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BIRD SPECIES DIVERSITY IN RIPARIAN BUFFERS, ROW CROP FIELDS, AND GRAZED PASTURES OF TWO AGRICULTURALLY DOMINATED WATERSHEDS

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Abstract: A design goal associated with most riparian buffer systems is the enhancement of wildlife habitat. To determine whether this goal was being met, we compared breeding bird composition at five sites, including riparian buffers, nearby row crop fields, and an intensively grazed pasture along Bear Creek and Long Dick Creek in north-central Iowa, USA. The riparian buffers consisted of native grasses, forbs, and woody vegetation and represented three different ages (14+, 9, and 2 years old). At each site, 10 min point counts for breeding birds were conducted using 50 m fixed radius plots, which were visited eight times between May 15 and July 10, 2008. A total of 54 bird species were observed over all of the study sites. The installed riparian buffers incorporated in this study had higher bird abundance, richness, and diversity than the crop and pasture sites. The fewest species were detected within row crop fields (15 species) while the most species were observed on the oldest riparian buffer (42 species); intermediate numbers were observed on the 9 year-old (27 species) and 2 year-old (28 species) buffers and the pasture (23 species). Our results suggest that re-establishing native riparian vegetation in areas of intensive agriculture will provide habitat to a broader suite of bird species. In comparison to row crop and grazing land, the buffers contain a greater diversity of vegetative structure in both horizontal and vertical dimensions. Many birds are known to respond positively to such habitat heterogeneity.

Key Words: bird habitat, breeding birds, Iowa, point count, species richness

INTRODUCTION

Since Euro-American settlement, land cover in the U.S. Midwest has been converted from native landscapes to intensive agricultural production. This is especially true in Iowa, which has the smallest percentage of its original natural habitat remaining out of all 50 states. Tallgrass prairie once covered approximately 85% of the state. Due to agricultural and urban growth, it now covers less than 1% of its original extent (Cosner 2001). Loss of habitat has caused populations of grassland birds to decline (Murphy 2003). Across the Iowa prairie landscape, riparian areas were heavily manipulated and converted for agricultural use with the Midwest generally showing some of the greatest habitat loss in the United States (Brinson et al. 1981, National Research Council 2002). By converting riparian land to agricultural use, many of the natural functions have been lost, including filtering sediment and chemicals from surface and subsurface runoff, stabilizing surface and streambank soil, and providing diverse wildlife habitat (Schultz et al. 2004). In recent decades, agricultural intensification has reduced habitat heterogeneity and farmland biodiversity (Benton et al. 2003).

Habitat loss and fragmentation have led to reduced available breeding habitat for many wildlife species, including many species of birds (Best et al. 1995) One way to enhance and increase potential habitat is to convert riparian areas from agricultural production to riparian buffers (Schultz et al. 2004). To assess whether this goal can be met, bird communities were compared between installed riparian buffers and the land cover of the surrounding matrix (row-crop fields and an intensively grazed pasture). Similar studies were conducted in these riparian areas in North-Central Iowa in 1994, 1997, and 1999. By comparing data from the past surveys to the 2008 survey, we can see how the bird communities on the same or similar aged sites change over time as established buffers grow and develop more species and structural diversity.

MATERIALS AND METHODS

Description of the study sites

The study was conducted in the Bear Creek and Long Dick Creek Watersheds in north-central Iowa. These watersheds are dominated by agricultural land use, primarily consisting of row-crop farming (corn and soybeans) and pasture. Bear Creek and Long Dick Creek watersheds are small (6941 ha and 9403 ha, respectively) drainage basins located within the Des Moines Lobe subregion of the Western Corn Belt Plains ecoregion. In general, the topography of this area is flat to gently rolling (Griffith et al. 1994)

Five sites were included in the study, including three different areas with riparian buffers, an area with intensively grazed pasture, and an area in row crops. The riparian buffer sites represent three different ages since planting (14+, 9, and 2). All buffers were composed of three-zones; a managed tree zone adjacent to the stream followed by a shrub zone and a native grass/forb zone adjacent to the cop field (Schultz et al. 2004). The tree zone included species such as silver maple (*Acer saccharinum* L.), green ash (*Fraxinus pennsylvanica* Marsh.), black walnut (*Juglans nigra* L.), willow (*Salix* spp), cottonwood hybrids (*Populus* spp., e.g., *Populus* clone NC-5326, a designated clone of the North Central Forest Experiment Station), red oak (*Quercus rubra* L.), bur oak (*Quercus macrocarpa* Michx.), and swamp white oak (*Quercus bicolor* Willd.). Shrub species included chokecherry (*Prunus virginiana* L.), Nanking cherry (*Prunus tomentosa* Thunb.), wild plum (*Prunus americana* Marsh.), red osier dogwood (*Cornus stolonifera* Michx.), and ninebark (*Physocarpus opulifolius* Max.). The grass zones consisted of mixtures of several native warm season grasses and up to 15 native forb species. The oldest site was a contiguous section consisting of a downstream segment planted in 1990 and an upstream segment planted in 1994; thus, vegetation on the entire site was at least 14 years old at the time of the study. The intensively grazed pasture was dominated by short bluegrass (*Poa pratensis*), but one large tree and a few small shrubs were present near the stream. The row crop area was located along the edge of a meander belt with narrow areas between the meanders dominated by cool-season grasses and forbs. An example of a buffer, the pasture, and the crop site are shown in Figure 1.

