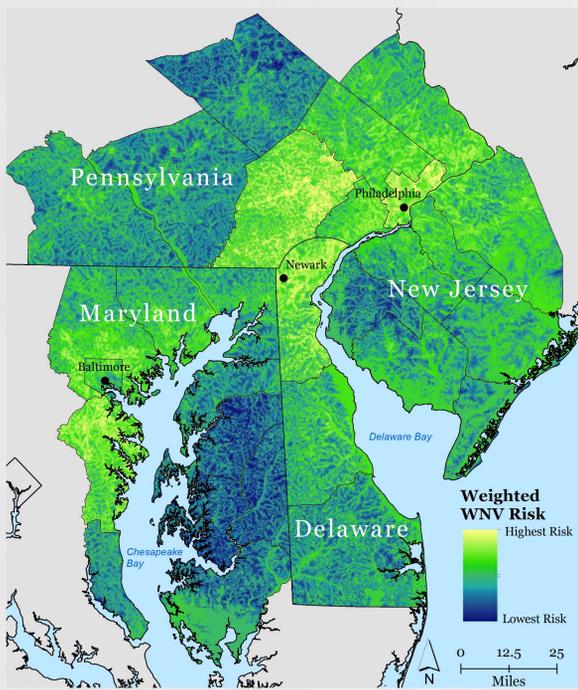


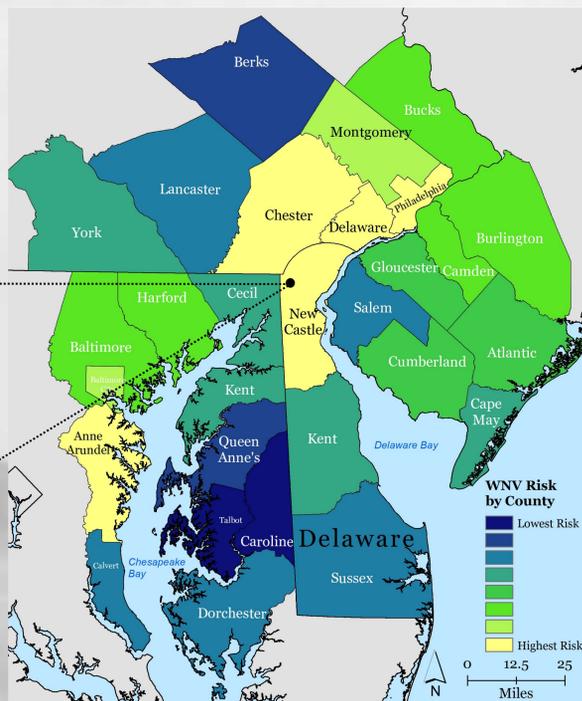
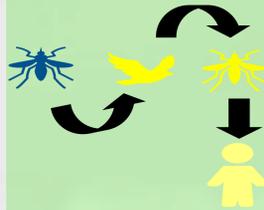
# Fowl Play:

## Using Avian Cases to Predict West Nile Virus Outbreaks in Chesapeake and Delaware Bay Areas



### West Nile Virus: A Constant Threat

West Nile Virus (WNV) is a zoonotic arbovirus that is spread by the *Culex pipens* mosquito. The virus first emerged in the United States in 1999, and has remained a significant problem since its emergence. Humans and most species of birds are both potential hosts for the virus through an infected mosquito bite. WNV causes severe neurologic symptoms in both birds and humans, and can be fatal if left untreated. Though not directly transmissible between hosts, uninfected mosquitos can transfer the virus from an infected bird and spread the pathogen to other susceptible individuals. Therefore, the location of bird cases is an important tool that can help determine where the next human outbreak may occur. In conjunction with other environmental and anthropogenic factors, this project utilized avian case data from Tri-State Bird Rescue in Newark, Delaware to predict potential risk in the areas surrounding Chesapeake and Delaware bays.



