

# The Spread of the West Nile Virus - A Visual Analysis

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Peter Ma, Utah State University
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## *Pests Get Under Their Skin*



*Wednesday July 24th 1805.*

*Our trio of pests still invade and obstruct us on all occasions, these are the Musquetoes eye knats and prickley pears, equal to any three curses that ever poor Egypt laiboured under*

*—Meriwether Lewis*



As the Corps moved toward the mountains, they left the portage behind but could not outdistance the mosquitoes. Possibly the most often repeated phrase in both Lewis' and Clark's journals is "Musquetors verry troublesom."

Clark claims the men could not have slept without the "musquetoe biers," or netting, Lewis had brought from Philadelphia. Caught one night away from camp without this protection, Lewis got no sleep at all and swore he would never forget it again.

# West Nile Virus ???

## ◆ Virus

- ◆ Initial event - Culex mosquito transmits virus within avian populations
- ◆ Bridging Aedes albopictus transmits virus from birds to animals and humans



# Overview

- ◆ US Analysis
- ◆ GIS Visualization: Choropleth Maps
- ◆ Statistical Visualization: Micromaps
- ◆ DC Analysis
- ◆ Web-based Access to WNV Data
- ◆ Conclusion



# US Analysis - Summary

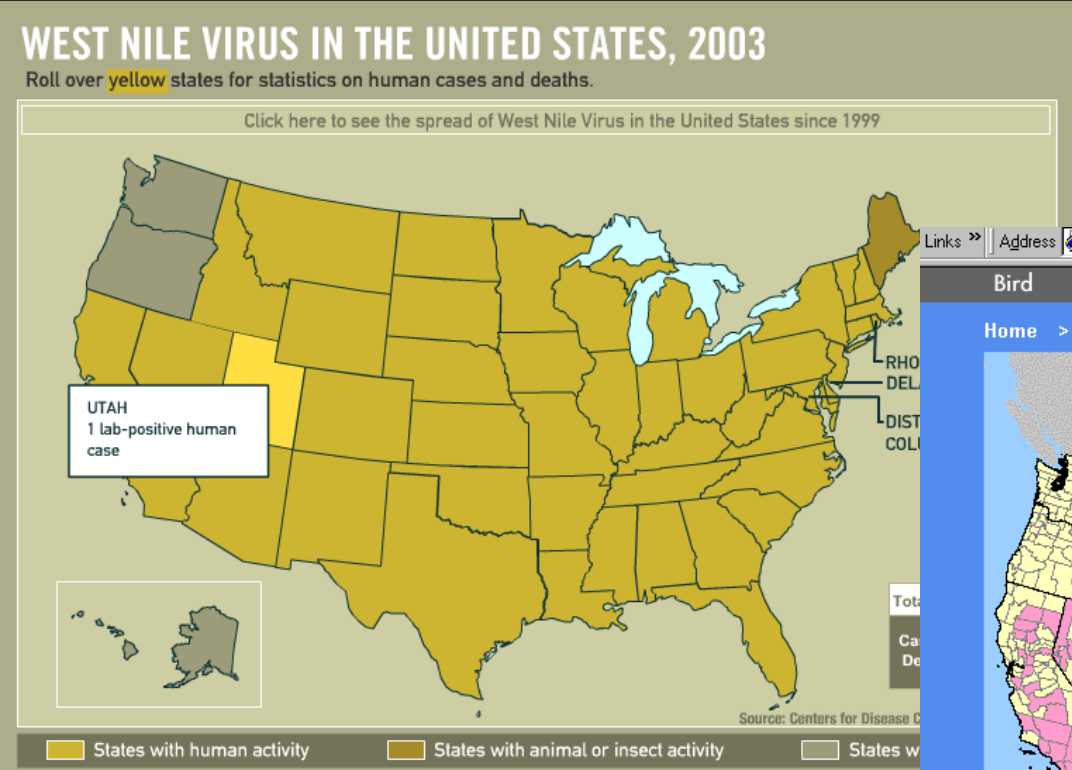
- ◆ In 2002
  - ◆ 4,156 total human cases (284 deaths) in US
  - ◆ Ecological damage
    - 140 species of birds, reptiles and mammals infected and killed - 100 US zoos reporting cases
- ◆ In 2003:
  - ◆ 9,862 total human cases (264 deaths) in US
- ◆ >> 14,000 horses killed since 1999
- ◆ 1999: 62 cases (7 deaths), 2000: 21 (2), 2001: 66 (1)
- ◆ 2004: 2151 cases (68 deaths) by 10/19/04

