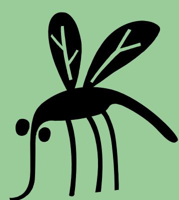
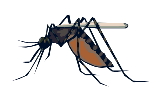
West Nile of the Pacific Northwest: Predicting high-risk areas with GIS



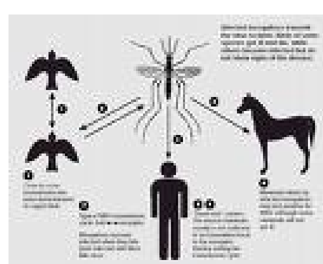
Kaleena Hughes
Samantha Barker

GIS II WINTER 2008



West Nile

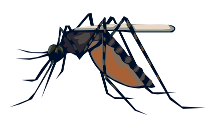
- West Nile: Inflammation of the brain
- First North American Case: 1999 New York, and is a seasonal epidemic
- West Nile is spread through the bite of an infected mosquito, having fed on an infected bird.



Is it getting warm in here?

- 2007 was the fifth warmest year for the world, and the tenth warmest year for the United States (NOAAnews)

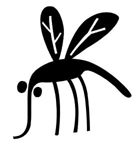
Mosquitos



- Accurate mapping of the spatial distribution of mosquito breeding habitats is essential for cost-effective deployment of control practices (Zou etal 2006)
- Objective of this study is:

  To assess potential larval habitats of Culex tarsalis (Mosquito) of the Pacific Northwest in an effort to establish a basis for predicting the risk of exposure to West Nile Virus. (WNV)

More about mosquitos…



- Mosquitoes of the genus *Culex* are the dominate disease vector and transmitter of West Nile Virus (Zou etal 2006).
- *Cx. tarsalis*
  - Small standing water species
  - Females attracted to water with high organic matter
  - Require very little disturbance from either waver or flow for development
  - In natural environments, often located at edges if small water bodies (Zou et all 2006)

Method: Looking for mosquito habitat

- Large water bodies of 4 ha [10 acres] are exposed to wind and wave action
- Running water as river or streams are not suitable for larval development
- Open water are unsuitable for larval and pupae are vulnerable to predation
- Nutrition concentrations of large water and running steams are must lower than pond edges and small standing water (Zou et all 2006)

Project Study Reach

- Oregon, Washington, Idaho
  - The “Western” U.S.   2007

Data Sources

- Center for Disease Control and Prevention
  - Infection data: U.S. 2007 (collective)
    - Human infections
    - Dead bird infections
    - Mosquito infections
    - Sentinel infections
    - Veterinary infections
- Penn State
  - State and stream layers
  - Vegetation layers
  - Digital Elevation Model

To bring it all together,
these wonderful tools and methods:

- Excel formatting
- ArcGIS table joining
- Landcover reclassify
- DEM reclassify
- Waterbodies Clip by County
- Identity
- Summary Statistics
- Union
- Statistical Clustering Analysis

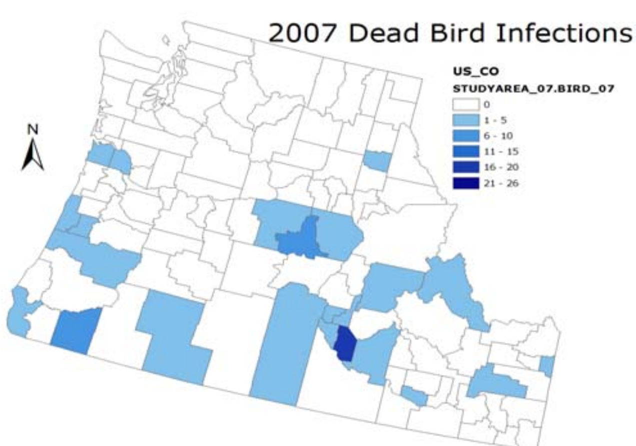
Statistical Analysis

- Method:
  - Does the clustering of the land cover type suitable for mosquito development significantly influence the development of West Nile infection rates, statistically?
    - Approach:
      - Explore the correlation between infections, stream lengths (mosquito habitat), and population

