

Memorandum To: Dr. Tom Neeson Associate Professor
Copied: Kevin Neal, Teachers Assistant
From: Matt Martin, Masters Student, Geography
Date: December 14, 2021

Subject: Spatial relationship of *Ictinia mississippiensis* to water bodies in North Carolina

Abstract

The focus of this project is investigating spatial trends in the observations of Mississippi Kites (*Ictinia mississippiensis*) in North Carolina. As a bird enthusiast, my inspiration for the paper came from personal interest in the unique and particular habits of birds. While driving across the state I have noticed Mississippi Kites in areas both associated and not associated with water bodies, seemingly favoring open areas. This observation correlates with some ornithology research suggesting that Kites enjoy open habitats both associated with water and not. The natural world is heavily researched, but we still know very little. Continued research on natural phenomena and the habits of animals is always needed to attempt to better understand the natural world. The hope of this statistical exercise is to understand if there is a less obvious relationship ongoing between water bodies and the Mississippi Kites. This project attempts to use a geographic weighted regression to discover if there is a statistically significant relationship between the target species and water bodies.

In this study a main source of data is a citizens science project focused on amateur ornithology. Using citizens science data like this allows scientists access to robust data sets that would otherwise not be available. Some researchers question the extent that citizen science data can be used in analysis claiming its amateur nature harms its legitimacy. A focus of this study will be testing if this data set is scientifically sensible.

Tags: R, Ornithology, GIS, eBird

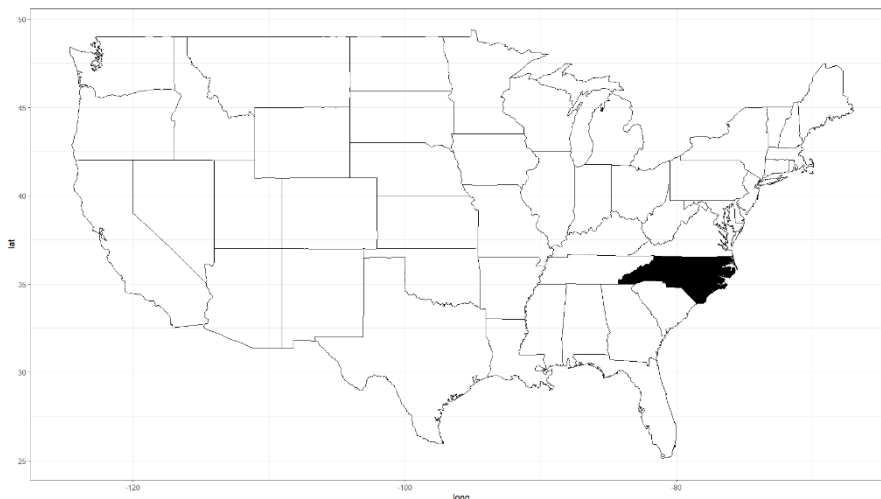


Figure 1: Location Map for North Carolina, USA.

Introduction

Once considered a rare migrant, Mississippi Kites (*Ictinia mississippiensis*) have long been observed in North Carolina, but their numbers are increasing. There seems to have always been the occasional occurrence of this species of kite in the state but researchers often referred to them as rare (Parker & Ogden, 1979.). The species was considered so rare that before 1980 only four observations had been officially recorded in the entire central Piedmont and mountain region of North Carolina, two were killed in Cherokee County in 1893, one was seen in Durham County in April 1976 and one was reported from Cedar Mountain in June 1976 (Quintilliano et al., 2015). In recent years local amateur biologists have reported observations of the kites within the state at a higher rate.

The species is a neotropical long distance migrator that breed in North America and spend the winter in South America (Juhant, 2013). Breeding has not historically taken place in North Carolina but in relatively recent years this has changed. The first confirmed nesting pair of Mississippi Kites was found in Scotland County in 1995, nesting in a sweetgum tree (*Liquidambar styraciflua*) in a residential neighborhood (Quintilliano et al., 2015).

The Mississippi Kites currently occupy a variety of habitats for both nesting and hunting, some of these habitats currently exist due to anthropogenetic changes to the landscape, such as highways and ecotonal changes along agricultural fields. A reliance on anthropogenic habitats has not always been the case, it is thought that during the 1800s and early 1900s there were around 80 million hectares (198 million acres) of forested freshwater wetlands that we used for nesting in the Mississippi Alluvial Valley (Bader, T. J., & Bednarz, J. C., 2010). A substantial portion of this historical habitat was impacted by European settlement and is continuously impacted by modern development. After this disturbance researchers worked to find habitat types that the Kites were now using, in a telemetry study seven main habitat types were found. The most commonly used habitat type was open water areas, researchers estimated that this was related to prey availability such as dragon flies (*Odonata*) and frogs (*Anura*) (Bader, T. J., & Bednarz, J. C., 2010). Many species have adapted well to anthropogenic changes in habitat with some using it to there advantage, some using powerlines and highways as new advantages in hunting (DeGregorio, B. A., Weatherhead, P. J., & Sperry, J. H., 2014).

