Exploring Bird Diversity with Urban Trees

California Polytechnic State University: Data Science Capstone Project
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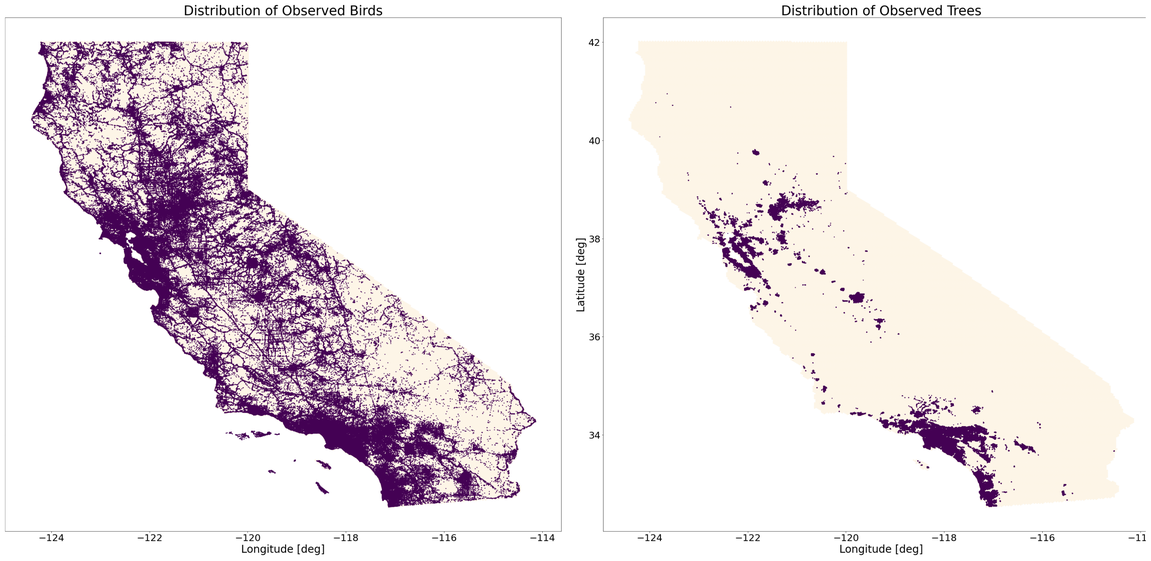


Distribution of our Tree and Bird Datasets. The tree dataset only contains observations of urban trees (street trees). Our bird dataset is a collaborative citizen science dataset of bird spotting's in California from Cornell's eBird Observation Dataset.

Relationship between urban trees and bird diversity

Introduction

Urbanization is driving diversity loss through the destruction and removal of the natural environment. Urban areas are also habitats for a wide range of plant and animal species. For example, cities harbor at least 20% of all known bird species (Aronson et al., 2014). However, many bird species commonly found in California have suffered steep population declines, as much as 96%, due in large part to diminishing tree habitats (Williams, 2007). Fortunately, there is an increasing public demand for eco-friendly urban planning in the form of street trees. Successfully understanding the relationship between urban trees and birds will yield insights for better incorporating trees into urban planning throughout California.

Environments

In order to consider urban tree and bird diversity, we must choose some form of spatial aggregation to represent an environment. City and county lines won't work because we need equally sized environments for them to be comparable. We created a grid of equally sized hexagons over California to represent environments

Diversity Measures

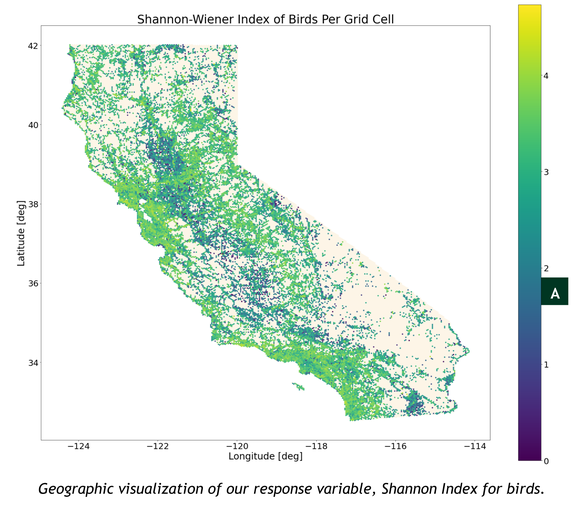
First, we need to quantify the diversity in each of our grid cells. There were three different measures that we worked with: Richness, Evenness, and Shannon-Wiener.

One of the simplest measures is Richness, which is just the total count of unique species in a grid cell. However, another component of diversity is how evenly distributed the individuals are to each species. Therefore, we calculated Evenness, which quantifies the balance between species in a grid cell. Finally, we calculated the Shannon-Wiener index, which takes into account both richness and evenness. Increasing either richness or evenness will increase Shannon-Wiener, and the highest values of Shannon-Wiener occur when both richness and evenness are high.