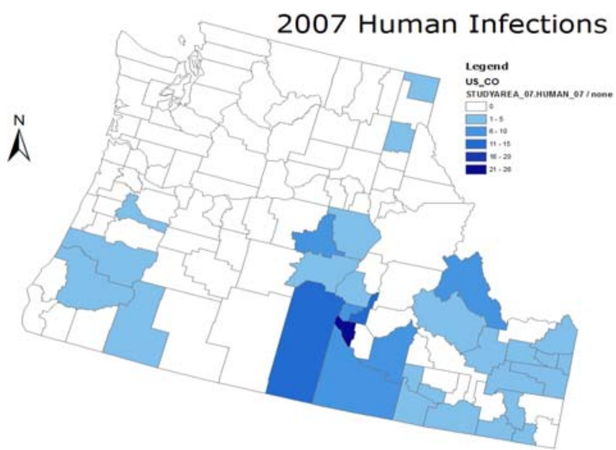
Total Infections for 2007

2007 Infections	Dead Bird	Human	Mosquito	Sentinel	Veterinary	Total
Idaho	15	132	18	0	16	181
Oregon	55	26	28	12	17	138
Washington	1	0	0	0	9	10
Study Area Total	71	158	46	12	42	329

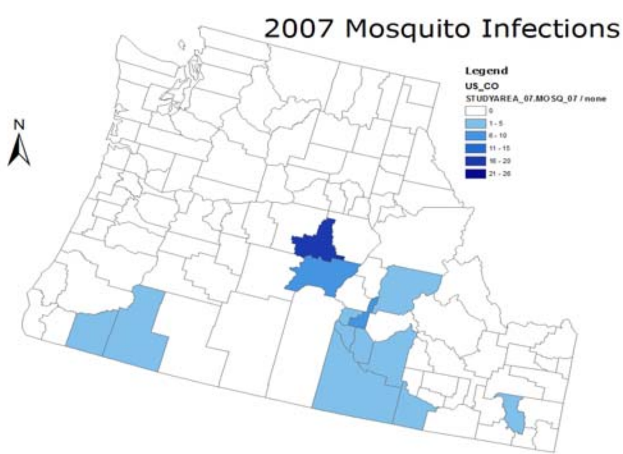
Dead Bird Infections



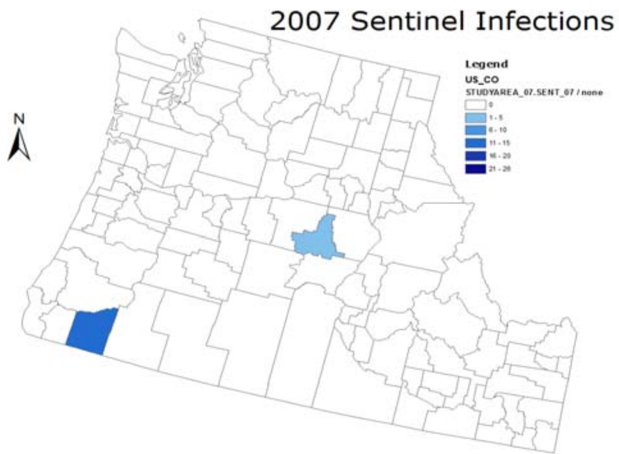
2007 Human Infections



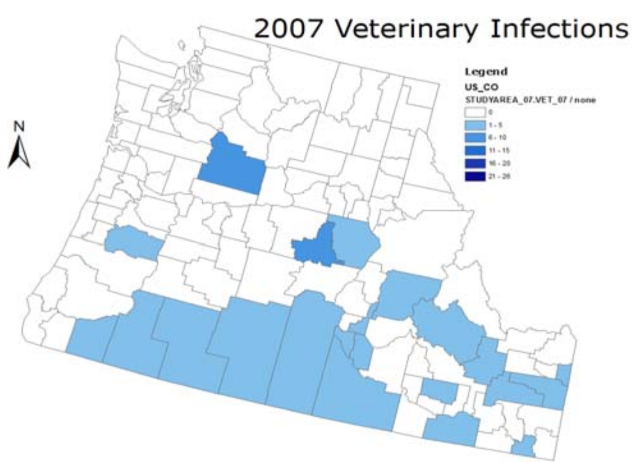
2007 Mosquito Infections



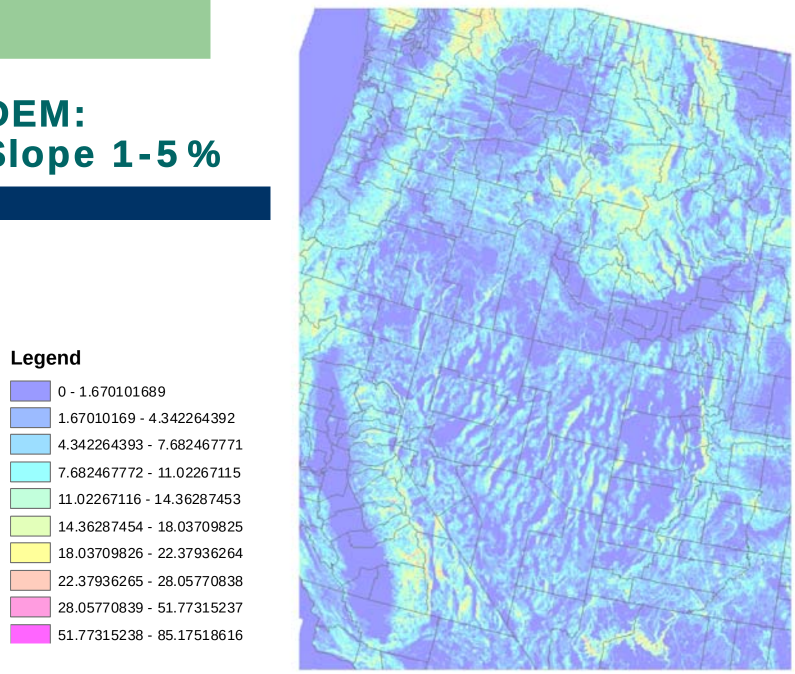
2007 Sentinel Infections



2007 Veterinary Infections

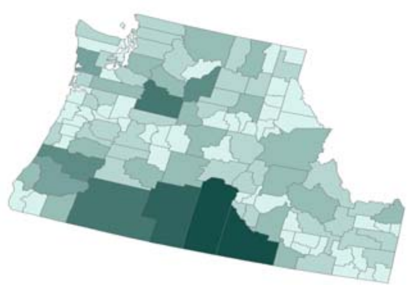


DEM: Slope 1-5 %



Stream Length:

- Increasing darkness relates to increasing amount of streams of proper width and type for mosquito development



West Nile Clustering Results (Moran's I)

Infection	Moran's Index	Z Score	Interpretation- Clustering due to:
Dead Bird	-0.02	0.19	random
Human	0.03	1.82	5-10% liklihood that this clustered pattern is the result of random chance
Mosquito	0.02	2.04	5% likelihood that this clustered pattern is the result of random chance
Sentinel	-0.01	1.11	random
Veterinary	-0.04	-0.51	random

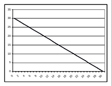
Interpreting Correlation Results

- How the function is derived:

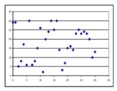
$$Correl(X,Y) = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{\sum (x-\bar{x})^2 \sum (y-\bar{y})^2}}$$

