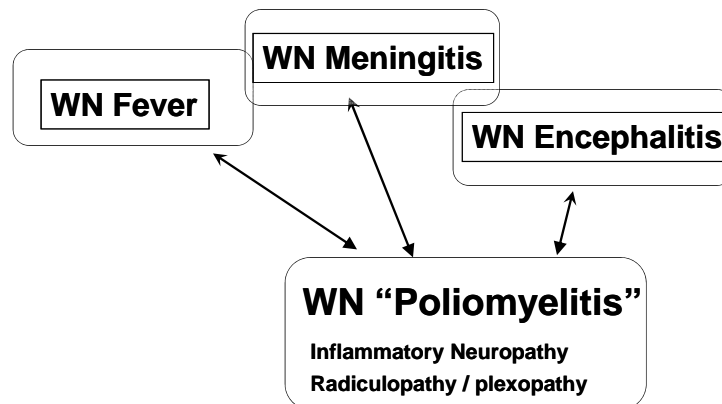
## West Nile Neuroinvasive Disease (WNND)



- “Meningitis”: Inflammation of the covering of the brain
- “Encephalitis”: Inflammation of the brain itself
- “Meningoencephalitis”
- “(Polio)Myelitis”: Inflammation of the spinal cord

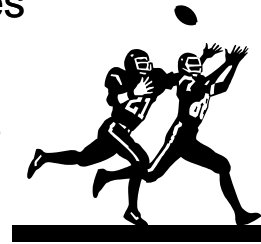


## Clinical Spectrum of WNV Illness: Revised



## WNV: Risk on School Campuses

- Mosquito breeding on campuses
- Outdoor night-time events:
  - \* Football & Baseball Games
  - \* Carnivals & Fairs
  - \* Night Classes
  - \* Special Events
- *ex. concerts, fireworks*



## Risk Reduction at Night-time Events

- **Personal Protection – prevent mosq.-bites**
  - wear loose fitting clothing
  - apply insect repellents
  - modify outdoor activities
  - prevention education
- **Prevent Mosquito Breeding**
  - no standing water
  - remove school yard clutter



## Vector Control

- **Conduct Surveillance\*\*\***
- **Source Reduction**
  - eliminate breeding sites
- **Larviciding**
  - apply larvicides
- **Adulticiding/Fogging**
  - prioritize fogging based on surveillance



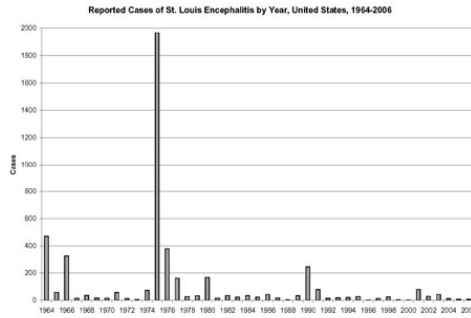
## **St. Louis Encephalitis Virus**

- Distribution similar to WNV in New World only
- Bird – mosquito cycle; similar primary mosquito vectors (*Culex* spp.) and transmission season to WNV
- Most similar to WNV in **urban** situations – sparrows and other peridomestic birds important for amplifying virus

