INFLUENCES OF LAND USE PATTERNS ON BLACKBIRD ABUNDANCE IN THE PRAIRIE POTHOLE REGION OF NORTH DAKOTA

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Abstract

One issue affecting sunflower growers in the upper Great Plains of North America is crop depredation by blackbirds. In this region, blackbirds annually destroy an average of $5.4 million of sunflower. To increase the understanding of how blackbirds are influenced by large-scale land-use patterns, we developed multiple regression models to explain how various land use patterns influence blackbird abundance. We used data from the North American Breeding Bird Survey and the USGS land cover assessment to develop regression models examining associations between land use characteristics and blackbird abundance. Both red-winged blackbirds and yellow-headed blackbirds were negatively associated with the amount of developed area, while the amount of wetland area strongly influenced yellow-headed blackbird abundance. Common grackles were positively associated with the number of land-use types in the landscape. These associations can be partially explained by habitat preferences of these species; however, many variables that would seemingly be good predictors of blackbird abundance were not significant. This result suggests that either a greater number of samples are needed to identify these associations, or the relationships in question are not detectable at the landscape level.

Introduction

Blackbirds are ubiquitous members of the avian fauna in the Prairie Pothole Region (PPR) of the United States and Canada (Sauer et al., 2003). They are significant agricultural pests on crops, especially sunflower. Cost estimates for blackbird damage to sunflower in the northern Great Plains average $5.4 million annually (Peer et al., 2003). The level of damage that blackbirds cause is due to their food preferences, flock feeding and communal roosting behaviors combined with large numbers (Weatherhead and Bider, 1979). Because of their importance to agroeconomics, it is imperative to understand how blackbirds respond to different land use patterns. A better understanding of how blackbird populations respond to large-scale habitat variation will allow biologists to make more informed decisions regarding blackbird management and concomitantly reduce agricultural damage.

An array of environmental and habitat variables can influence the habitat selectivity and abundance of breeding blackbirds. Factors which may influence breeding blackbird populations in the PPR include weather, day length, food availability, vegetation, and the presence of predators, competitors, and nest parasites (i.e., brown-headed cowbirds, *Molothrus ater* Boddaert) (Beletsky and Orians, 1996). These factors operate at varying degrees from the individual scale to the landscape scale. Previous research has focused mostly on studying smaller scale influences on blackbird populations, while landscape effects have drawn little research effort. This study focuses on evaluating the land use factors that influence blackbird populations in the PPR using multiple regression techniques.

Materials and Methods

We examined land use influences on blackbird populations in North Dakota using data from the North American Breeding Bird Survey (BBS) (Sauer et al., 2003) and land use data from the USGS National Land Cover data set (USDI Geological Survey, 1992). The BBS consists of >3,700 roadside routes spread across North America that are surveyed annually by experienced birders. Each route is 24.5 miles (39.4 km) in length, and the observer stops at 0.5 mile (0.8 km) intervals along the route for a total of 50 stops. At each stop, an observer records all birds seen or heard within a quarter-mile radius. Land use data created by the USGS were derived from Landsat Thematic Mapper satellite imagery from the early- to mid-1990s and have a 30-m spatial resolution.

Breeding bird survey routes were selected by using ArcInfo version 8.3 (Environmental Systems Research Institute, 2000) to select routes that overlap with the Prairie Pothole Region of North Dakota. Abundance data were corrected for observer bias by removing observations that did not conform to BBS standards and by deleting observations that were recorded in an observer's first year of data collection at a particular route (Sauer et al., 1994, Flather and Sauer, 1996). Land use data for North Dakota were reclassified into a modified Level I Anderson et al. (1976) classification and were quantified within a 10-km buffer surrounding each breeding bird survey route. We used FRAGSTATS to calculate landscape metrics which might influence blackbird abundance within each buffer (McGarigal et al., 2002). Area was computed for each land use type; contagion, landscape dominance, fractal dimensions, richness, and diversity were calculated for the entire landscape within the 10-km buffer (Table 1).

