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Introduction

Blackbirds are ubiquitous members of the avian fauna in the Prairie Pothole Region. However, their abundance combined with their food habits make blackbirds significant agricultural pests on sunflower. Cost estimates for blackbird damage to sunflower in the northern Great Plains range from 4-11 million U.S. dollars per year. Because of their economic impact on agriculture, it is imperative to understand the environmental factors that influence blackbird abundance patterns. This study attempts to quantify the effects of landscape-level land use and climate patterns on blackbird abundance in the Prairie Pothole Region of the United States.

Study Area

Our study area is the Prairie Pothole Region (PPR) of the United States (Figure 1). The landscape of the PPR was formed approximately 12,000 years ago when the last glaciers melted and left behind a region of small wetlands and sloughs. Because blackbirds show an affinity for wetland habitats, the PPR provides an ideal study area to examine land use and climatic effects on blackbird populations.

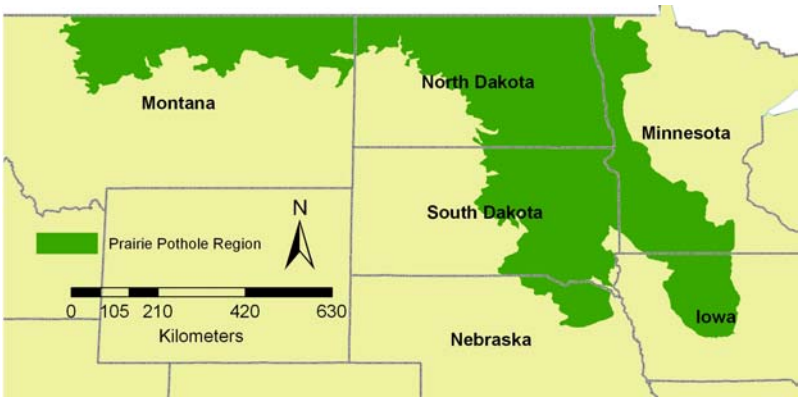

Figure 1. Prairie Pothole Region of the United States within the context of North America

Existing Datasets

We used several preexisting large-scale datasets to construct models to evaluate bird-habitat relationships in the PPR. Bird abundance data were taken from the North American Breeding Bird Survey (NABBS) which is a continent-wide effort to monitor bird population trends in North America (Figure 2). Land cover information was derived from the National Land Cover Dataset 1992 (NLCD) and was reclassified into a modified Anderson Level I classification to reduce inaccuracies present at finer classification levels. Climate data from 245 weather stations were taken from the National Climatic Data Center and National Climate Data and Information Archive.

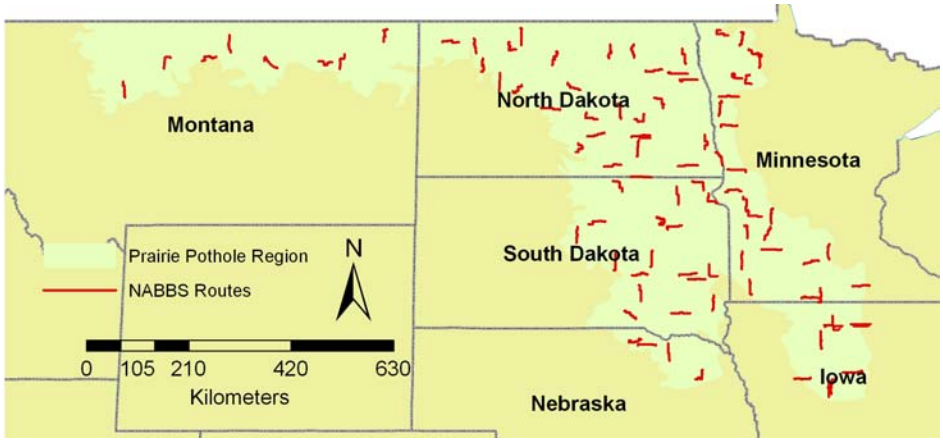

Figure 2. Distribution of North American Breeding Bird Survey Routes across the United States region of the Prairie Pothole Region

Methods

Land-use patterns were evaluated at 3 spatial scales around each NABBS route by creating 3 sizes of buffers: 0.1-km (~1,000 ha), 1-km (~10,000 ha), and 10-km (~100,000 ha). The kriging function of the Spatial Analyst extension of ArcGIS 9.1 was used to create a continuous surface for each climate variable from 1980-2000 over the PPR using weather data from 245 stations. The grid cell values within a 10-km buffer surrounding each NABBS route were averaged to compute a value for each weather variable for each route for each year.

We reviewed published habitat associations and life histories for red-winged blackbirds, yellow-headed blackbirds, and common grackles to determine which environmental variables would be most likely to affect abundance. These variables were used to construct candidate sets of models at each spatial scale for each focal species. Spearman's rank correlations were calculated for environmental covariates; covariates with a correlation coefficient >0.5 were not included in the same *a priori* model.
Bird abundance from the NABBS was modeled as a function of nuisance effects, land use variables, and climatic influences using a hierarchical modeling approach within a Bayesian framework. Hierarchical models are useful for modeling NABBS data because

they acknowledge correlation among multiple observational units which are present in the survey design. Models were fit using Markov chain Monte Carlo techniques using Gibbs sampling. Markov chain Monte Carlo simulations were run for 25,000 iterations, including a 20,000-iteration burn required for convergence. Models were ranked as to how well they fit the data by comparing the Deviance Information Criteria (DIC) among models and ranking them accordingly. Inference was constrained to models that were within 4 DIC units of the best model, which approximates a 95% confidence set of best models.