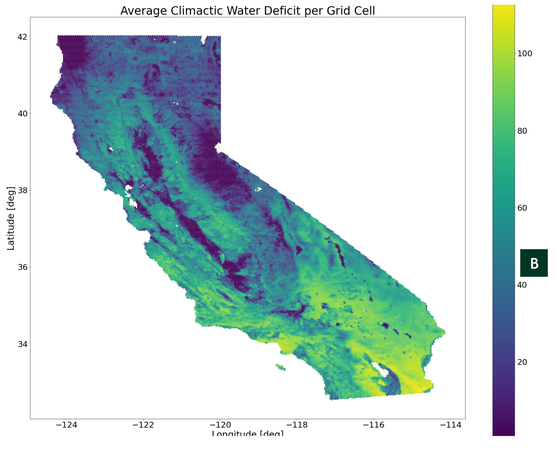
Variables

In order to really try to understand bird diversity, we'd need to consider any variable that may have an effect on bird diversity.

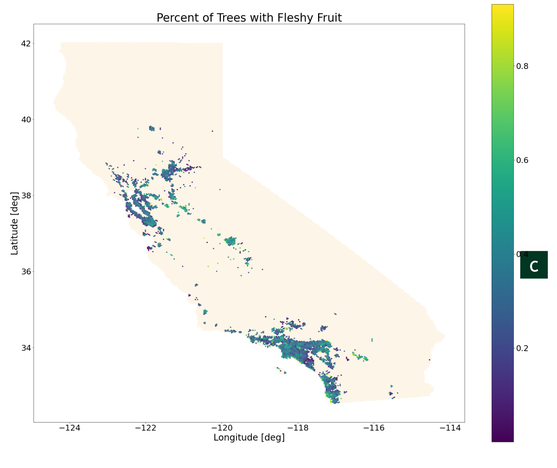
The first variables that we already calculated are bird diversity as the response variable and tree diversity for some explanatory variables. We are also interested how different kinds of trees effect bird diversity. Therefore, we considered tree attributes like average tree height, average tree width, foliage type, fruit types, the percent of trees that are native to California, etc. We also calculate the human population per hexagon to try to adjust for sampling bias. Finally, we calculated some climate variables like temperature and climatic water deficit. In total we had 28 explanatory variables, with a few visualized to the right.



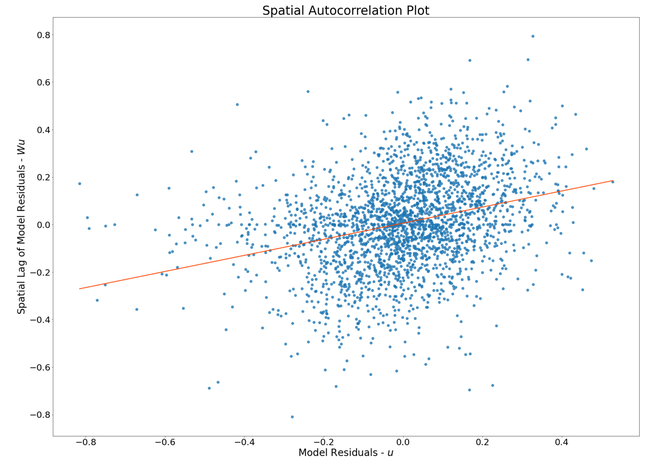
Geographic visualization of our response variable, Shannon Index for birds.



Above shows the average climactic water deficit per grid cell, one of our climate explanatory variables.

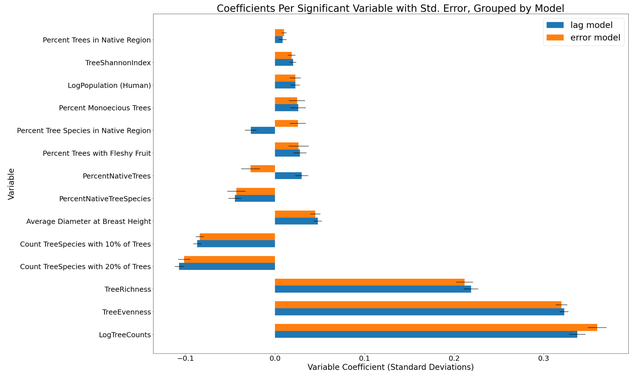


Below shows the percent of trees with fleshy fruit.



Spatial Modeling

With Linear Regression, one of the assumptions is independence. However, with our spatial data, any hexagon is likely to be correlated to its neighbors, violating that assumption, which can be seen in the spatial correlation plot above. Therefore, we used two spatial models, spatial lag and spatial error, which account for the spatial dependence in the data. With those, our inferences will be more reliable. Below we have plotted the variables that were significant in both models, sorted ascending by the magnitude of the coefficients. We standardized all the variables, so the coefficients are comparable.



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3 Williams, A. (2007, June 15). *Study finds huge decreases in bird populations.* Los Angeles Times. Retrieved April 28, 2022, from https://www.latimes.com/local/obituaries/la-me-birds15jun15-story.html