### Methodology:

To analyze the potential threat of WNV, the six parameters below were incorporated into a weighted risk calculation to identify areas of highest danger. These factors included environmental attributes that indicate suitable land for mosquito breeding, anthropogenic features that represent large human populations, and prior avian and human West Nile Virus cases. Certain factors, like human case number and proximity to water bodies, were weighted more heavily because they are stronger indicators of WNV suitable situations. The table below illustrates the benchmarks for each risk criteria.

Factors	1 (Low Risk)	2	3	4 (High Risk)	Weight
Proximity to Urban Areas (Meters)	Over 15 miles (24241-40320)	10-15 miles (16094-24240.9)	2-10 miles (3219-16093.9)	Under 2 miles (0-3218.9)	10%
Proximity to Water Bodies (Meters)	Over 1 mile (1610-5060)	0.5-1 mile (805-1609.9)	0.25 - 0.5 miles (403-804.9)	0-0.25 miles (0-402.9)	20%
Human Cases per County (2014-2017)	0-2	3-6	7-10	10-17	20%
Land Cover	Scrubland, Cultivated Crops, Pasture/Hay, Grassland/Herbaceous	Barren Land, Developed High Intensity	Developed Medium Intensity, Deciduous Evergreen, and Mixed Forest, Open Water	Wetlands, Developed Low Intensity, Developed Open Space,	20%
Population Density (per square meter)	0-1,500	1,501-4,500	4,501-12,100	12,101-16,3900	15%
Number of Bird Cases per County (2017-2018)	0	1-5	5-11	11-28	15%

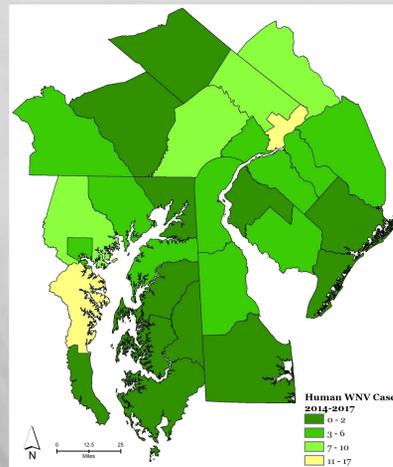
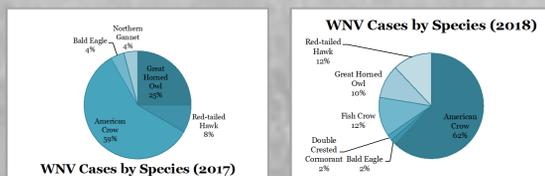


Tri-State Bird Rescue and Research is a non-profit wildlife rehabilitation facility located in Newark, Delaware. Staff at TSBRR have over fifty years of experience treating native birds, and annually see over 3,000 avian patients suffering from illnesses and injuries.

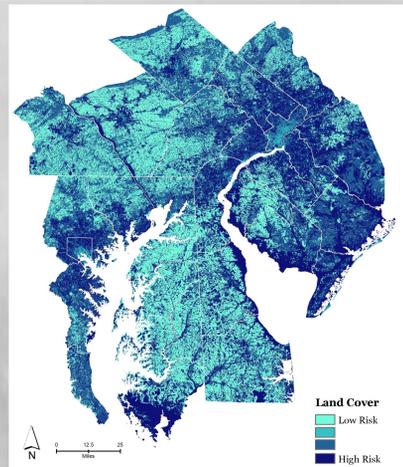
### Results and Conclusions:

The completed weighted raster map indicated WNV risk for smaller, specific locations throughout the study area. This gives a more detailed view of specific regions that are particularly susceptible. The second map shown compiles all of the data to give a representative average risk score on the county level. Areas with yellow coloration on both maps indicate the highest risk of future mosquito prevalence and potential WNV outbreaks. Although multiple species were found with WNV, the majority of avian cases were found to be American crows and great horned owls.

Lowest Risk Counties	Highest Risk Counties
Talbot (MD)	Philadelphia (PA)
Caroline (MD)	Chester (PA)
Queen Anne's (MD)	Anne Arundel (MD)
Berks (PA)	New Castle (DE)



Human WNV cases were gathered from the Center for Disease Control and compiled to show the number of human cases diagnosed and reported between 2015 and 2017 by county.