# **GIS Visualization: Choropleth Maps**

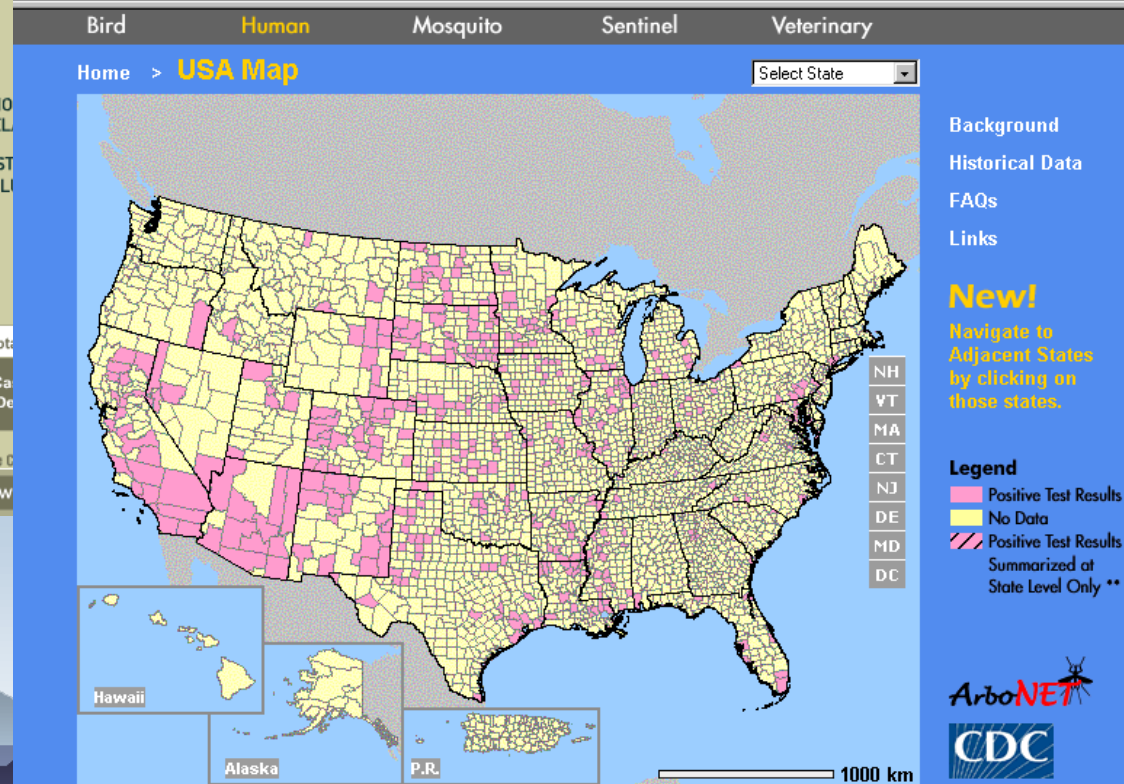


# West Nile Virus Maps in the News

Links >> Address <http://www.cnn.com/SPECIALS/2004/west.nile/map.html>

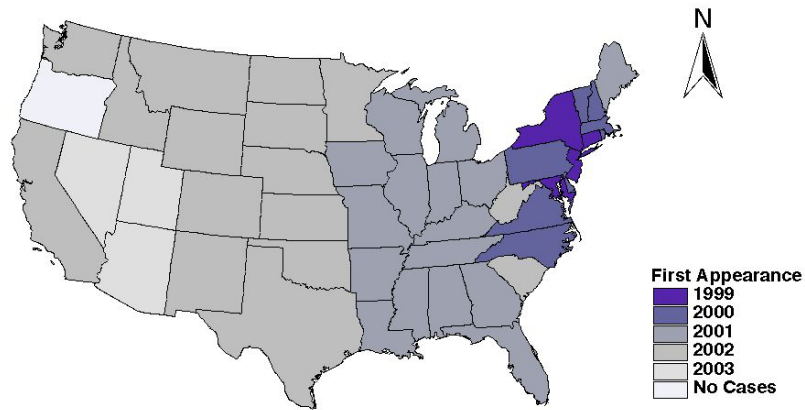


Links >> Address [http://westnilemaps.usgs.gov/us\\_human.html](http://westnilemaps.usgs.gov/us_human.html)

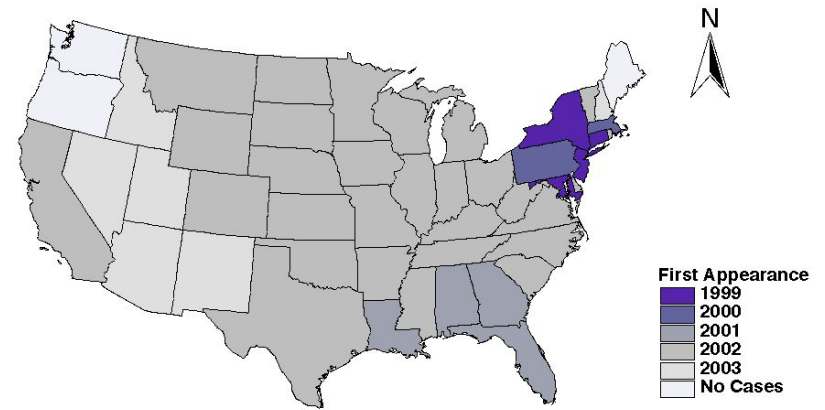


# US Analysis

**First Appearance of West Nile Virus in Birds, Mosquitoes, and Other Animals by Year**



**First Appearance of West Nile Virus in Humans by Year**



# **Statistical Visualization: Micromaps**



# Micromaps

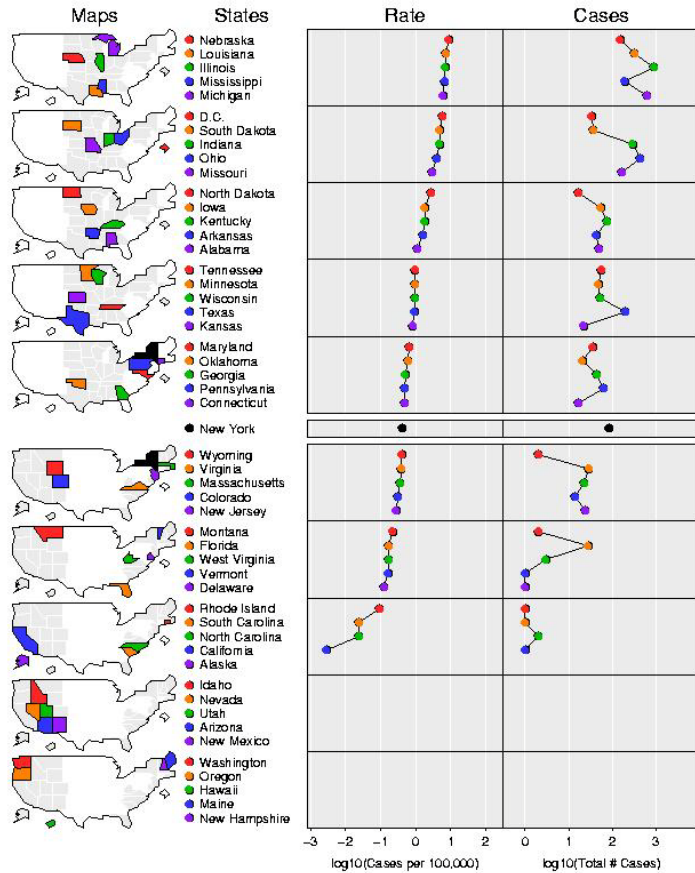
- ◆ Link of row-labeled univariate (or multivariate) statistical summaries to corresponding geographical region
- ◆ Focus on statistical display and not on maps