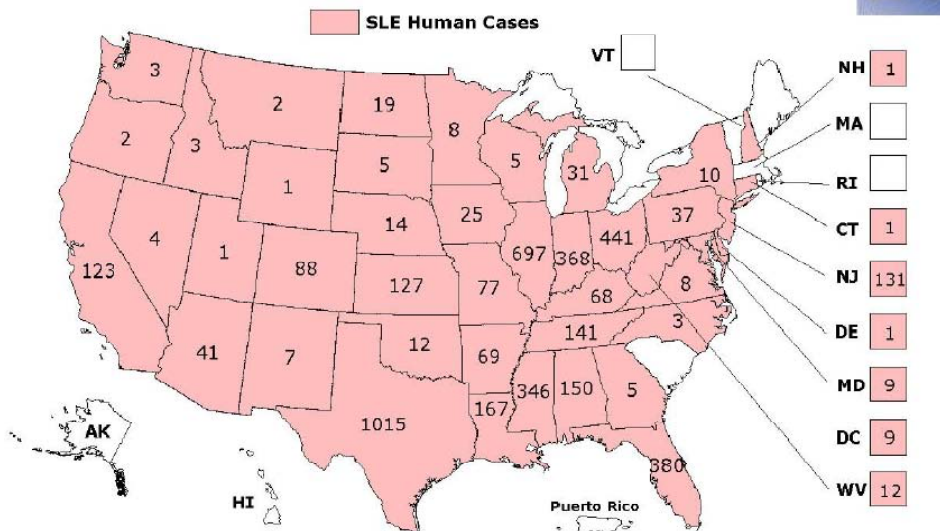


During extended spring droughts vector mosquitoes and nestling, juvenile, and adult wild birds congregate in selected refuges, facilitating epizootic amplification of SLEV.

1975



Human Saint Louis Encephalitis Cases by State, 1964-2007



Less than 1% of St. Louis encephalitis viral infections are clinically apparent

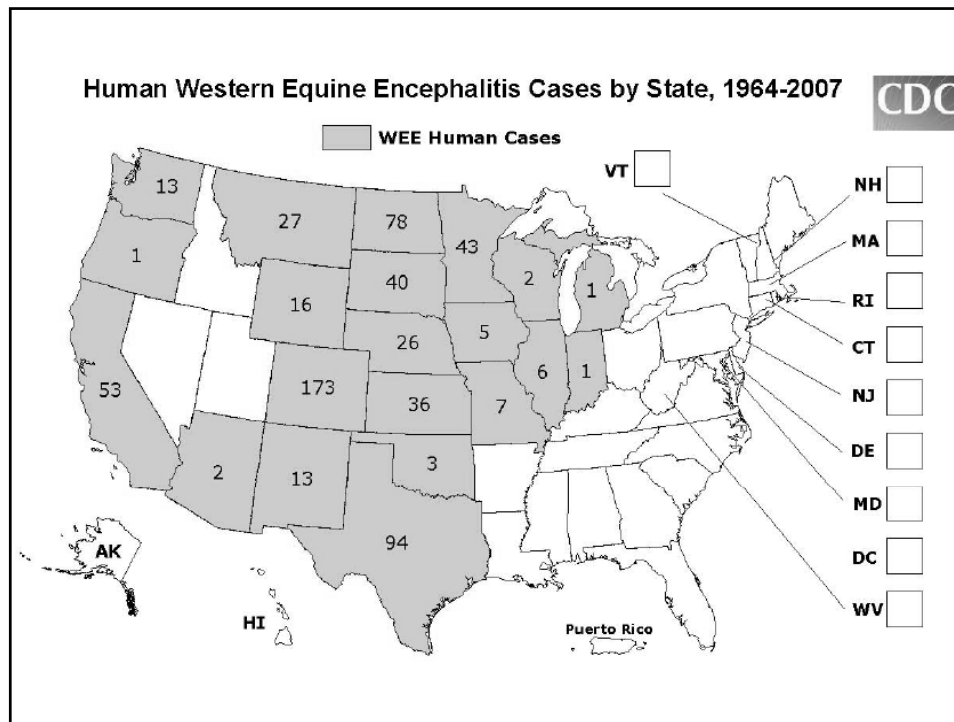
## **SLE Symptoms and Risks**

- 0 – 2,000 cases/year (1975), but usually smaller outbreaks; average of ~ 130 cases/yr
- Most infections asymptomatic or mild, with case-fatality ratio of 5 to 15%
- Severe disease – meningitis, encephalitis, coma, death
- Similar risk to WNV – increasing age, outdoor exposure in urban or periurban areas

## **Western Equine Encephalitis Virus**

- Distribution in Western US, Canada, Central and South America
- *Culex tarsalis* – bird transmission cycle
- Vector tends to be associated with irrigation or other farming practices
- Rural or periurban transmission most common
- Also infects horses – 50% mortality in unvaccinated animals





## WEE Symptoms and Risk

- 640 confirmed cases since 1964, but less than 0-2/year in past 10 years
- ~ 13% of infections show disease (*30% of infants*) with 3% case fatality ratio
- Severe disease - encephalitis, coma, death; seizures common in infants
- Rural areas where the vector is common

## Dengue Virus

- Distribution worldwide (*50-100 million cases with ~200,000 severe*) – not common in US, but recent S. Texas cases
- Human – mosquito transmission, *Aedes aegypti* vector
- Vector develops in containers and feeds during the daytime
- Typically urban transmission in overpopulated tropical/subtropical areas



## Dengue Virus

- More than one-third of the world's population live in areas at risk for transmission
- Dengue infection is a leading cause of illness and death in the tropics and subtropics.
- As many as 100 million people are infected yearly.