- Values range between

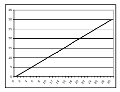
-1



random



+1

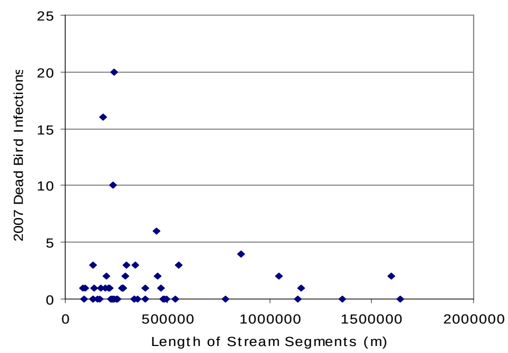


Dead Bird & Stream Length Correlation Results

Correlation: -0.0104271

-not correlated, random

r-value: 0.010872

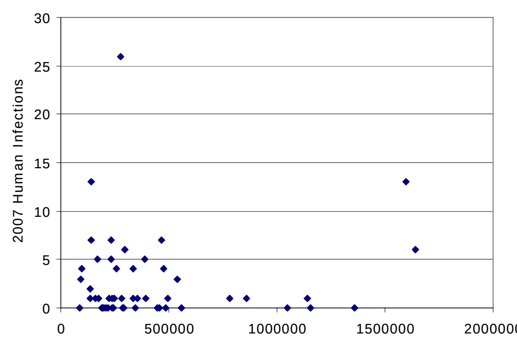


Human & Population Density Correlation Results

Correlation: 0.058988

-not correlated, random

r-value: 0.00348

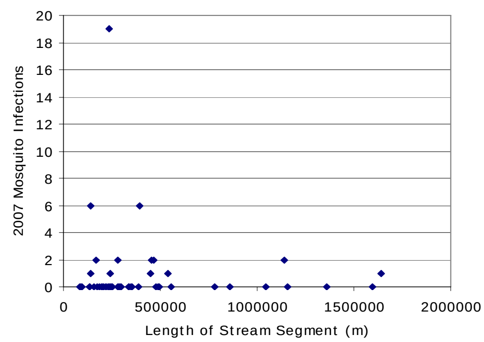


Mosquito & Stream Length Correlation Results

Correlation:
 -0.0737

-not correlated,
 random

r-value: 0.008432



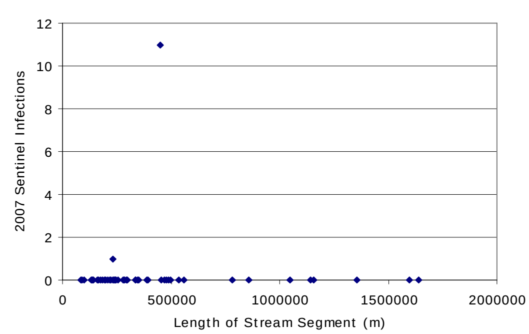
Sentinel & Stream Length Correlation Results

Correlation:
 0.001574

-not correlated,
 random

r-value:

2.47609 x 10-6

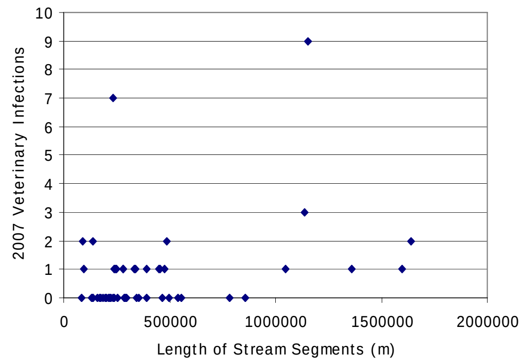


Veterinary & Stream Length Correlation Results

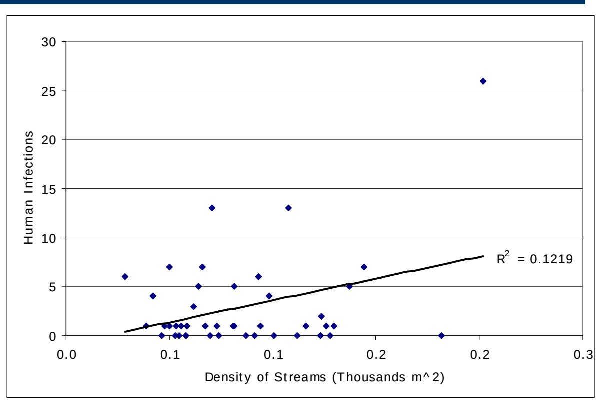
Correlation: 0.327453

-not correlated, random

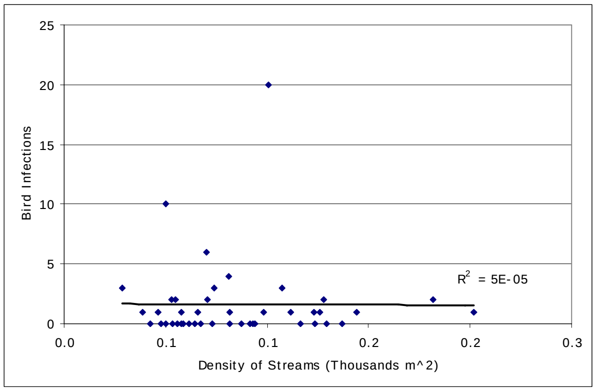
r-value: 0.107225149



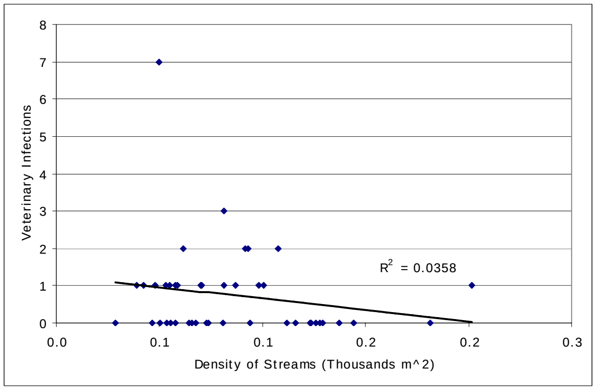
Human Infections & Density of Streams



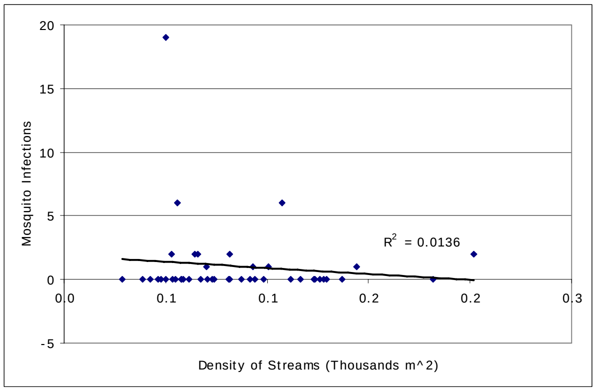
Dead Bird Infections & Density of Streams



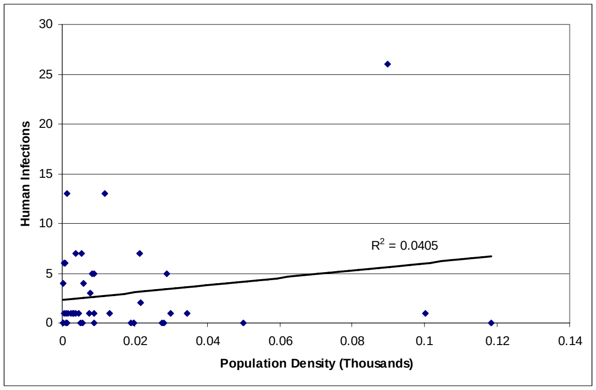
Veterinary Infections & Density of Streams



Mosquito Infections and Density of Streams



Human Infections & Population Density



Reflections

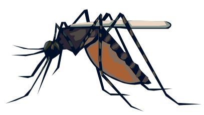
- How does this analysis relate to previous years?
- Source of error (of many): Collection of infections, voluntary basis only and related to population and size of each county

References

- USGS. West Nile Human/Bird/Mosquito/Sentinel/Veterinary Disease Maps 2007. (Internet at: http://diseasemaps.usgs.gov/wnv_us_human.html)
- Minter, Martin. Developing a GIS-Based West Nile Virus Infection Model. January-March 2005. ESRI, ArcUser Online. (Internet at: http://www.esri.com/news/arcuser/0205/west_nile1of2.html)
- National Oceanic and Atmospheric Administration. 2007 was the Tenth Warmest for U.S., Fifth Warmest Worldwide. January 15,. 2008. (Internet at: http://www.noaanews.noaa.gov/stories2008/20080115_warmest.html)
- Penn State (Internet at:)
- Zou, Li, Scott Miller, and Edward Schmidtmann. Mosquito Larval Habitat Mapping Using Remote Sensing and GIS: Implications of Coalbed Methane Development and West Nile Virus. 2006. Journal of Medical Entomology. 2006 Entomological Society of America
- Transmission Cycle Image (Internet at:**www.co.wayne.nc.us/departments/health/eh/WNV.asp**)

Questions

WHAT DO YOU THINK?



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