# Usage of Micromaps

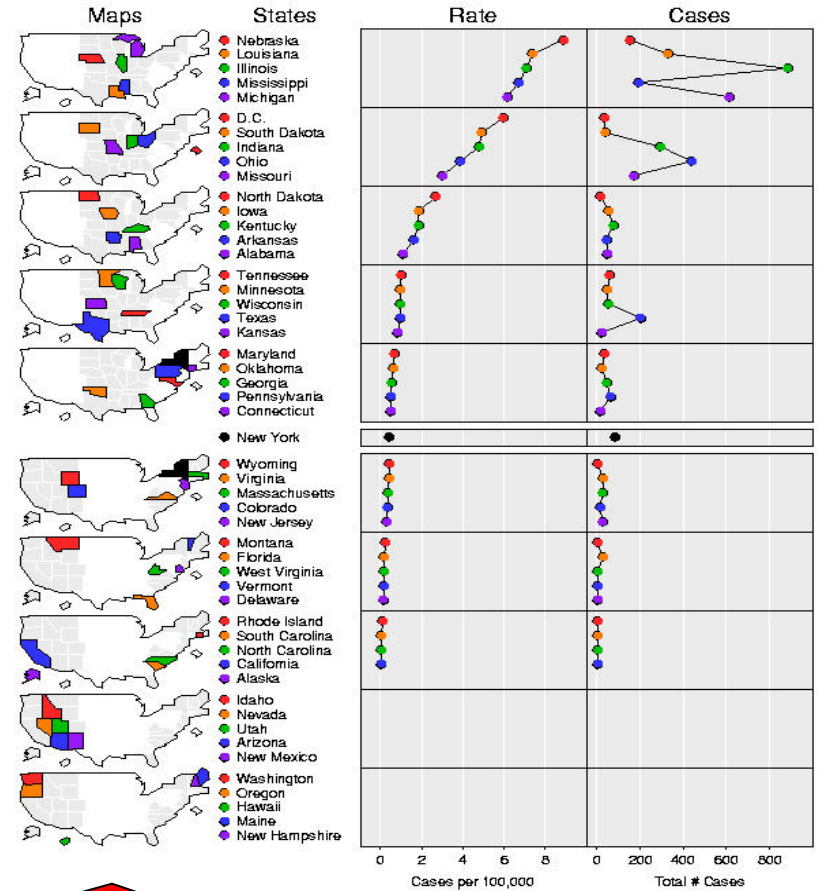
- ◆ First presented at 1996 American Statistical Association's annual meeting (Olsen, Carr, Courbois, Pierson)
- ◆ EPA: Cumulative Exposure Project (1998 - intended)
- ◆ USDA-NASS: Agricultural Census (2000)
- ◆ NCI: Cancer Data (2003)

# From 2002 CDC Web Page to Micromaps

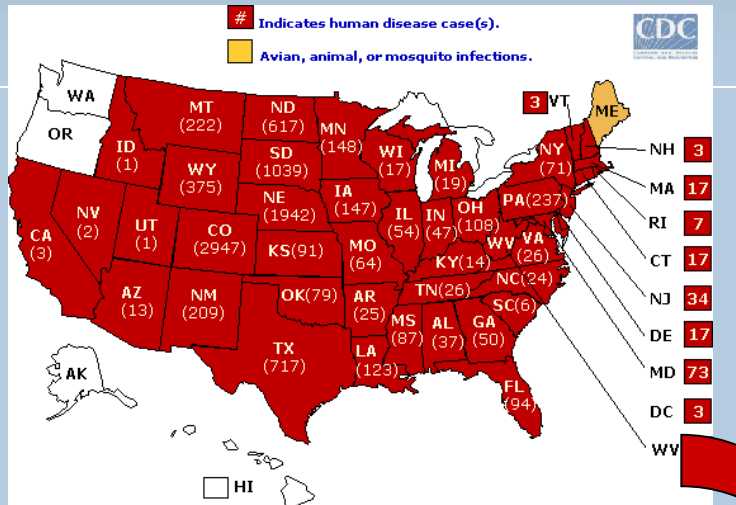
**West Nile Virus 2002  
Lab-Positive Human Cases**



