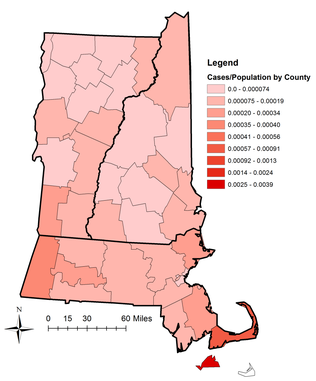
Lyme Disease Outbreak in New England: A Spatial Analysis for Future Risk

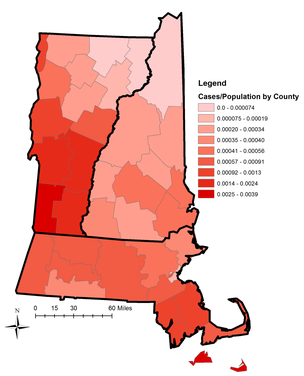
INTRODUCTION

Lyme disease is the most commonly reported vector-borne disease worldwide (Donohoe, Pennington-Gray & Omodior, 2015). This disease is most prevalent in the Northeastern United States and is transmitted by a bacterium carried by ticks. However, since the year 2000 the number of reported cases has increased in many states where the disease is commonly transmitted. The reason for the uptick in cases of Lyme disease is speculated but largely unknown, part of the difficulty in finding answers to this question results from the diversity of the area in which Lyme disease is found and lack of data. This study aimed to determine why is there such an increase in cases of Lyme Disease in the Northeast region of the United States compared to other areas, with a specific focus on Massachusetts, Vermont and New Hampshire due to the variety in weather as well as land composition among these states. This project maps several variables thought to be linked to risk of Lyme disease over a fifteen year time span in order to generate a map detailing areas at greatest risk for an uptick in Lyme disease cases within the next five years.

LYME CASES 2000



LYME CASES 2015



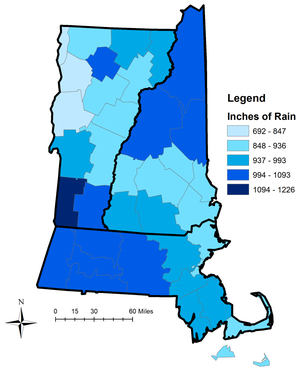
METHODS

First I created maps depicting number of reported cases of Lyme in each county in Vermont, New Hampshire and Massachusetts for 2000 and 2015 normalized by the population in each county for each of these time points. After creating these images, to assess the effect of hypothesized variables on reported cases of Lyme, maps were created depicting each variable in the year 2000 and the year 2015. The variables of interest in this study were: air temperature, rainfall and type of land use. After maps for each variable were created I made a risk indicator raster by combining data from 2015 for all variables, converting each layer into a raster, and then reclassifying each variable on a scale of 0-3 (detailed in the table below).

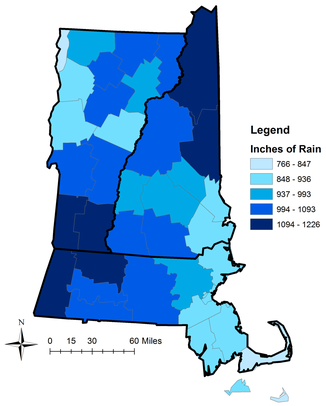
Table 1. Determining risk level

Factor	0-No Risk	1-Low Risk	2-Moderate Risk	3-High Risk
Land use	Other	Developed	Water	Forest
Precipitation (inches of rain/ year)	692 - 856	857 - 934	935 - 990	991 - 1116
Air temperature (°C)	5.4 - 6.1	6.11 - 7.4	7.41 - 9.6	9.61 - 12.7