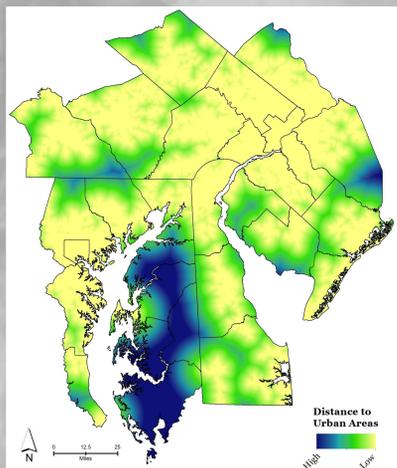


Land cover was analyzed for the suitability of mosquitos to reproduce and thrive in the environment. Wetlands and low density urban development were two of the highest risk factor, while pasture and shrub lands had the lowest risk of mosquito colonization.

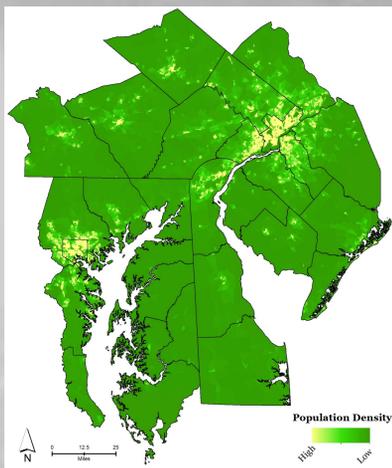
**Kristen Bishop**  
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MCM 591: GIS for Conservation Medicine

**Projection:**  
NAD 1983 CORS96 UTM  
Zone 18N

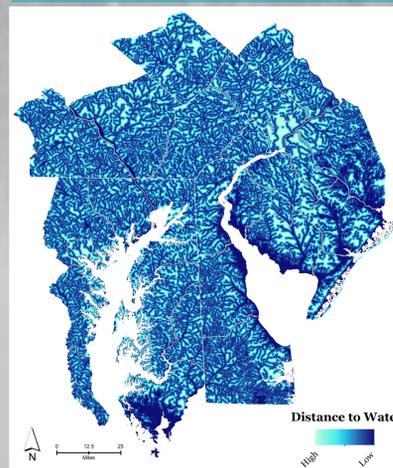
Data Sources:  
Tri-state Bird Rescue and Research  
CDC, USFWS National Wetlands Inventory, Arcmap Online, ESRI Datamap 10, Data.gov



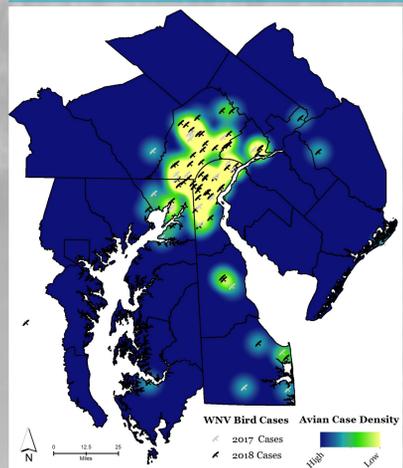
Mosquitos are more likely to exist and reproduce in urbanized and residential areas, therefore Euclidean distance was used to determine locations closest to developed spaces.



Areas of high human population density have been proven to have a greater chance of WNV incidence. Population density was measured at the census block group level, and kernel density was used to determine the groupings of highest density areas.



Mosquitos require water to lay their eggs, so areas that are in close proximity to water bodies are at higher risk than those that are not. *Culex* mosquitos utilize both salt and fresh water, so oceans and bays were included in this analysis.



Avian cases were collected from TSBRR's patient records. Each point represents the location that a WNV-positive or suspected bird was found by a local citizen. Kernel density was then used to determine areas with the highest number of cases.



Tufts University Cummings School of Veterinary Medicine

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