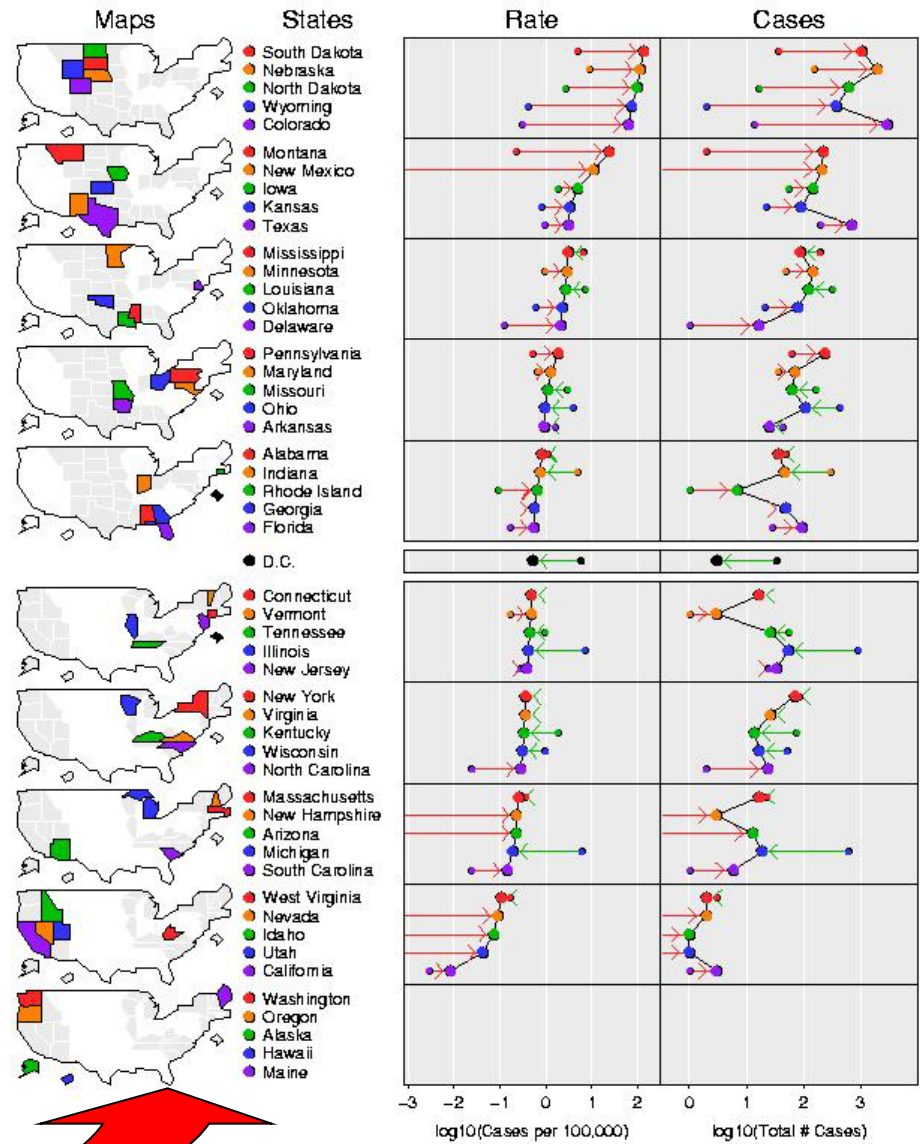
**West Nile Virus 2002  
Lab-Positive Human Cases**



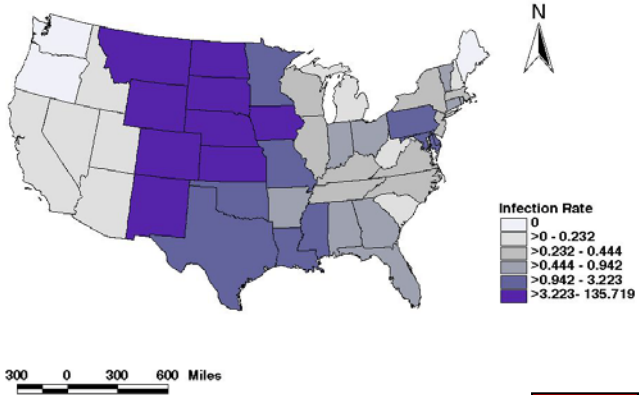
# From 2003 CDC



## West Nile Virus 2003 Lab-Positive Human Cases



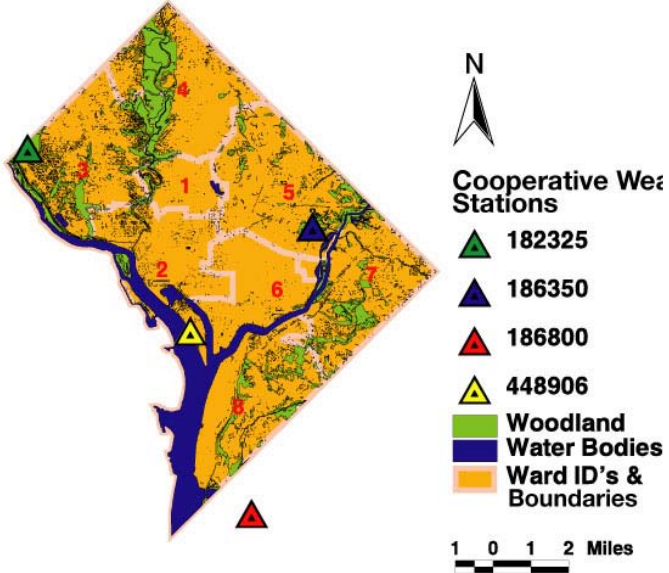
Human West Nile Infection Rate for 2003  
(Cases per 100,000)