## DEN Symptoms and Risk

- There are 4 serotypes (*DEN 1-4*) and all can cause classical dengue (*sudden fever, headache, severe aches and rash*) known as “breakbone fever”
- Following sequential infection with different serotypes, severe hemorrhagic manifestations known as dengue hemorrhagic fever (*DHF*) can result
- DHF risk highest for <15 years of age



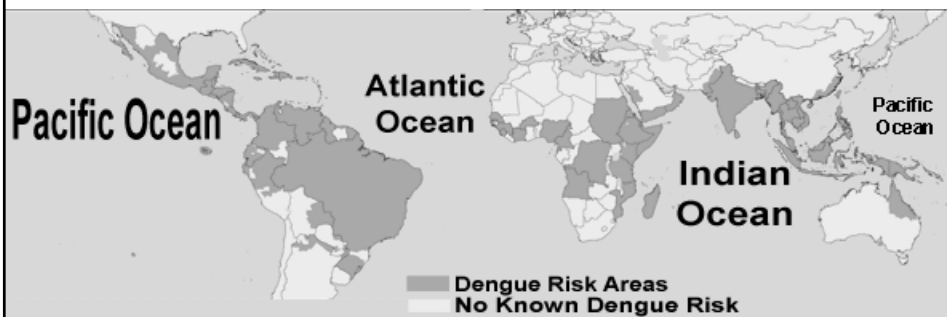
West Nile Virus



- 1950 Pan American Health Organization begins eradication campaign to prevent urban yellow fever.
- Dengue declines.
- Eradication program discontinued in the US in 1970.
- Geographic distribution of *Ae. aegypti* in 2009 is much wider than before eradication.



**2008**



- No dengue vaccine is available.
- An effective dengue vaccine for public use will not be available for 5 to 10 years.

## Recent Dengue in the US

- Texas – endemic transmission 6 times between 1980 and 2004
- First local DHF case in south Texas in 2005 and studies show undetected local DEN
- Hawaii – 88 cases in 2001-02 (*Aedes albopictus vector*)
- Low but increasing risk for local transmission, since 1977, ~ 4000 cases imported to US (100-200 cases/year)

## Dengue Risk

- Areas in the southern and southeastern US where both one or both vectors are present (*especially Aedes aegypti*) are at risk for sporadic outbreaks
- Increased influx of residents from dengue endemic regions outside the US (*as currently occurs in New Orleans following Hurricane Katrina*) further adds to the risk of introduction and local transmission



West Nile Virus

## **Prevention Education Campaign**

- **ADHS WNV website: [www.westnileaz.com](http://www.westnileaz.com)**
- **WNV brochures in English & Spanish**
- **WNV poster – backyard prevention**
- **PSA Campaign—primarily radio - statewide**
- **State PH Hotline – recorded:  
(602) 364-4500  
(800) 314-9243**



Bed bugs may be a vector for hepatitis B<sup>1</sup> and in endemic areas for American trypanosomiasis - Chagas disease<sup>2</sup>. Of note, reports have indicated the risk of insect transmission of HIV, if any, is extremely low and likely nonexistent<sup>3,4</sup>.

<sup>1</sup> Ogston CW, Wittenstein FS, London WT, Millman I. *J Infect Dis.* Sep 1979;140(3):411-4.

<sup>2</sup> Pipkin AC Sr. *Int Rev Trop Med.* 1969;3:1-47.

<sup>3</sup> Iqbal MM. *J La State Med Soc.* Aug 1999;151(8):429-33.

<sup>4</sup> Webb PA, Happ CM, Maupin GO, Johnson BJ, Ou CY, Monath TP. *J Infect Dis.* Dec 1989;160(6):970-7.