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Habitat Quality Modeling for Bird Species at Furman University

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Emma Cook, Introduction to Geographic Information Systems (GIS), Fall 2016

FURMAN

Introduction

In rapidly urbanizing areas, such as Greenville County in Upstate South Carolina, it is important to study habitat use and quality across land cover types in order to maximize conservation (Guisan and Thuiller 2005). Habitat fragmentation is a threat to many species of birds in areas with increasing development, especially those species that utilize larger forest patches for nesting and foraging (Stratford and Stouffer 2015). While land cover type and patch size are extremely important factors in determining habitat quality for birds, recent research has shown that the matrix of surrounding landscape proves to be very important as well (Guisan and Thuiller 2005, Jorgensen et al. 2014, Stratford and Stouffer 2015). The landscape matrix, sometimes called landscape mosaic, considers the land cover characteristics of neighboring areas and interactions between land cover types (Andrén 1994, Rodewald 2003). Birds are a good study species because they inhabit a wide range of land covers and have wide ranges of tolerance to disturbances; therefore they are a good indicator species of habitat quality for other species as well (Stratford and Stouffer 2015). The goal of this study was to assess habitat quality and develop a predictive species distribution model to predict occupancy for selected bird species and overall species richness based on the land cover matrix. The study species include the Eastern Kingbird and the Eastern Towhee. Species distribution models are useful in conservation planning because they can be used to designate protected areas and inform conservation efforts to adequately protect species (Guisan and Thuiller 2005, Niemuth et al. 2005). Data on habitat use on a small college campus in upstate South Carolina may also be able to inform habitat use in larger scale urban residential areas. Furman University is ranked among the most sustainable universities in the nation. Biodiversity and conservation are pillars of sustainability. Information on habitat qualities on campus and predictive distribution maps could help Furman improve conservation planning.

Methods

Point counts were conducted at 39 sampling sites across Furman University (Figure 1). Sites were randomly selected from a grid of 50 meter cells and were at least 200 meters away from one other to reduce counting redundancy. We conducted three ten-minute point counts at each site between June and July of 2016, recording all birds seen and heard. Land cover data was obtained from NLCD to analyze the land cover distribution across campus (Figure 2). I created 125 m buffers around the sampling sites, representing the sampling areas (Figure 1), and used the zonal histogram tool, which outputs a table indicating the number of cells of each land cover type within the buffer zone. From that table, I calculated the percentages of land cover types within the buffer zones using Microsoft Excel. To determine percent land cover in the matrix, land cover types were simplified to deciduous, pine, developed, and other in Excel. I ran linear regressions in R Studio using a binomial distribution to compare the presence or absence of selected bird species (Brown Thrasher, Brown Headed Nuthatch, Eastern Kingbird, Eastern Towhee, Eastern Bluebird and Pine Warbler) with the land cover breakdown of sampling sites. A linear regression using a binomial distribution was appropriate because we were analyzing presence (1) or absence (0) of a species corresponding to a certain landscape matrix. I ran a separate linear regression to compare species richness with the land cover breakdown of selected sites. For species with significant, or close to significant p values, I back-transformed the slope and intercepts of the regressions using the formula *1/(1+1/exp(x))* in Excel. I reclassified the land cover layer to all 1's, creating a base. I then reclassified it three more times as deciduous, pine, or developed, making the respective values 1 and the others 0. For the reclassified land cover rasters, I used the circular Focal Statistics Tool in ArcGIS to calculate a new value for each raster cell corresponding to the number of cells within a 125m radius with the respective land cover. I then used the Raster Calculator to generate raster layers that gave the percentage of the respective land cover by dividing the Focal Statistics layer corresponding to the land cover by the Focal Statistics layer for the base (which gives the total number of cells in the 125m radius matrix) and multiplying by 100. These raster layers indicate the percentage of the land cover matrix surrounding each raster cell that is deciduous, pine, or developed, respectively. To map the regressions I used Raster Calculator, specifying the formula *mx+b* with the back-transformed slope and intercept as *m* and *b,* and *x* as the percentage land cover raster previously calculated for the land cover that corresponds with the bird species based on the regression results. I then calculated the average for the richness rasters for deciduous and developed to get habitat quality as a factor of both land cover types, assuming both have equal effect on richness. The resulting habitat quality maps were then analyzed.

