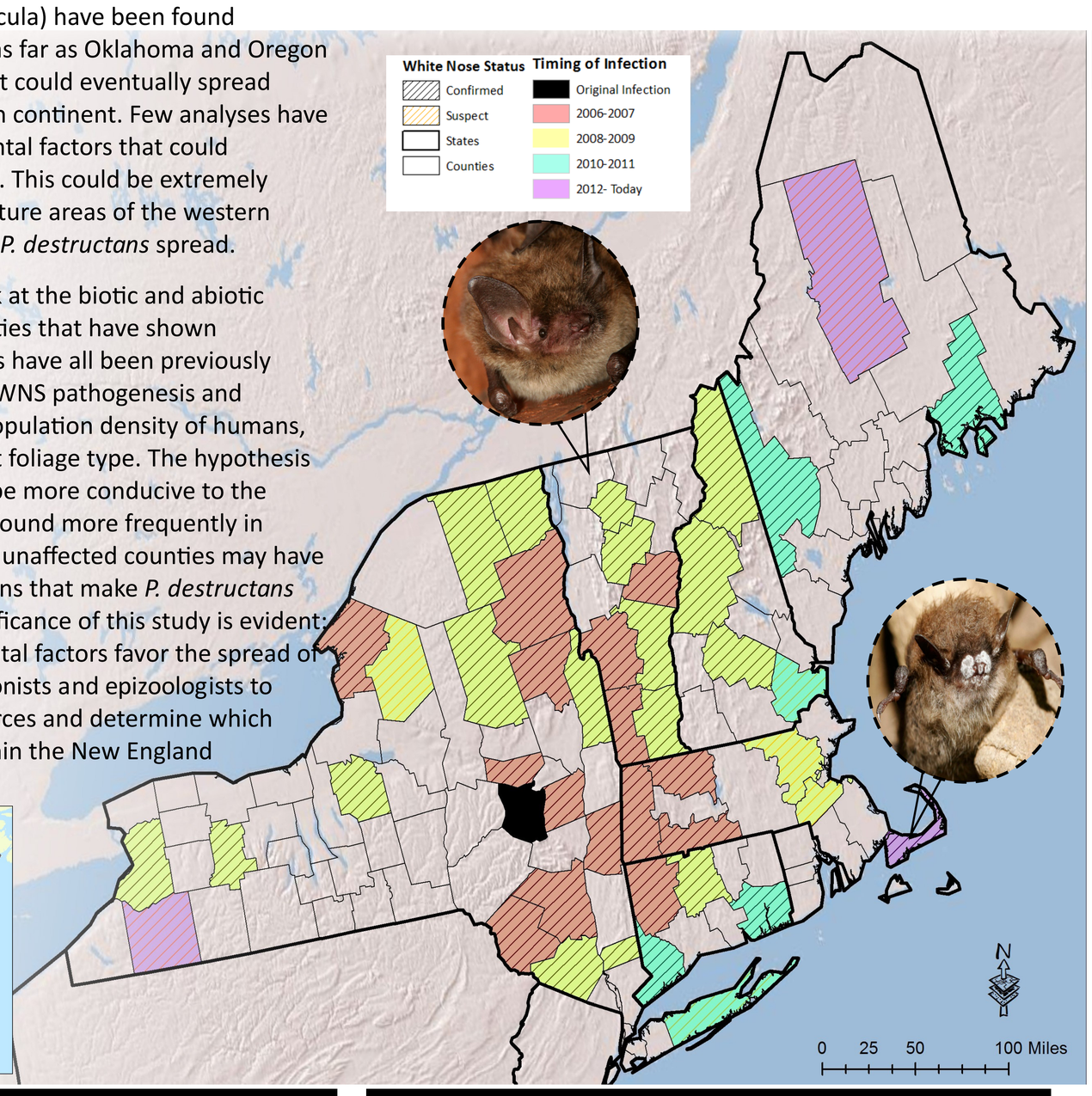
WEAPONS OF MASS *DESTRUCTANS*

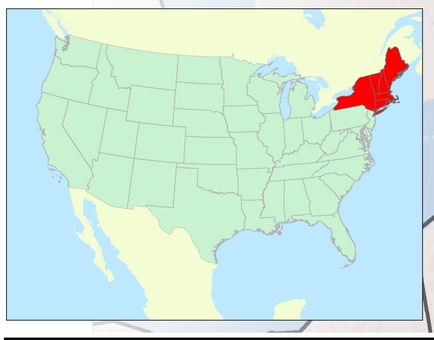
Can Environmental Factors predict White Nose Syndrome Infection in New England Bats?