Monitoring a potential change in habitat use by neotropical long distance migrators like the Mississippi Kite could be an important indicator of large scale climate changes. Patterns of connections among specific summer and winter populations may have important consequences for the ecology and evolution of migratory birds (Juhant & Areta, 2013). The increase in observations of the species in travel and nesting in North Carolina could be indication of a subtle change pushing these migrators slightly further North. Some researchers advocate for large scale citizen science actives like eBird in order to get a more accurate understanding of these possible subtle changes in the wildlife community. It is imperative to collect real-time data on spatial distribution of individuals, robust spatial data needed to understand how wildlife use and select habitat can be challenging to obtain, however, especially for highly mobile or wide-ranging species (Atuo & O'Connell, 2018). Other researchers do point out potential flaws in using eBird and data collected in this style, stating that they pose significant challenges wherein high data volume and dimensionality can create noise accumulation, spurious correlations, and incidental endogeneity (Sorte et al., 2018). Cornell has attempted to build some guards against generating superficial data

caused by misidentification. To further improve data quality, eBird uses volunteer experts who develop regional filters based on spatiotemporal coordinates and date of observation. Setting limits for the species observed and the maximum number of individuals for that species for certain volunteers, if a count surpasses the max or indentation of a bird is reported outside of a specified date range the record is flagged for further scrutiny by expert reviewers (Callaghan & Gawlik, 2015). While eBird has some range to be debated I believe it has a valuable use in providing large data sets and continues monitoring that would otherwise not be possible. The administrators of the program have included appropriate fail safes to try to remove any false information from misidentification of species and I believe that the dataset is appropriate for the analysis that this project is conducting.

Data:

The dataset proposed for this project was acquired from eBird a citizen science data project. This project is administered by University of Cornell ornithology lab. The data is largely collected by amateur bird enthusiasts and is later vetted by researchers before release for research. A limitation that always exists when using citizen science derived data is the reliability of the data. This dataset has already been retrieved from eBird and is comprised of over eleven thousand observations of the Mississippi Kites throughout North Carolina spanning years 2015 through the summer of 2021. The eBird data used in the analysis is shown in Figure 2. The data set for water body comparison is the State of North Carolina's Major hydrology shapefile, shown in Figure 3. The state hydrology data is not a complete inventory of streams in the state but only a subset of major hydrologic features. The decision was made to target major hydrologic features, opposed to smaller unnamed tributaries, because they hypothetically should act as ecological 'highways' for species including those preyed upon by the target species. Additional datasets used in this project are a county file shapefile of North Carolina and a USA national boarder shapefile.

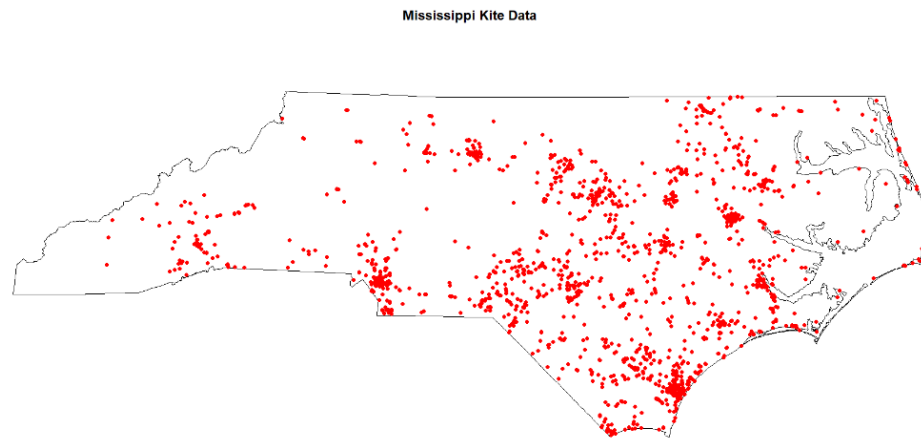


Figure 2: Mississippi Kite Dataset (eBird)