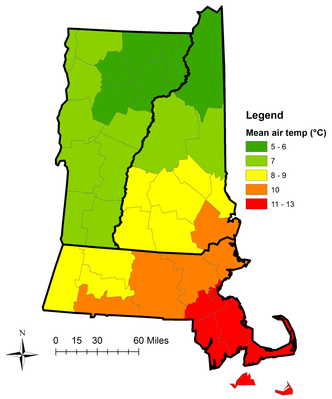
PRECIPITATION 2000



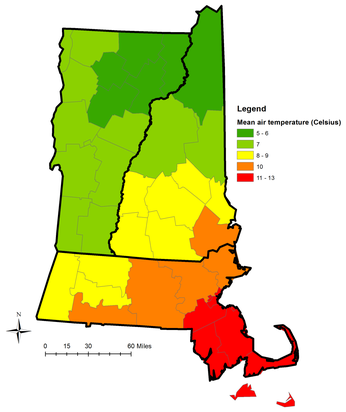
PRECIPITATION 2015



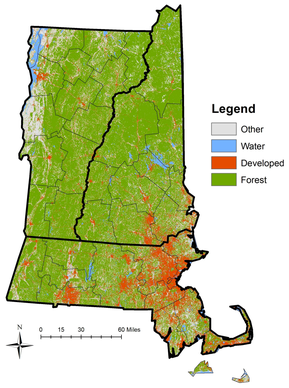
AIR TEMPERATURE 2000



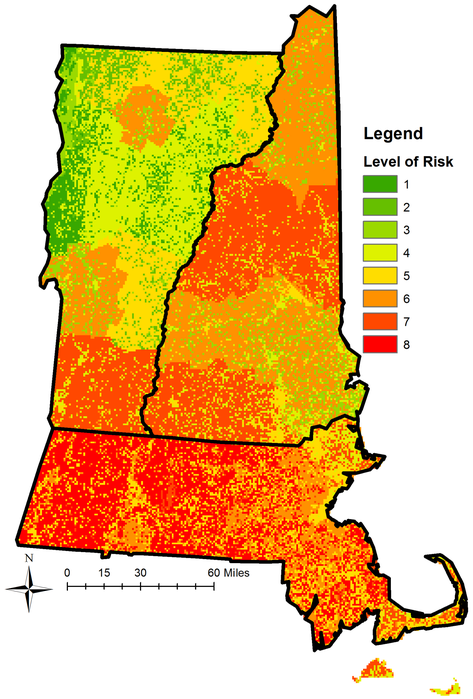
AIR TEMPERATURE 2015



LAND USE



RISK ANALYSIS FOR 2020



RESULTS AND CONCLUSIONS

This study revealed interesting and surprising trends when analyzing these variables in a fifteen year interval. While precipitation increased in this interval, air temperature was relatively stable, but Lyme cases drastically increased. When combined with land use data, the combined raster indicates high level of risk in many parts of the study area, which may be due to the size of the spatial unit (county) for most variables. Massachusetts appears to be most at risk in the future, which matches the trends in the past fifteen years. However, there were limitations to this study, one of which being limited data. I could only find land use data from the year 2005 and I could not find data relating to the biologic vectors of the disease (mouse and deer) which are known to be more reliable predictors of disease outbreak. Additionally, by comparing only two years in my analysis I was unable to determine if there were outbreaks at other periods of time or see a clear pattern over the fifteen year span. Based on this study, future work could be done to precisely locate areas deemed at the highest level of risk, and analyze other factors that might make these areas particularly susceptible.

SOURCES

Cartographer: Valerie Willocq

Class: GIS 101 Intro to Geographic Information Systems Spring 2017
Date: May 9, 2017
Data sources: Center for Disease Control (CDC), Mass GIS, Tufts GIS M Drive, 5 Year ACS Estimate, US Census Bureau, NCAR GIS Program. 2012. Climate Change Scenarios, version 2.0.
Projection: Transverse Mercator
Coordinate System: WGS1984 UTM Zone 19N
References:

Donohoe, H., Pennington-Gray, L., Omodior, O. (2015). Lyme disease: Current issues, implications, and recommendations for tourism management

Image: https://commons.wikimedia.org/

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