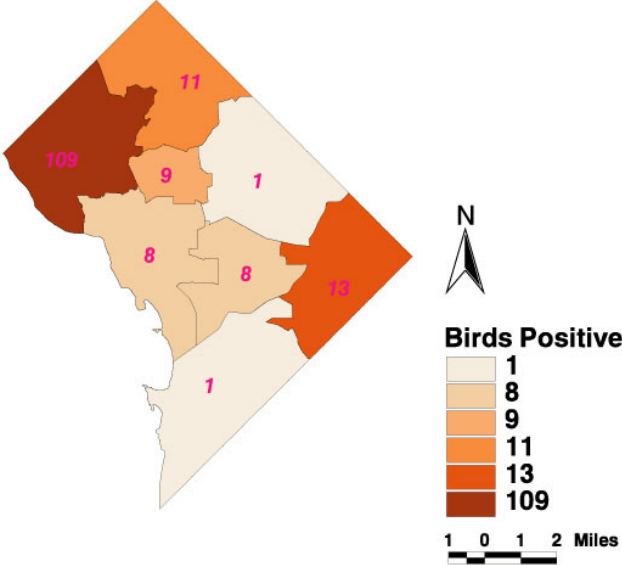
# DC Analysis

# DC Analysis

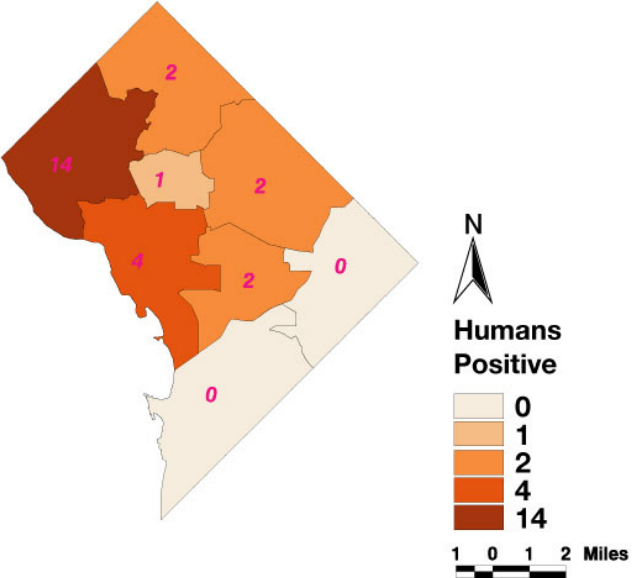
## Washington, DC by Ward



## Total Number of WN Infected Dead Birds by Ward in DC for 2002

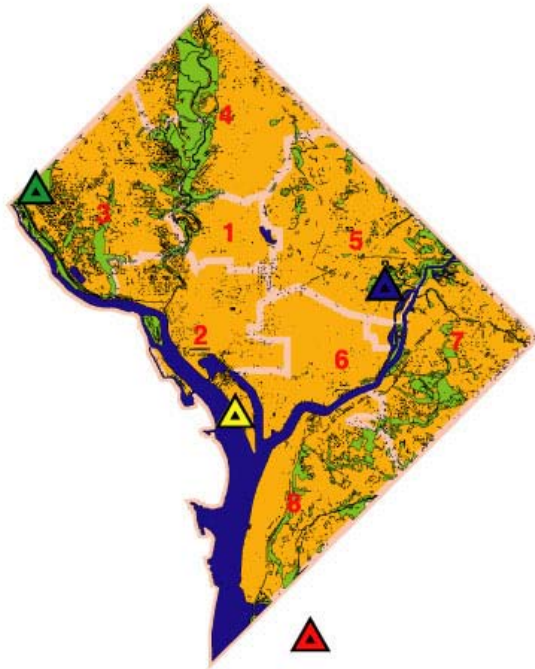


## Total Number of West Nile Cases in Humans by Ward in DC for 2002



# West Nile – DC Geographic Time Series

## Washington, DC by Ward



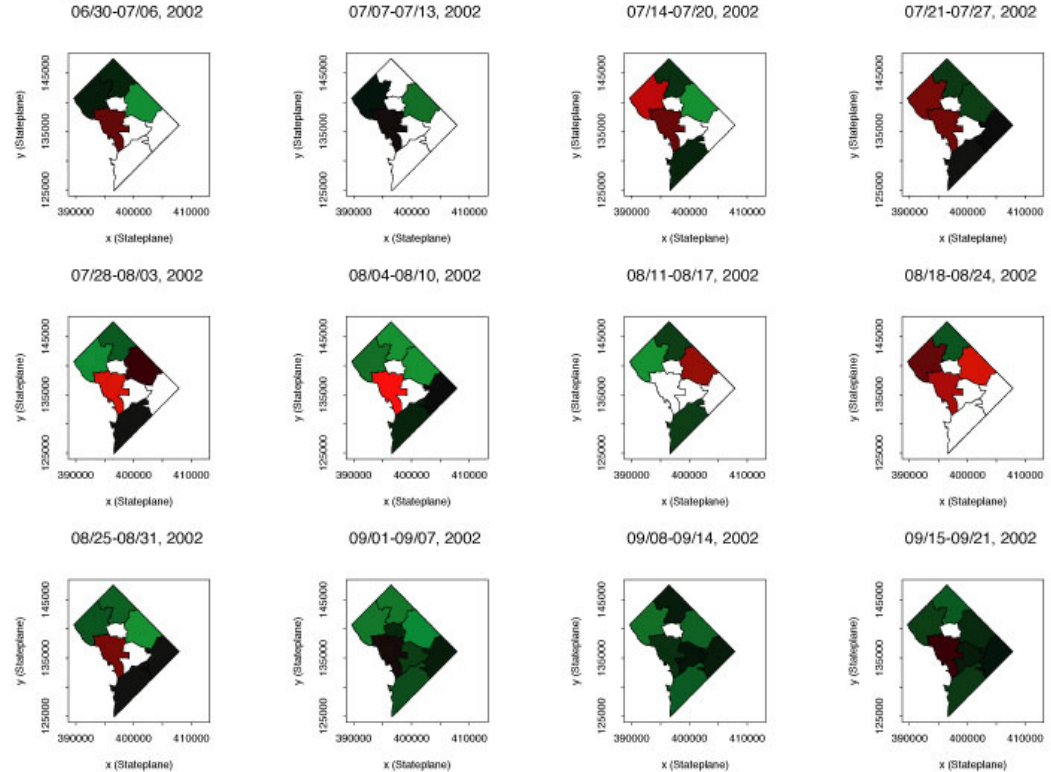
### Cooperative Weather Stations

-  182325
-  186350
-  186800
-  448906

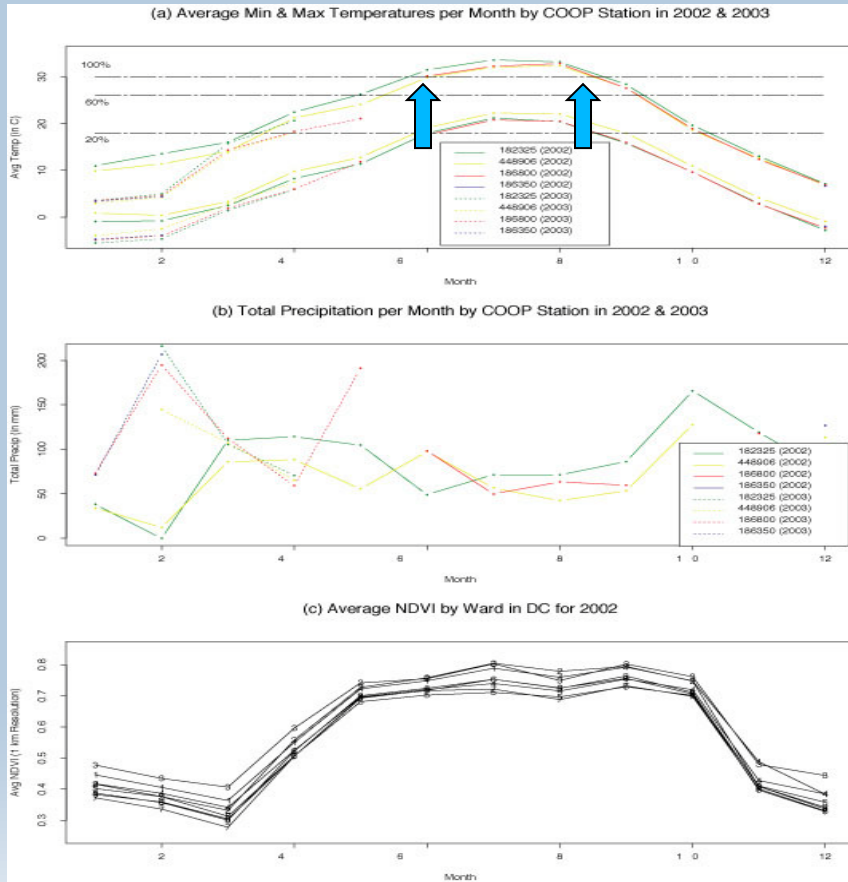
-  Woodland
-  Water Bodies
-  Ward ID's & Boundaries