Figure 1. Randomly selected sites for point counts at Furman University.

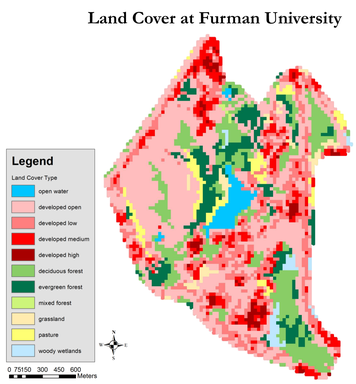

Figure 2. NLCD 2011 Land Cover data for Furman University.

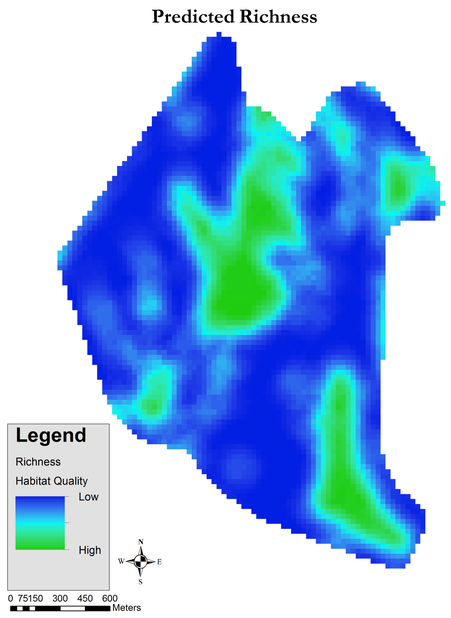

Figure 3. Predicted species richness at Furman University as a factor of percent developed and deciduous land cover. The p value for the regression between richness and percent deciduous forest was 0.07, nearly statistically significant, and 0.18 for richness and percent developed land. This map is an average of the regression rasters for deciduous and developed. Dark Blue represents poor habitat quality and low probability of occupancy of all bird species, and green represents better habitat quality and higher probability of occupancy.

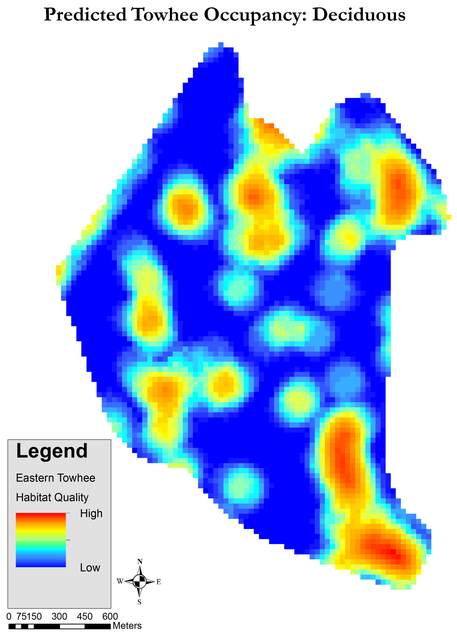

Figure 4. Predicted Occupancy of Eastern Towhee at Furman University as a factor of percent deciduous forest in surrounding matrix. The p value for the regression was 0.29. Red indicates good habitat quality and high probability of occupancy.

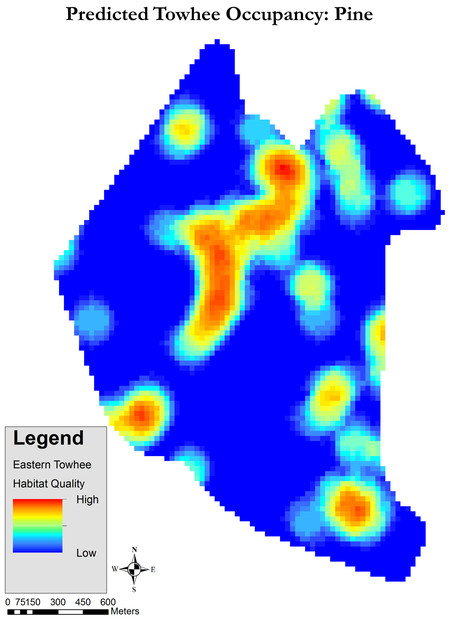

Figure 5. Predicted Occupancy of Eastern Towhee at Furman University as a factor of percent pine forest in surrounding matrix. The p value for the regression was 0.17. Red indicates good habitat quality and high probability of occupancy.