Introduction

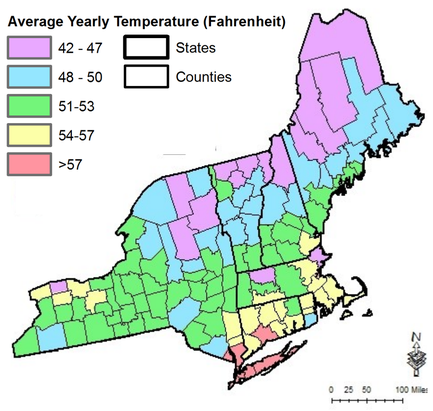
White-Nose Syndrome (WNS) is an infectious fungal disease of bat colonies that is caused by the fungus *Pseudogymnoascus destructans*. Since the introduction of *P. destructans* to New York State in 2006, it has caused massive mortality events in cave-nesting North American microbat colonies, sometimes exceeding 95%. Infection with *P. destructans* causes a white fungal growth on the noses, ears, and muzzles of hibernating bat, as well as a reduction of bat fat and early arousal from hibernation. WNS is an important issue for wildlife conservation, due mainly to the fears that it could continue to spread and impact bat populations that are already threatened by habitat destruction, hunting by invasive species, human disturbance during hibernation, and climate change. Since 2006, infected colonies (hibernacula) have been found continually westward, reaching as far as Oklahoma and Oregon in 2015, giving rise to fears that it could eventually spread across the entire North American continent. Few analyses have looked at large-scale environmental factors that could contribute to the spread of WNS. This could be extremely important for predicting what future areas of the western United States are most at risk of *P. destructans* spread.

This study will use ArcGIS to look at the biotic and abiotic conditions in New England counties that have shown incidences of WNS. These factors have all been previously identified to be associated with WNS pathogenesis and include: rainfall, temperature, population density of humans, average elevation, and dominant foliage type. The hypothesis is that certain conditions might be more conducive to the spread of WNS and will thus be found more frequently in affected counties. As a corollary, unaffected counties may have different environmental conditions that make *P. destructans* introduction less likely. The significance of this study is evident: understanding what environmental factors favor the spread of *P. destructans* allows conservationists and epizoologists to figure out how to allocate resources and determine which hibernacula are most at risk within the New England Region.



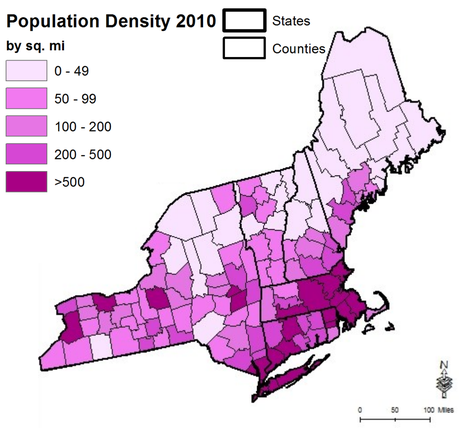


Average Annual Temperature



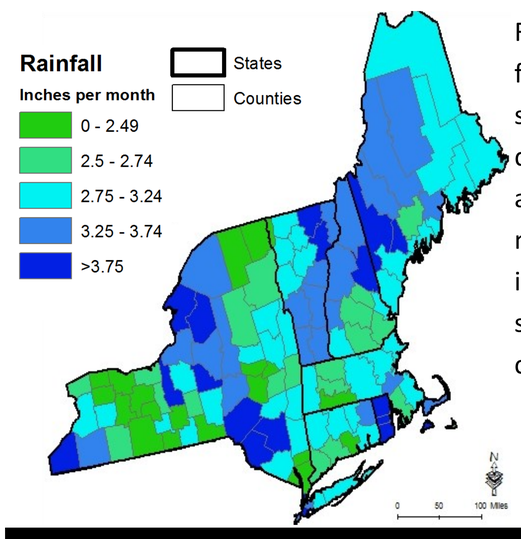
Temperature data for New England (2015) was obtained and geo-referenced from High Plains Regional Climate Center. The average annual temperature for each county was determined and reclassified.

Human Population Density



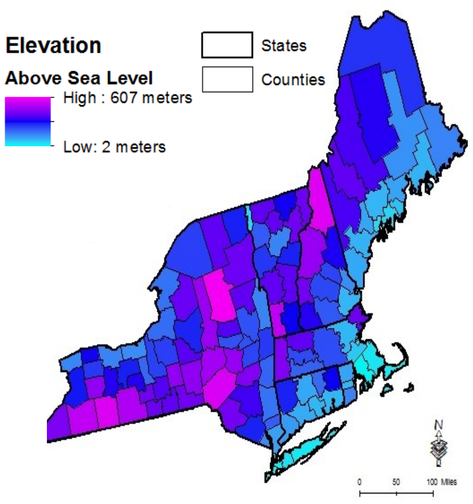
Census data by county (2010) was downloaded from census.gov and clipped to New England. The population density was calculated per square mile per county and symbolized to show varying degrees of density.