1 0 1 2 Miles

## Weekly Mosquito West Nile Positive Rates by Ward in DC for 2002



# Enviro-Climatic Coupling



- ◆ Prior precipitation regime conducive to hydration and hatching of mosquito eggs
- ◆ Transmission competency ( $26^{\circ}$  to  $30^{\circ}\text{C}$ ) - indicative of higher efficiency of mosquito to transmit the virus
- ◆ Positive mosquito and human cases seen previously to occur within this time frame

# **Web-based Access to WNV Data**



**Left Column Data**

Area: US - state level

Data Group: West Nile Virus

Host Group: Human Cases

Statistic: Infection Rate

Year: 2002

Sex: Both Sexes

**Right Column Data (optional)**

Data Group: West Nile Virus

Host Group: Human Cases

Statistic: Infection Count

Year: 2002

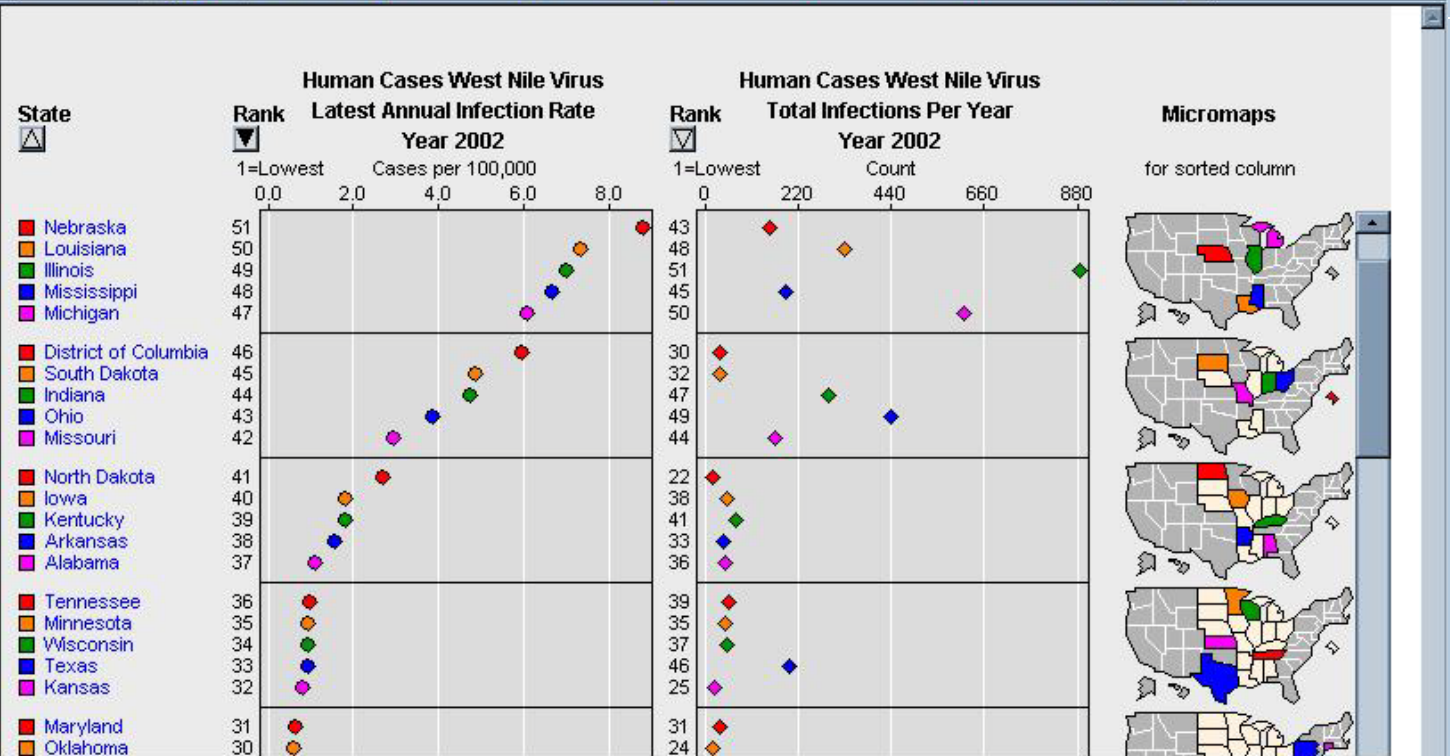
Sex: Both Sexes

Draw Clear

Overview

Options ? [Print] [Refresh]



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Back Forward Stop Refresh Home Search Favorites Media Print Mail My Yahoo! Games Yahoo! Personals LAUNCH Sign In

Address <http://webcat.gis.usu.edu:8080/index.html> Go Links

Search Web Mail My Yahoo! Games Yahoo! Personals LAUNCH Sign In

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**Right Column Data (optional)**