SPECIES	LANDCOVER	SLOPE
EAKI	Deciduous	-10.14
EATO	Pine	8.059
	Deciduous	3.892
RICHNESS	Deciduous	-10.06
	Developed	-6.794

Table 1. Regression Results from R Studio. Species indicates EAKI (Eastern Kingbird), EATO (Eastern Towhee) and RICHNESS which is a count of how many species were present. Slope indicates the resulting estimated slope from the regression analysis.

Data Sources

Land cover data from National Land Cover Database (NLCD 2011):
http://www.mrlc.gov/nlcd11_data.php
Point Count Data collected during surveys with the help of my research team.
All maps developed using Environmental Systems Research Institute (ESRI) ArcDesktop, 10.4.1.

Acknowledgements

I would like to thank Alec Schindler and Jillian Marlowe for helping me conduct point counts. Dr. Quinn, my research advisor, and Mike Winiski for helping me analyze data and create maps to represent the data.

Results

The linear regressions showed that there was a significant negative relationship between Eastern Kingbird occupancy and percent deciduous forest in the surrounding landscape matrix (Table 1, Figure 6). This result makes sense because the Eastern Kingbird habitat is mainly shrub and forest edge, therefore dense deciduous cover would not be good habitat for this species (All About Birds). The linear regressions showed other observable patterns as well. The regression for richness suggested that there is a negative relationship between species richness and percent deciduous cover, as well as percent developed land in the surrounding matrix (Table 1, Figure 3). We would expect that richness would decrease as percent developed land increases as this data suggests. The trend that richness decreases as deciduous forest increases could probably be explained by observer error and a lower probability of detection in dense forest cover. Figures 4 and 5 represent the predicted occupancy of Eastern Towhees in relation to both percent deciduous and percent pine forest. Interestingly, the data suggests that Towhees have a positive relationship with both land cover types. This can likely be explained because the Towhee is a forest edge species, so it makes sense that in both forest types, likely because patch sizes are so small on campus, Towhees are likely to be found (All About Birds).

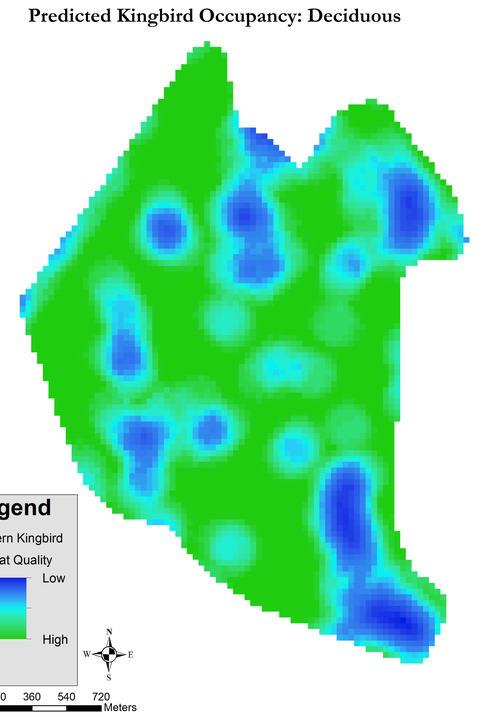

Figure 6. Predicted Occupancy of Eastern Kingbird at Furman University as a factor of percent deciduous cover in surrounding matrix. The p value for the regression was 0.04. Blue indicates poorest habitat quality.

Conclusion and Future Research

These species distribution maps are able to show the likely distribution of bird species across campus as a factor of land cover. The effect of percent developed land cover on species richness is the most striking result as it marks nearly all of campus as poor habitat quality. This is likely because birds are less likely to occupy areas with buildings and impervious surfaces and few trees. A possible solution to this problem, to increase species richness and diversity of birds across Furman University would be to incorporate more trees, shrubs and other features to increase quality of the habitat for birds, along with buildings.

Further research needs to be conducted, at a larger scale to increase significance, to test the impact of scale on habitat quality—test multiple buffer sizes. Research should also have a focus on the interaction of different landscape types within a matrix and the effect of these interactions on species.

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