Figure 1. Representative photos from the study area; the left photo is the 14+ aged buffer, the middle photo is of the pasture site, and the right photo is the crop site with grass in the meander belt.

Bird Surveys

All sites were surveyed for breeding birds eight times between May 15 and July 10, 2008 using 10 minute point counts with a 50 meter recording radius. At each site, three-to-seven non-overlapping point-count locations were placed randomly along each stream reach and extended across the stream on both sides, for a total of 21 survey plots. The number of plots per site was based on the length and complexity of the site. Surveys began at sunrise and ended by 9:30 a.m. Data were not collected on mornings with high winds or rain because these factors could affect bird activity. All birds seen or heard within each 10 minute point-count period were recorded. Non-resident migrant birds observed were recorded but were not included in the data analysis. To prevent recording the same individual more than once, the location of each observed individual was recorded on a diagram of each plot and notations were made if a bird flew from its initial location during the count period. To reduce temporal bias, the order in which the sites were surveyed was rotated between days. No attempt was made to establish whether the birds were nesting within the plots. Some of the birds may have been using the plots to feed or rest.

Habitat Sampling

Vegetation sampling occurred on all of the 21 survey locations during the first few weeks of September, 2008. Each plot was divided into subplots based on the dominant category of vegetation. The subplot categories were tree, grass/forb, shrub, shrub/grass, tree/shrub, and crop. The data collected for each subplot were canopy height, percent canopy cover (using a spherical densiometer), total number of trees, shrub density, percent grass/forb cover, and the dominant tree, shrub, grass, and forb species. Canopy cover was estimated for plots with trees or shrubs. Shrubs were defined as woody vegetation at least 0.3m tall and with a dbh < 5cm. Dominant vegetation subplots were delineated on aerial images of the 50 m radius plots and a Geographic Information System (GIS) was used to determine the percent of each plot in each of the dominant vegetation categories for use during analysis.

Data Analysis

Total bird abundance, species richness, and Shannon-Wiener Diversity were calculated for each of the survey plots. Total bird abundance was calculated for each plot by summing the maximum number of individuals of each species observed across all surveys at the location. Abundance was then averaged across each point count location to obtain a site-based estimate. Species richness was calculated by counting the total number of species observed across all surveys at each point count location; all plots were then averaged to obtain a site-based estimate. The Shannon-Wiener Diversity Index combines species richness and the relative abundances of species observed for an integrated measure of bird response (Molles 2008). A one-way ANOVA and a pairwise comparison using a Student-Newman-Keuls method were used to test for differences in diversity among the five sites with a significance level of $P<0.05$. Regression analysis was used to compare the results of the 2008 study to those from the previous studies. Statistical analysis was done using SigmaPlot 11.

RESULTS

In total, 2255 individuals from 54 bird species were observed across all surveys and locations. A total of 42 bird species was detected on the 14+ year-old, 27 species on the 9 year-old, 28 species on the 2 year-old riparian buffer sites, respectively, and 23 species in the pasture, and 14 species on the row-crop site.

The highest total bird abundance was in the 2 year-old buffer and the lowest was in the crop site (Figure 2). The buffer sites did not have significantly different total bird abundance when compared to each other, but significantly differed from the pasture (14+ yr, P=0.007; 9 yr, P= 0.007; 2 yr, P=0.003) and crop sites (14+ yr, P=0.005; 9 yr, P=0.007; 2 yr, P=0.002).

Average species richness across all survey dates was highest in the 14+ year-old buffer and lowest in the crop site (Figure 2). The species richness data failed the normality test and so could not be compared in ANOVA.

The Shannon-Wiener Diversity Index was also highest in the 14+ year old buffer and lowest in the crop site (Figure 2). Diversity was not significantly different between the different ages of buffers. While the 14+ year-old buffer site was significantly more diverse than the pasture site (P=0.043), the 9 and 2 year-old buffers were not. All buffer sites had significantly higher diversity than the crop site (14+ yr, P<0.001; 9 yr, P=0.012; 2 yr, P=0.002).