Blackbird abundance mapping was performed by creating 3 sizes of regular lattices the PPR; the 3 sizes correspond to the spatial extents examined in the study (1,000 ha, 10,000 ha, and 100,000 ha). For each blackbird species, environmental covariates were summarized in a lattice size corresponding to the scale they were determined to be important. Final maps of avian abundance were computed using the raster calculator in the Spatial Analyst extension of ArcGIS 9.1.

Results

Both land use and climatic factors were shown to be important predictors of blackbird abundance in the PPR. The influence of scale was less pronounced as models with the same predictor variables at different scales had similar DIC values. Climate variables strongly contributed to predicting bird abundance for all species. No candidate models in the best subset for any species lacked climate variables, and candidate models without climate covariates had much higher DIC values (and, thus, lower support) than models with climate predictors. Red-winged blackbirds were abundant across the PPR with the lowest densities in northern Montana and the highest concentrations in eastern North Dakota and south central South Dakota. The predicted abundance map for yellow-headed blackbirds show locally high numbers occurring throughout North Dakota and eastern South Dakota and lower abundances elsewhere. Common grackles were predicted to be most abundant in western Minnesota and southeastern South Dakota with lower densities elsewhere (Figure 3).

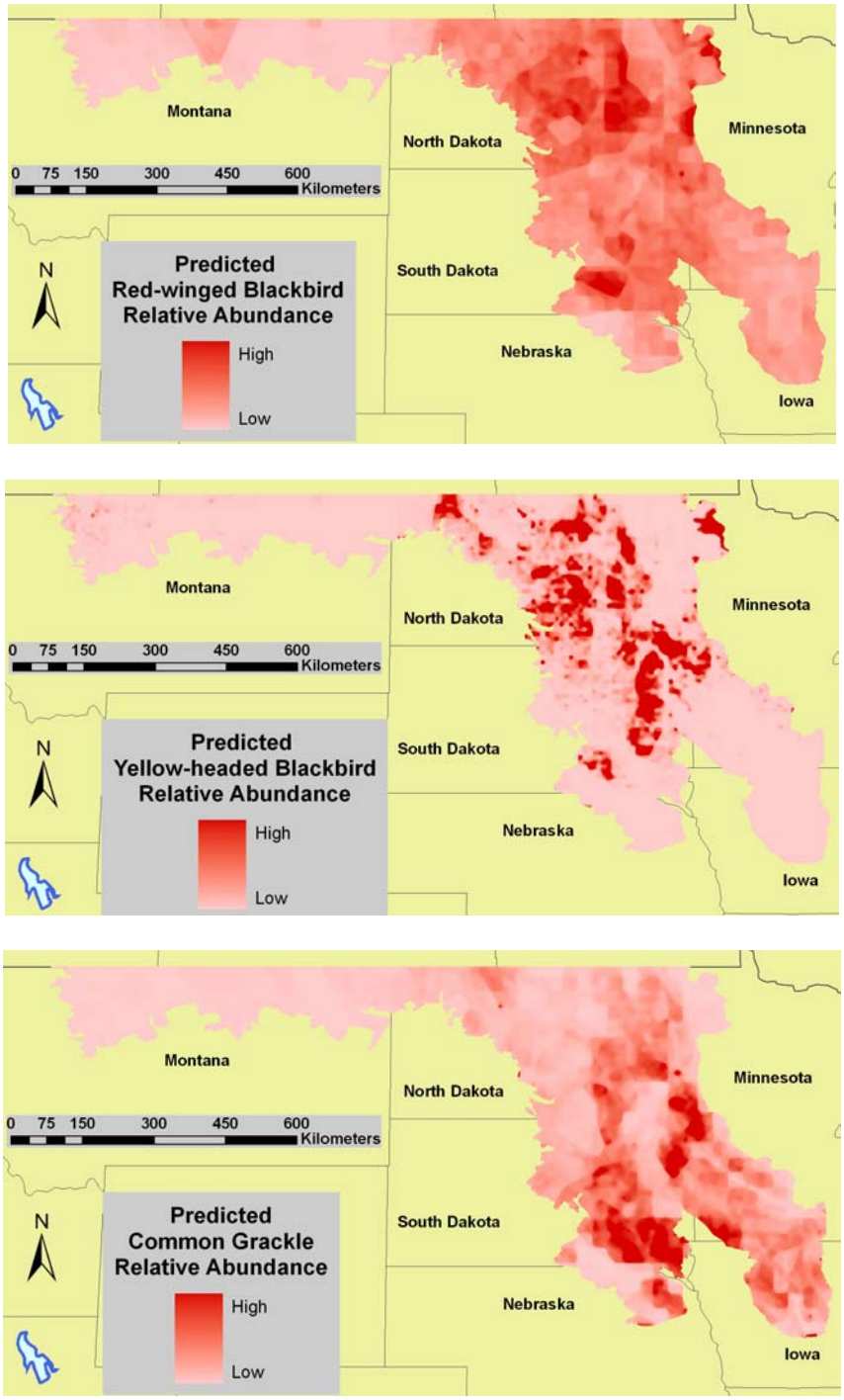

Figure 3. Predicted relative abundance maps for blackbirds in the United States Region of the Prairie Pothole Region.

Discussion

Sunflower growers lose millions of dollars to blackbird depredation every year. Further understanding of land use and climatic effects on blackbirds may help wildlife managers further understand the factors that regulate populations which can lead to more informed management decisions. Maps of relative abundance show locations of high densities where management efforts can be focused to be most effective. Although we feel our models are reliable, ancillary field data should be collected to validate the presence of high densities of blackbirds before localized management decisions are implemented. This information will contribute to management decisions that aim to reduce blackbird depredation on sunflower in the Prairie Pothole Region of the United States.

Acknowledgements

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