Average Rainfall per Month



Rainfall data from NOAA for New England weather stations (2016) was downloaded and averaged. Over 11 months. The data were interpolated and then summarized at the county level.

Elevation



Elevation DEM raster data (120m x 120m cells) for the United States was downloaded from USGS and clipped to New England. Zonal statistics were calculated to determine the average elevation on the county level.

Cartographer Information

Cartographer: Lucas Stegman

Completed: 16 December 2016

Course: MCM 591: GIS for Conservation Medicine

Projection: USA Albers Equal Area Conical

Data Sources: ESRI Datamaps 10; Tufts University M Drive. United States Census 2016; Tiger Lines. Bat Conservation International, Pennsylvania Game Commission, A. Hartman; *Spread of White Nose Syndrome in North American Bats;* 2015. NLCD; 2011. NOAA; National Centers for Environmental Information; Custom Global Summary of the Month 2016. High Plains Regional Climate Center (HRPCC); *Provisional Data*; 2016.

Image Sources: Vectorpatterns.co/uk (banner), Fordham University (WNS bat), ClipArt Panda (Cutout Bat), Bat-worlds.com (Healthy Bat)

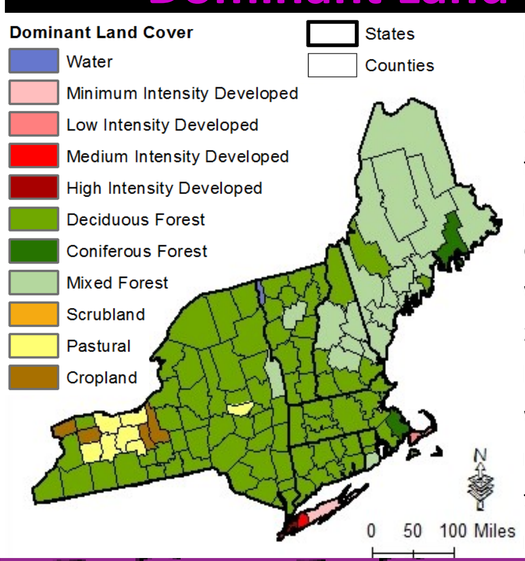
Methodology

Data from the Pennsylvania Game Commission on the epidemiology of WNS was downloaded and symbolized to show different years of infection as well as status of the infection. The presence of WNS in each county was used as the dependent variable in an Ordinary Least Squares (OLS) Regression with average county temperature, population density, rainfall, and elevation as independent variables. Counties with suspected WNS were excluded.

Regression Results

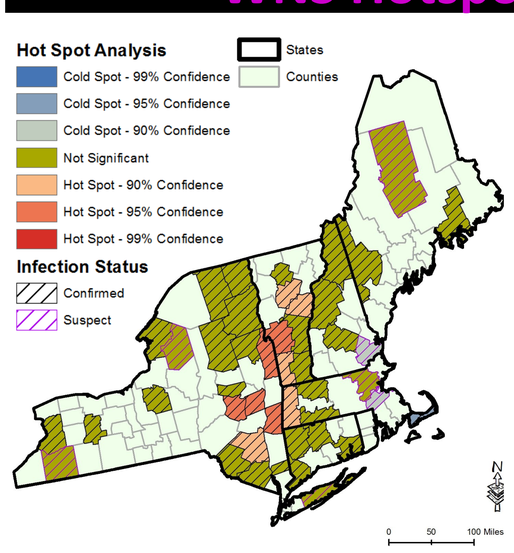
Variable	Beta Coefficient	P Value	Adjusted R^2
Population Density	-0.000005	0.525	---
Precipitation	-0.023	0.713	---
Elevation	0.00074	0.0043**	---
Temperature	-0.0016	0.640	---
Unified Model	---	0.038*	0.048

Dominant Land Cover



Land Cover raster data (30m x 30m cells, 2011) was obtained from the NLCD. The most abundant land cover type by county was determined using zonal statistics. Dominant land cover was excluded from the regression analysis due to the categorical nature of the data.

WNS Hotspots



An Ord's Gi Hot Spot analysis was performed on the Pennsylvania Game Commission data in order to determine hot spots and cold spots. Both suspected and confirmed cases were included for this analysis.

Conclusions

The results of this analysis suggest that there is no way to consistently predict WNS infection by environmental factors on the county level. Of the measured variables, only higher altitudes showed any significant correlation with WNS infection. Additionally, there to be a moderate preference for cases that occur in deciduous forest , though this is likely an artifact of the prevalence of deciduous forest in New England. This analysis would likely have been more conclusive if data on individual WNS -infected hibernacula had been available instead of Boolean county data, as this would have allowed a far more in-depth and higher-resolution study. Summarizing variables like elevation on a county scale is less than ideally meaningful.