Influence of Tree Density Upon the Spatial Distribution of Mosquito Populations

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Abstract

Mosquitoes are vectors for pathogens such as West Nile Virus, Dengue (DV), Zika (ZIKV), and Malaria. Determining the abiotic factors that contribute to the spread of these diseases and the conditions under which mosquito habitats thrive are essential to mitigating mosquito populations and mosquitos as a public health threat. This study aims to assess the effect of tree density and tree concentration on mosquito populations and the correlation between tree density and mosquito species composition. Using photos collected from NASA Globe Observer, we investigated three different three by three-kilometer areas of interests representing various ecological settings within the surrounding Houston, Texas area. These photos were then analyzed using a GitHub program that assessed both tree number and density within each area. This data was then compared to a representative mosquito population dataset from GBIF and ARCGIS database. From this data, we found no clear correlation between either tree density or concentration with mosquito populations.

Introduction

Throughout the world, mosquitos pose an ongoing threat to public health, and with the spread of often deadly vector-borne diseases that these insects carry, it is important to determine the conditions in which mosquitos thrive. As mosquitos need sources of moisture to lay eggs and often search out areas of shade for breeding, such as holes in tree trunks, forested areas are ideal spaces for mosquito reproduction. One aim of this project was to identify the effects of tree density on mosquito populations, as well as the density at which these populations begin to waver, using Houston, Texas as a case study. Due to Houston's subtropical climate, characterized by warm and humid summers, as well as the city's large populations of disease carrying mosquitoes such as Aedes Aegyptii and Asian Tiger Mosquitos, Houston presents itself to be an ideal environment for mosquito breeding and the spread of vector borne illnesses. Using Houston, Texas as our model, we can identify the relationship between tree density and tree concentration with mosquito populations and help inform citizens of their relative risk to vector borne diseases and due to high mosquito populations. We hypothesize that an increase in tree density will lead to an increase in mosquito populations.

Materials

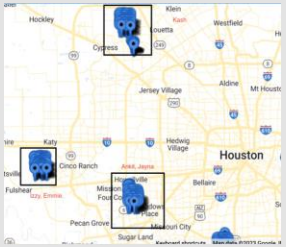
GLOBE is an international science and education program that focuses on promoting scientific literacy and building connections between people passionate about the environment. Mosquito Habitat Mapper is an extension of GLOBE Observer that allows users to submit their own mosquito larvae findings.

ArcGIS Online is a cloud-based mapping and analysis solution. It is used to make maps, analyze data, share with others, and collaborate.

GitHub is a cloud-based software development service, that allows users to create and store code.

Methodology

This research was performed by gathering 500 preliminary pictures of land cover data around three areas of interest in Houston, Texas, of which included the following neighborhoods: Cypress, Fulshear, and Meadows Place. These photos were then uploaded to a GitHub program that analyzed land cover imagery and generated graphs depicting the tree densities of these areas and the average distance between trees in each location. This data was then compared with mosquito population data from citizen science databases, including ARCGIS and GBIF, in order to determine the level of correlation between tree density mosquito population in each area.



Results

Figure A

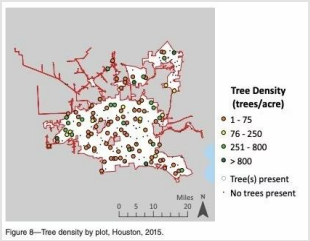
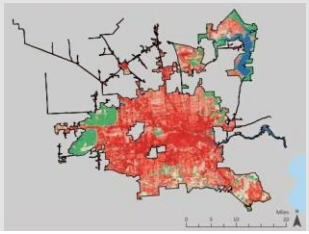


Figure 8—Tree density by plot, Houston, 2015.

Figure B



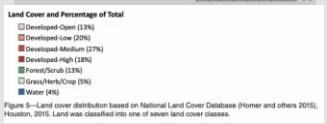
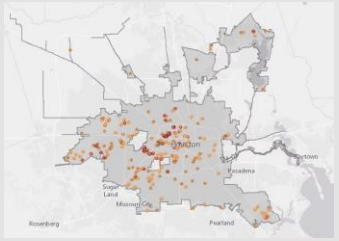


Figure 5—Land cover distribution based on National Land Cover Database (Homer and others 2015), Houston, 2015. Land was classified into one of seven land cover classes.

Figure C



Conclusions

These three graphs show the concentrations of different entities in the Houston area. Figure A shows the tree density throughout the area, Figure B shows the land cover percentages and urbanization, and Figure C shows the mosquito density within Houston. Figure A and Figure B are somewhat opposites because in places where urbanization is high, it usually means that the tree density is lower. In Figure C, it is also clear that there are more mosquitoes in the center of the metroplex, which is where there are more people to act as a vector for disease spread. By comparing these graphs with each other, it becomes very clear that there are more mosquitoes in places where the tree density is lower and the urbanization is higher. This completely contradicts our hypothesis. There are many explanations for this but the one that makes the most sense is that mosquitoes are more abundant in places where there are more people as disease vectors. And more people are located in the most urbanized areas, which is usually in the middle of the city and in places where construction has prohibited the growth of trees. Therefore, our conclusion is not that less trees leads to more mosquitoes, but that increased urbanization leads to more mosquitoes. And a side effect of that increased urbanization is a decrease in trees.

Discussion

From this data, it can de determined that there is both a positive correlation between urbanization and mosquitoes, and a negative correlation between tree density and mosquitoes.
This data can be used in determining which locations are at the highest risk for mosquito borne illnesses. Places with high levels of urbanization are more likely to host more significant mosquito populations, and thus the citizens of these areas are at higher risk.
In the future, this experiment can be expanded by choosing different locations with more points (I.e. six locations in the Las Vegas area). The points of landcover could then be analyzed in a similar process to determine results. We could then cross reference this data to our current data to see if it is similar. This data refutes the previous hypothesis where it was predicted that the higher the tree density, the higher the mosquito population.

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