

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

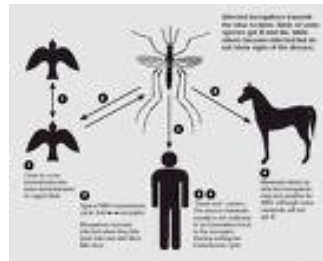


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GIS II WINTER 2008

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 et al 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 et al 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

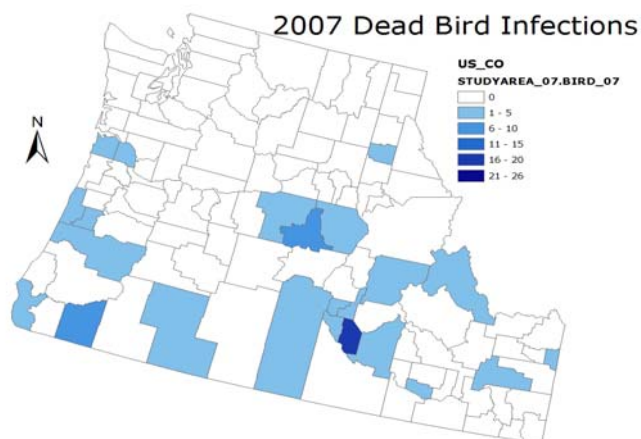
Statistical Analysis

- 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

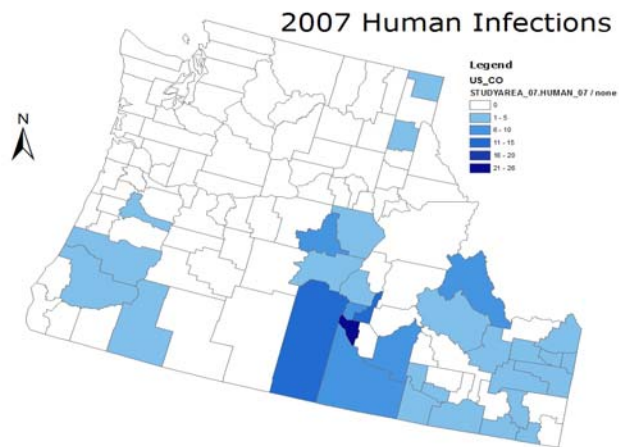
Total Infections for 2007

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

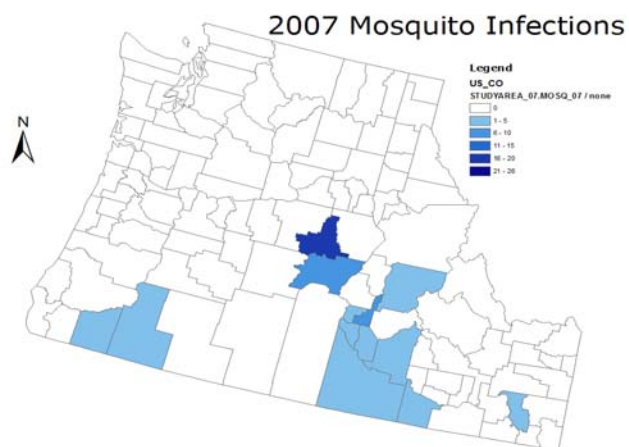
Dead Bird Infections



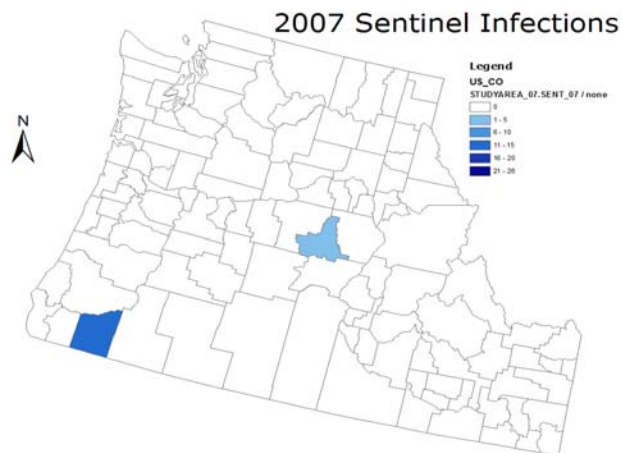
2007 Human Infections



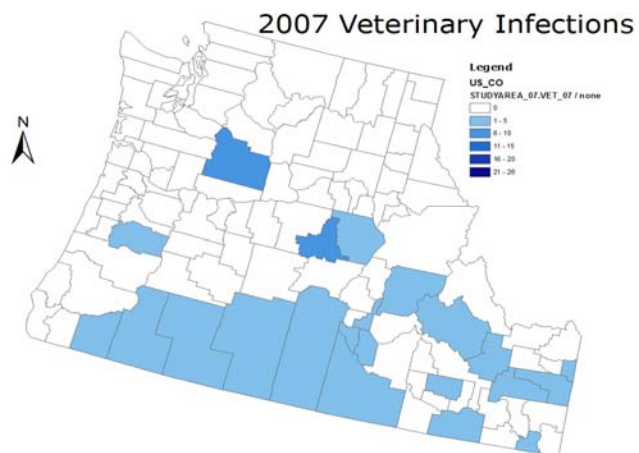
2007 Mosquito Infections



2007 Sentinel Infections



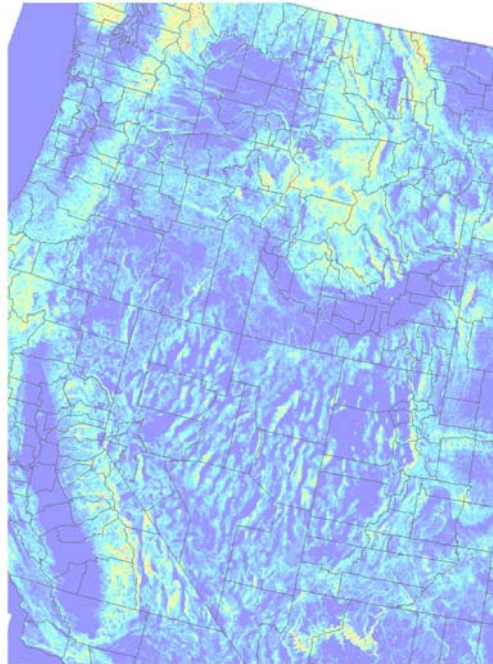
2007 Veterinary Infections