We used stepwise multiple regression to determine which landscape attributes accounted for the most variation in blackbird abundance. Stepwise multiple regression identifies which variables explain the most variation in blackbird abundance and enters them into the model individually starting with the single best variable (Sokal and Rohlf, 1995). Landscape variables were included in each model if they were significant at $\alpha = 0.05$. Variables were standardized to a standard normal distribution so the coefficients in the models could be compared among each other. All statistical analyses were performed with SAS version 8.2 (SAS Institute, 1999). Landscape-level habitat models were developed for red-winged blackbird (*Agelaius phoeniceus* L.), yellow-headed blackbird (*Xanthocephalus xanthocephalus* Bonaparte), and common grackle (*Quiscalus quiscula* L.).

Table 1. Explanatory variables used in multiple regression analyses to explain variation in blackbird abundance.

Abbreviation	Description
BAR	Total amount of barren land
DEV	Total amount of developed land
FORUP	Total amount of forested land
HERBPL	Total amount of herbaceous planted land
HERBUP	Total amount of herbaceous upland
SHRUB	Total amount of shrubland
WATER	Total amount of water
WET	Total amount of wetland
RICH	Number of land use types within the landscape (10-km buffer)
CONTAG	Contagion quantifies the degree to which land-use types are aggregated. A high value indicates there are a few continuous land-use types.
DIV	Shannon diversity index applied to land-use types.
FRAC	Perimeter-area fractal dimensions provides an index of shape complexity. Higher numbers indicate more complex shapes of land-use types.
DOM	The dominance index measures the degree which the landscape is dominated by a few or many land-use types. Higher values indicated the landscape is dominated by one or a few land-use types.

Results and Discussion

Landscape metrics used in the analyses partially explained blackbird abundance observed during BBS surveys (R-Square range: 0.144-0.529), and resulting habitat models were highly significant (Table 2). The amount of developed area significantly explained variation in both the red-winged blackbird and yellow-headed blackbird, but not the common grackle. Both red-winged blackbirds and yellow-headed blackbirds were negatively associated with the amount of developed area; red-winged blackbirds were also negatively associated with the amount of shrubland. Yellow-headed blackbirds were positively associated with the amount of wetland habitat in the landscape, while common grackles were positively associated with landscape richness (Table 2).

Table 2. Blackbird habitat models, R-Square values and model *P*-values derived using stepwise multiple regression. Only variables that were significant at $\alpha = 0.05$ are presented. Data were standardized to a standard normal distribution which resulted in the y-intercepts being zero.

Bird Species	Model	Model R-Square	Model *P*-value
Red-winged Blackbird	0 – 0.482(DEV) – 0.427(SHRUB)	0.346	0.004
Yellow-headed Blackbird	0 + 0.606(WET) – 0.338(DEV)	0.529	0.0001
Common Grackle	0 + 0.380(RICH)	0.144	0.042

Given the yellow-headed blackbird's strong affinity for wetland habitat (Twedt and Crawford, 1995), it is not surprising that they were found to be significantly associated with the amount of wetland area. Red-winged blackbirds also nest in wetland area, but the lack of an association with wetland area may be because this species is more of a generalist and will also nest in upland area and open patches in woodlands (Yasukawa and Searcy, 1995). Fletcher and Koford (2002) also did not find the percentage of wetland area to be a significant predictor of red-winged blackbird density in grasslands of northern Iowa. Both red-winged blackbirds and yellow-headed blackbirds avoided developed areas which lack a significant amount of suitable nesting habitat. Common grackles were only found associated with landscape richness. This result is likely because common grackles are a habitat generalist and will nest in a variety of habitats including open woodlands, swamps, and around human habitation (Peer and Bollinger, 1997).

This study, which only examined landscape influences on blackbird populations in North Dakota, is part of a larger project to examine the effects of land use and climate on wetland birds across the PPR. Because this paper only used data from North Dakota, it is possible that additional influences (both land use and climate) will be discovered when additional information is used from other areas of the PPR. Increasing the sample size will likely improve the ability to find significant predictors of blackbird abundance in the PPR.

Sunflower growers lose millions of dollars to blackbird depredation every year. Further understanding of land use effects on blackbirds might help wildlife managers develop and implement more informed decisions regarding blackbird management. This information will hopefully aid in reducing blackbird depredation on sunflower in the Prairie Pothole Region of the United States and Canada.

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