ADAPTING CITIZEN SCIENCE DATA FOR USE IN GIS: SPECIES RICHNESS MODELS OF BIRDS IN CALIFORNIA

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Introduction

Citizen science is a growing field that allows hobbyists, professionals, and researchers to connect and share data about the topics they enjoy. Large datasets can be put together through carefully planned organizational events such as the National Audubon Society's Annual Christmas Bird Count (CBC). The CBC has been using continually evolving field protocols to create and maintain a database of that goes back 115 years, and contains a wealth of knowledge about birds in the United States and abroad. In California, nearly 160 locations are involved in the count, which takes place throughout December and into January. California host a large number of habitats and is in the path of the Pacific Flyway, a major migratory route. Fluctuations in climate such as the El Niño also effect birds species in California, especially along the coastline. This project looks into the ways that the citizen science datasets collected by the National Audubon Society an be interpreted from the spreadsheet form that they are dispersed in, to useful and aesthetic visualizations such as maps.

Figure 1. *Example of a Christmas Bird Count radius used by the National Audubon Society's Colorado Springs chapter. Similar maps are used at each center point to divide individual groups into smaller sections where those involved in can cover as much area as possible without overlapping. (https://sites.google.com/site/cscbcmaps/)*

Data and Data Sources

The data that was used in this project was chosen to best fit the geographic region of California while incorporating free, open source information about birds and species richness. Data sets that added context such as climate data and rainfall amounts were also added.

Table 1. *List of data and data sources used in the project*

Data	Sources
Location of bird-count center points	Audubon Christmas Bird Count Data Page http://netapp.audubon.org/cbcobservation/
El Niño Data	National Oceanic and Atmospheric Administration http://www.elnino.noaa.gov/
Species Count Totals	Audubon Christmas Bird Count Data Page www.audubon.org/science/christmas-bird-count
State Zones	California Department of Fish and Wildlife https://www.wildlife.ca.gov/Regions
Rainfall Totals	National Oceanic and Atmospheric Administration http://www.cnrfc.noaa.gov/rainfall_data.php

Timeline

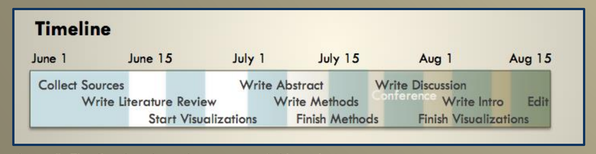

Figure 2. *Timeline that shows the progress of this project.*

Methodology

This project used data from Christmas Bird Count spreadsheets to create visualizations that could be used for an analysis of avian species richness in California. First, data from the source (the National Audubon Society) was made into a feature class with a spatial component containing the center point where the bird count began. The amount of birds seen at each location was used as an attribute, and the data was assigned to each of the years it represented (2004, 2009, and 2014). After the feature class was completed, data were converted into a raster through Kriging interpolation. Results of the Kriging provide an estimate of species richness that was visible across the entire state. Maps were made of the output. Kriging rasters were used in a raster calculation to show how change had occurred between 2004 and 2009, and between 2009 and 2014.

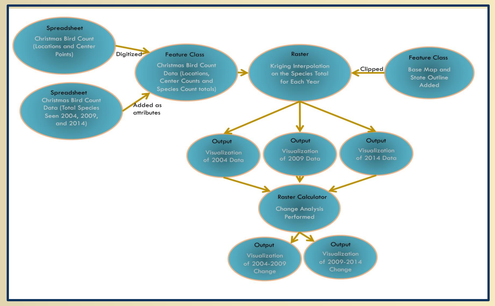

Figure 3. *Flow chart explaining the methodology used in this project.*

Figure 5A, 5B, and 5C. *Series of three maps that represent the estimated avian species richness across the state of California. Estimations were made with kriging interpolation.*

In maps A and B no areas with the highest classification range, (170 to 199), are visible, however in map C, areas with the highest classification occur along the north-central coastline. Map A represents the year that a positive El Niño was present and the rainfall along the coast was highest.

Figure 6A and 6B. *These maps show the change analysis between the years that the Kriging rasters represent (Figure 5). The change analysis maps make the movement of species more visually understandable and show that it is less static than the graph in Figure 4 portrays.*

The change analysis and Kriging rasters were clipped to the California boundary using the NAD 1983 California Teale Albers projection. The Kriging interpolation rasters symbolize species richness through six classifications ranging from 75-199 species. A sequential color scheme was applied to show the species richness densities, with the darkest color suggesting the higher amount of species seen. The change analysis rasters were symbolized with a divergent color scheme. Red was used to indicate a decrease in species richness and green indicating an increase. A graph was also created as an additional visualization tool. The graph uses parallel coordinates to show the averages of the six California Department of Fish and Wildlife zones, the coastal zone, a few specific areas, and the average of species richness throughout the state.