DEM: Slope 1-5 %

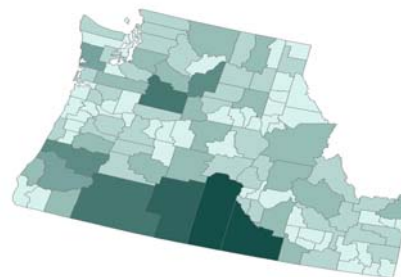
Legend

0 - 1.670101689
1.67010169 - 4.342264392
4.342264393 - 7.682467771
7.682467772 - 11.02267115
11.02267116 - 14.36287453
14.36287454 - 18.03709825
18.03709826 - 22.37936264
22.37936265 - 28.05770838
28.05770839 - 51.77315237
51.77315238 - 85.17518616



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% likelihood 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

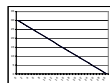
Interpreting Correlation Results

- How the function is derived:

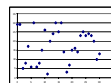
$$\text{Correl}(X, Y) = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}}$$

- Values range between

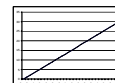
-1



random

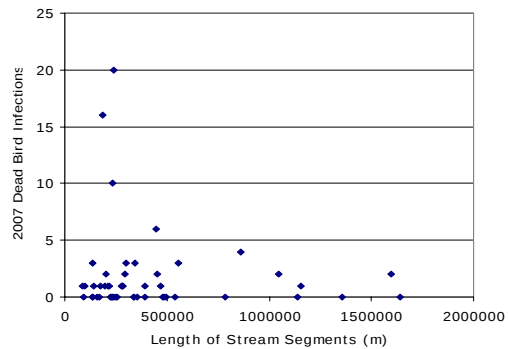


+1



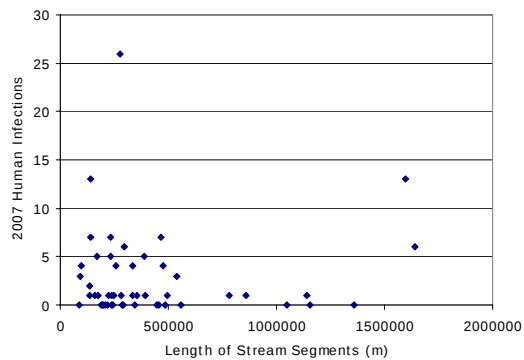
Dead Bird & Stream Length Correlation Results