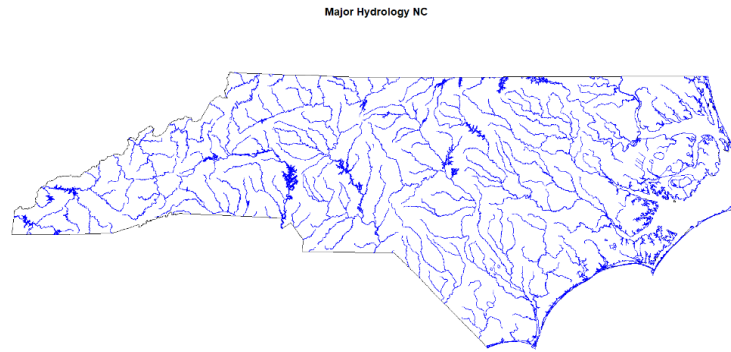


Figure 3: Major Hydrology Dataset

Methods

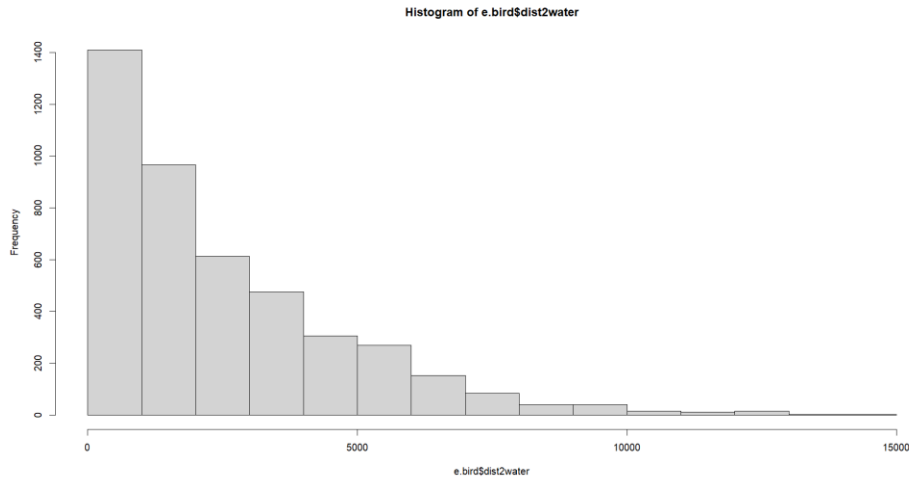
All figures, graphs and analysis was performed in R using Rscript.

The proposed statistical analysis is fitting a regression model to estimate Kite density relying on the distance to the nearest water body. Beginning with setting the appropriate workspace for where the project files are stored. Next input the shapefiles. Followed by a reduction in the number of columns to make the data cleaner and easier to work with. Using the plot function figures 2 and 3 are made, both shown with the outline of North Carolina for a more presentable look and to assist readers in understanding where they are. Figure 1 was completed using the ggplot function, showing the state of North Carolina as a shaded black.

Before beginning the larger spatial analysis portion of the project it is important to make sure all the data sets used are in the same projection. To check the projection the compareCRS function is used, in this project all the files aligned and showed “true” indicating they are the same spatial projection. The hydrology data set came as a line shapefile, in order to fit a distance regression we need to format it to a point file, to make this adjustment we use “as” “spatialpointsdataframe”. Next we create a distance to water tow in the e.bird data, this is done by using a nncross with the major hydro points. After that we remove the NA values. Last we create a regression model to see if the observed trend is statically significant.

Results

North Carolina is a state with 100 counties during the analysis we discovered that 79 of the 100 counties have observations of Mississippi Kites. The county with the highest count was New Hanover County with 481 observations. Seven counties have only one observation, Caswell, Chowan, Davie, Iredell, Rockingham, Rowan, and Warren. Figure 4 shows the frequency of the target species plotted against the distance to water. Visually there does appear to be a trend occurring.



*Figure 4: Frequency of the target species
plotted against the distance to water.*

Discussion

Unfortunately, an error was encountered that I was unable to get around. This prevented me from moving further in the analysis where we assign a regression and make a statement about the significance of the problems. Figure 4 still does reveal some valuable information that we can discuss; there does appear to be a visible trend in the data that is supported by the background research review. The visible trend appears to show that the Mississippi Kites have a preference for the larger water bodies in the major hydro shapefile. Additional anecdotal evidence is the county with the most observations. New Hanover county is a coastal county that is entirely a peninsula, with the Atlantic Ocean boarding to the East and the Cape Fear River boarding to the West and South. One objective of this research was to decided if EBird data was scientifically sensible, without the statistical backing we cannot make a strong statement. The data from EBird does seem to make sense with the habitat descriptions. One potential bias of the data I noticed was that highly populated areas have higher number of observations. Also there are a higher number of observations around some college campuses, this could be explained by universities exposing students to the platform as a way of sparking student interest in citizen science or ornithology. Since errors were encountered in the analysis preventing a statically outcome statement future work would be recommended to correct the R code error and discover if the findings are significant.

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