Results

The results of this project include a set of visualizations that can be used to understand species richness in California, and how it has changed. A graph (Figure 4) was used to show the average values for each of the California Department of Fish and Wildlife zones mapped. The graph also helps the reader see that although the averages changed only a small amount between the five year gaps, some specific locations such as at Mt. Shasta and Long Beach-El Dorado saw significant changes. Three maps were made that show the post-Kriging raster values that are specific to each year. An animation was made to show the change between these maps in a more interactive way. The 2004, 2009, and 2014 maps shows how species richness counts increase along the central and southern coastlines. The change analysis (Figure 6A and 6B) adds a visualization that shows areas of distinct increase and decrease in species richness.

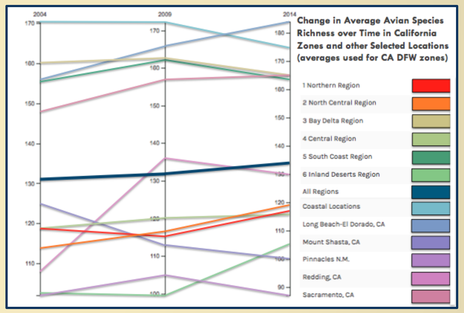

Figure 4. *Change in species richness between 2004, 2009, and 2014.*

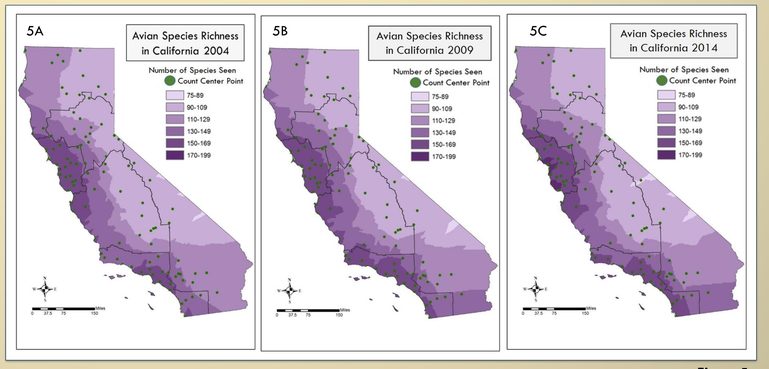

Figure 5.

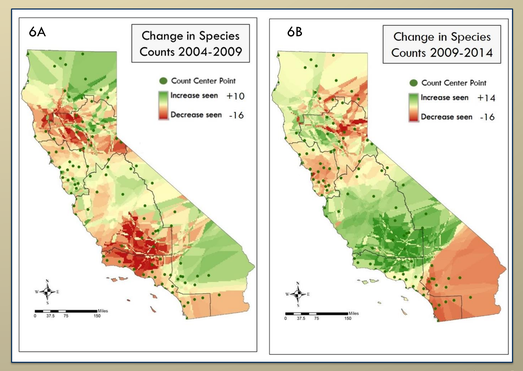

Figure 6.

Discussion

The visualizations created in combination with the tabular data shows that there was a variety of changes happening in avian species richness over the course of the ten years. Species richness averages throughout the state remained almost unchanged, increasing by only three species between 2004 and 2009 (Figure 4). Although those averages make the data seem static, the maps show a different story. There are dynamic variations visible in the change analysis that show a decrease in species richness in the Los Angeles area between 2004 and 2009 (Figure 6A). In comparison, the same geographic area shows a strong increase in the 2009 to 2014 analysis (Figure 6B). In the animation series that uses the three kriging rasters, the concentration of species increase along the coastline in 2009, and again in 2014 (Figure 5). The graph (Figure 4) collaborates the visual change seen in the maps which increased in average species in counts near the coastline from 170 to 175 over the ten year period. The visualizations also showed that years with increased rainfall from El Niño did not make a large difference, however, some decrease in species richness was seen along the coastline in the strongest year, 2004.

There are many ethical consideration related to this project. This includes understanding how the information provided by citizen science groups can be used with dishonerable intentions. Mapping out species richness and related information can expose species that are already vulnerable to hunting or illegal capture. Conversely, the information is intended to help the collectors of the data and researchers see trends and protect preservation areas that improve the chance of retaining healthy ecosystems throughout the state of California.

Conclusion

The work that was completed during the course of this project was influenced by a variety of internal and external factors. The data acquired from the National Audubon Society showed some areas that could be improved upon such as the way that data is disseminated. Currently, data is available one spread sheet at a time, and acquires extensive time to compile for an analysis.

The adaptation of the birding data for visualizations went well and could be improved upon by adding additional years analysis. These years would add a better flow to the animation. Doing so would also create a better visualization of the continuous change that is occurring in California avian species richness. Additionally, having data from the years directly before and after an El Niño event may be more useful for analyzing changes associated with its climate fluctuations.

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