Correlation:
-0.0104271
-not correlated,
random
r-value: 0.010872



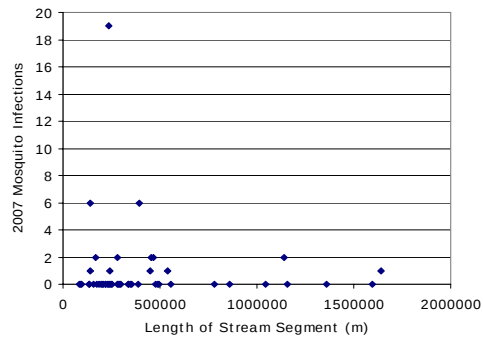
Human & Population Density Correlation Results

Correlation:
0.058988
-not correlated,
random
r-value: 0.00348



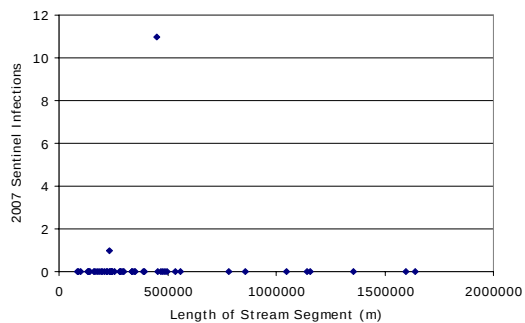
Mosquito & Stream Length Correlation Results

Correlation:
-0.0737
-not correlated,
random
r-value: 0.008432



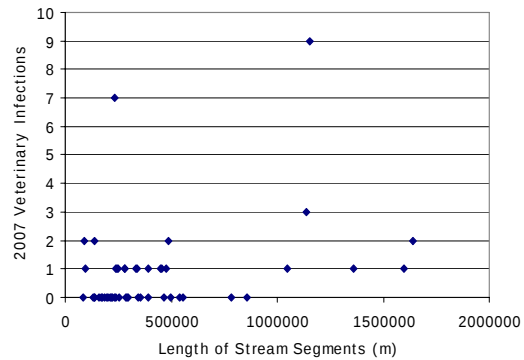
Sentinel & Stream Length Correlation Results