Data Group: West Nile Virus

Host Group: Human Cases

Statistic: Infection Count

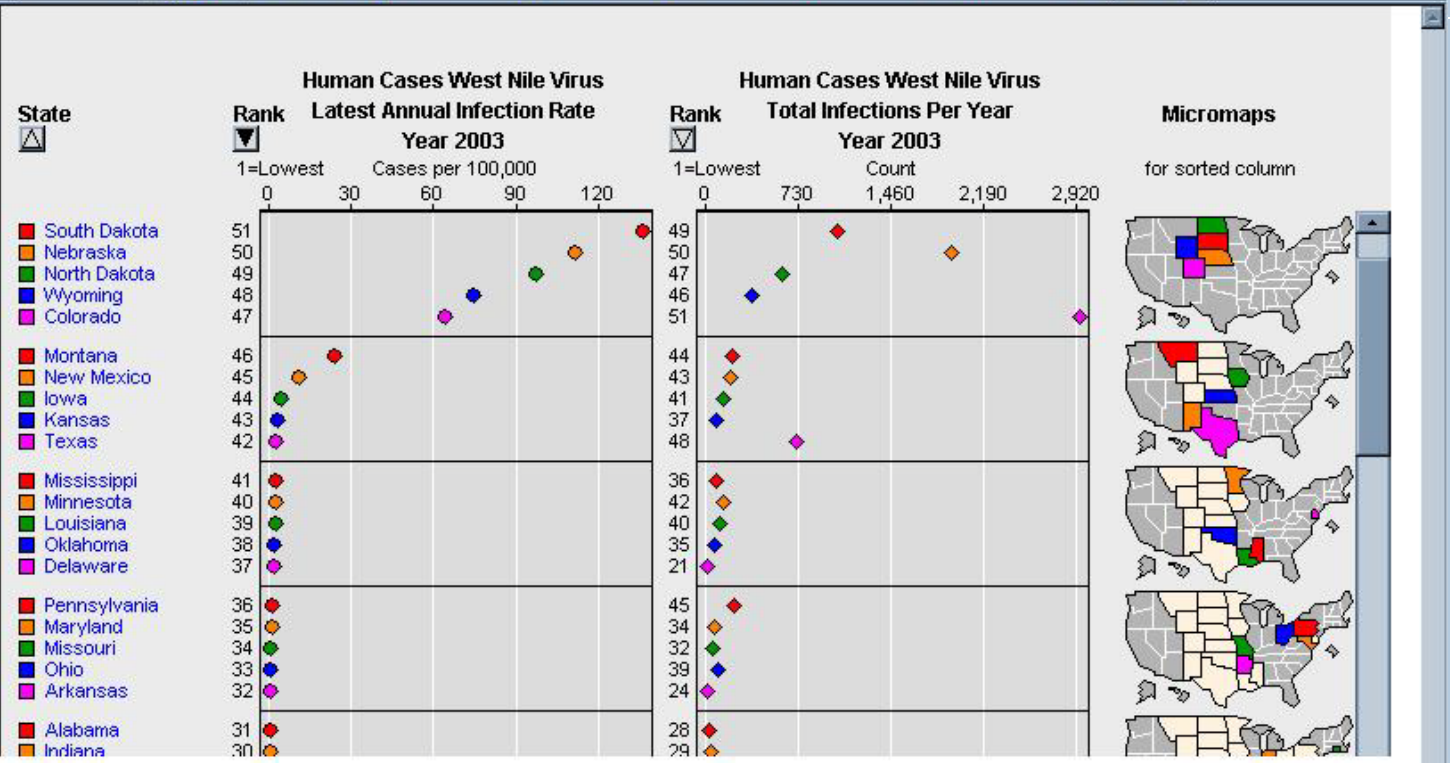
Year: 2003

Sex: Both Sexes

Draw Clear

Overview

Options ? [Print] [Refresh]



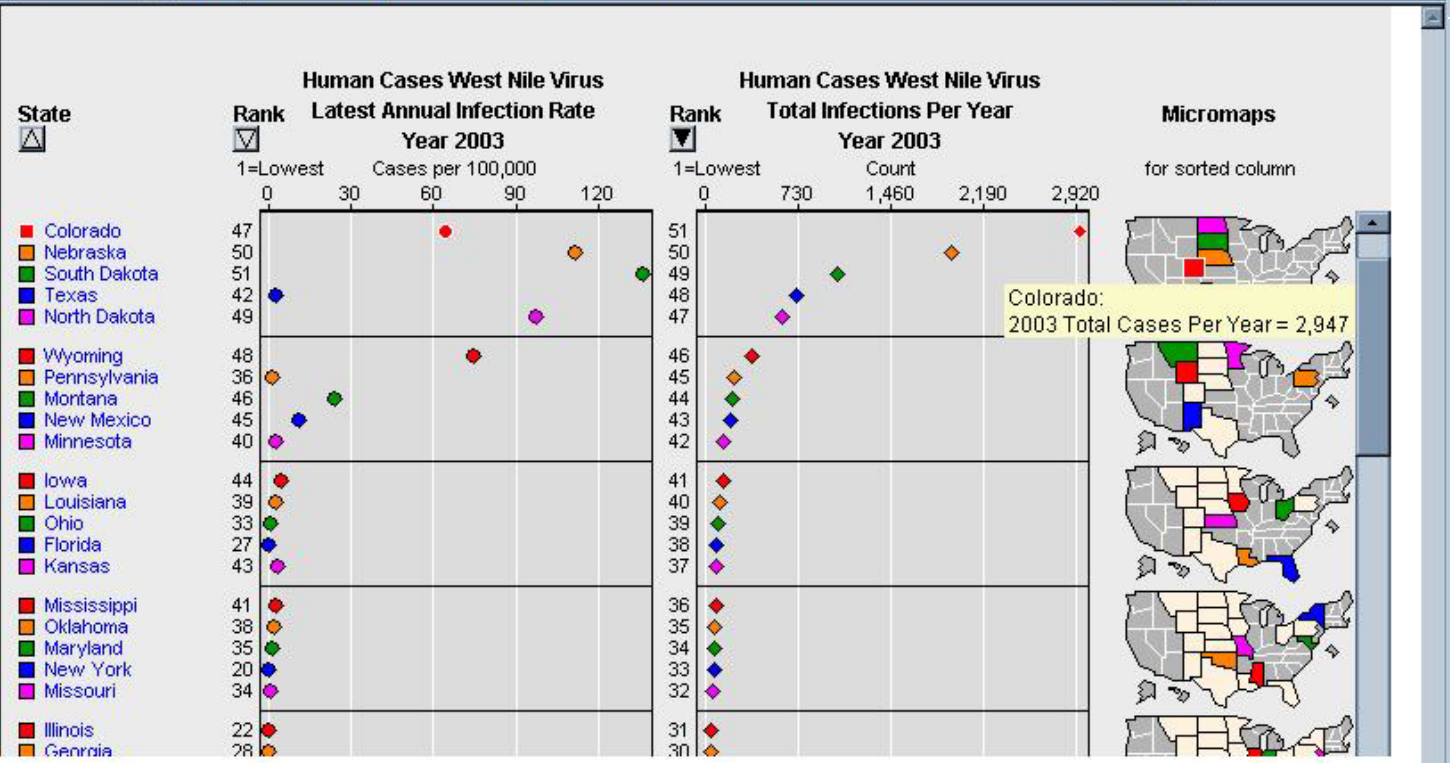
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 Year: 2003  
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**Right Column Data (optional)**