Correlation:
0.001574
-not correlated,
random
r-value:
 2.47609×10^{-6}

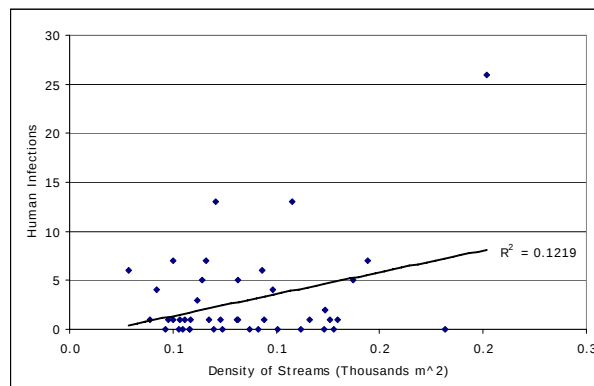


Veterinary & Stream Length Correlation Results

Correlation:
0.327453
-not correlated,
random
r-value:
0.107225149

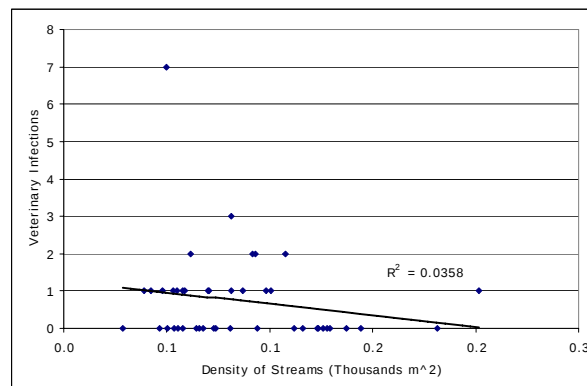


Human Infections & Density of Streams

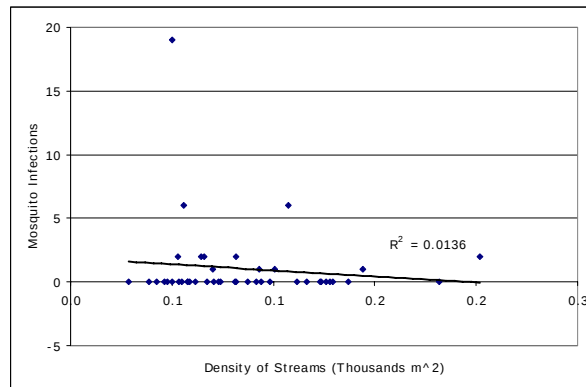


A scatter plot showing the relationship between Bird Infections (Y-axis) and Density of Streams (Thousands m²) (X-axis). The Y-axis ranges from 0 to 25 with major ticks every 5 units. The X-axis ranges from 0.0 to 0.3 with major ticks every 0.1 units. The data points are represented by blue diamonds. A horizontal regression line is shown with $R^2 = 5E-05$, indicating a very weak correlation.

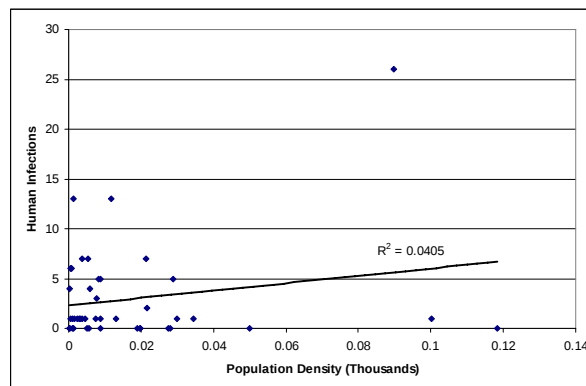
Density of Streams (Thousands m ²)	Bird Infections
0.05	3
0.06	1
0.07	1
0.08	1
0.09	1
0.10	1
0.10	10
0.11	1
0.12	1
0.12	6
0.13	1
0.14	4
0.15	1
0.16	3
0.17	1
0.18	2
0.19	1
0.20	1
0.21	1
0.22	2
0.23	1
0.24	2
0.25	1
0.26	1
0.27	1
0.28	1
0.29	1
0.30	1
0.31	1
0.32	1
0.33	1
0.34	1
0.35	1
0.36	1
0.37	1
0.38	1
0.39	1
0.40	1
0.41	1
0.42	1
0.43	1
0.44	1
0.45	1
0.46	1
0.47	1
0.48	1
0.49	1
0.50	1
0.51	1
0.52	1
0.53	1
0.54	1
0.55	1
0.56	1
0.57	1
0.58	1
0.59	1
0.60	1
0.61	1
0.62	1
0.63	1
0.64	1
0.65	1
0.66	1
0.67	1
0.68	1
0.69	1
0.70	1
0.71	1
0.72	1
0.73	1
0.74	1
0.75	1
0.76	1
0.77	1
0.78	1
0.79	1
0.80	1
0.81	1
0.82	1
0.83	1
0.84	1
0.85	1
0.86	1
0.87	1
0.88	1
0.89	1
0.90	1
0.91	1
0.92	1
0.93	1
0.94	1
0.95	1
0.96	1
0.97	1
0.98	1
0.99	1
1.00	1
1.01	1
1.02	1
1.03	1
1.04	1
1.05	1
1.06	1
1.07	1
1.08	1
1.09	1
1.10	1
1.11	1
1.12	1
1.13	1
1.14	1
1.15	1
1.16	1
1.17	1
1.18	1
1.19	1
1.20	1
1.21	1
1.22	1
1.23	1
1.24	1
1.25	1
1.26	1
1.27	1
1.28	1
1.29	1
1.30	1
1.31	1
1.32	1
1.33	1
1.34	1
1.35	1
1.36	1
1.37	1
1.38	1
1.39	1
1.40	1
1.41	1
1.42	1
1.43	1
1.44	1
1.45	1
1.46	1
1.47	1
1.48	1
1.49	1
1.50	1
1.51	1
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1.64	1
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1.71	1
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1.73	1
1.74	1
1.75	1
1.76	1
1.77	1
1.78	1
1.79	1
1.80	1
1.81	1
1.82	1
1.83	1
1.84	1
1.85	1
1.86	1
1.87	1
1.88	1
1.89	1
1.90	1
1.91	1
1.92	1
1.93	1
1.94	1
1.95	1



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.noaa.gov/stories2008/20080115_warmest.html)
- Penn State (Internet at:)
- Zou, Li, Scott Miller, and Edward Schmidtman. 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?



THE END