Data Group: West Nile Virus  
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 Statistic: Infection Count  
 Year: 2003  
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Draw Clear  
 Overview  
 Options ? ? ?

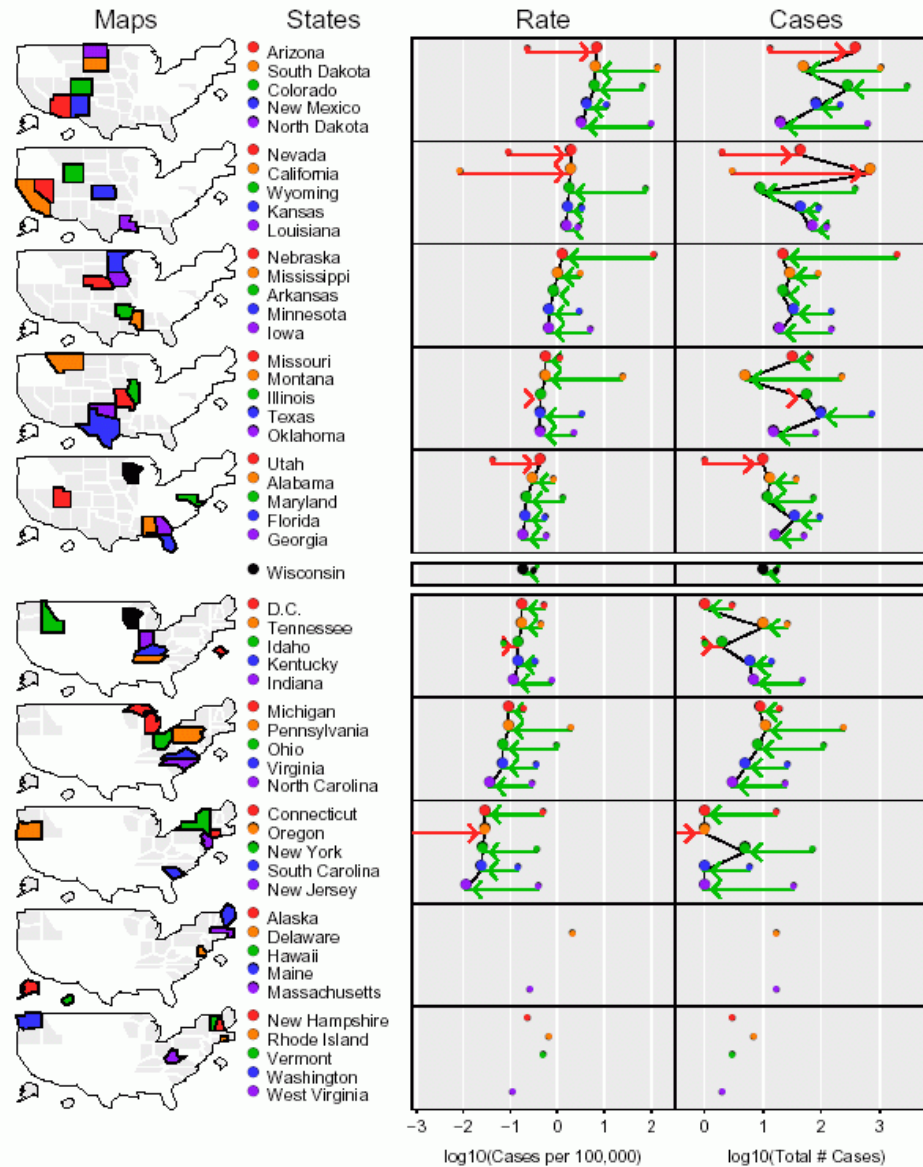


# **WNV in 2004**



# West Nile Virus 2004 (as of 10/19/04)

## Lab-Positive Human Cases



# Concluding Remarks

- ◆ WNV, as an example of a vector-borne pathogen, is a spatially and temporally complex phenomenon, but can be
  - ◆ Described well &
  - ◆ Summarized, using visualization techniques



# Ongoing Work

- ◆ Linking of West Nile Micromap Server with USU Climate Data Base
- ◆ Assessment of spatially adjusted WNV-positive human, avian, and mosquito locations in DC
- ◆ Spatial statistical analysis tools can be used to provide an analytical representation of the WNV DC data

# Acknowledgements

- ◆ Thanks to everyone who provided data!
- ◆ USU West Nile Micromap Server based on source code from NCI's micromap cancer Web site (<http://www.statecancerprofiles.cancer.gov>)
- ◆ S-Plus micromaps adapted from S-Plus sample code from Dan Carr
- ◆ Color suggestions obtained from Cindy Brewer's Web site (<http://colorbrewer.com>)

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Questions ???