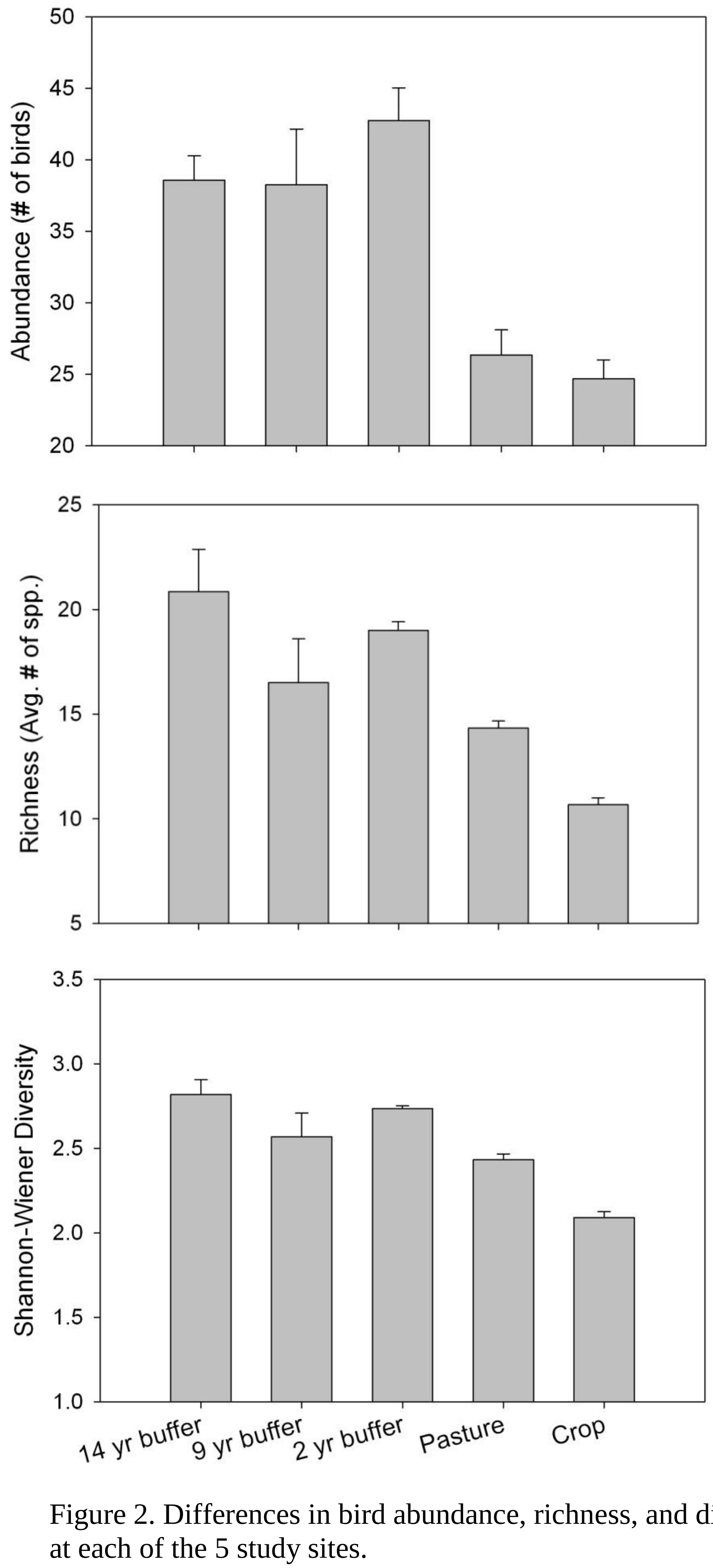

Figure 2. Differences in bird abundance, richness, and diversity at each of the 5 study sites.

The 14+ year-old buffer had the most vertical and horizontal stratification of all of the sites. It had a variety of sizes of trees and shrubs and so attracted more forest and edge species (i.e., Baltimore Oriole, Eastern Phoebe, Least Flycatcher, and Red-eyed Vireo). The 9 year-old buffer did not have many large trees and had many shrub and edge bird species such as Common Yellowthroats, American Goldfinches, and Gray Catbirds. The 2 year-old buffer had some large trees and shrubs that were there before the buffer was planted. The rest of the site was dominated by grasses, and so attracted more grassland birds such as Savanna Sparrows, Dickcissels, and Western Meadowlarks. The number of species on each of the buffer sites was similar, but the species were not necessarily the same.

The pasture and crop sites had less suitable habitat for many bird species. The pasture was dominated by bluegrass and had only one tree and a few small shrubs near the stream but had few other places to perch and no tall grass. Many of the birds found on the pasture were grassland birds (i.e., Western Meadowlark and Bobolink). Some birds made use of the only large tree in the pasture. Others came over periodically from the tall grass that was planted adjacent to the pasture on one side. The crop site had grass and small shrubs that could be suitable for birds, but this vegetation was in a narrow strip along the channel. The rest of the site was composed of corn crops that had not yet reached maturity. Most of the birds that used the site (i.e., Red-winged Blackbird, Song Sparrow, and Common Yellowthroat) were concentrated in the thin grass strip. The only bird species observed in the crop field consistently was Killdeer.

When comparing the buffers from the 2008 study to the past studies, there was a general trend of an increase in the number of bird species observed at a decreasing rate as the age of the buffer increased (Figure 3). The polynomial regression plot shows that 64.2 % of the variance is described by the age of the buffer (P=0.041).

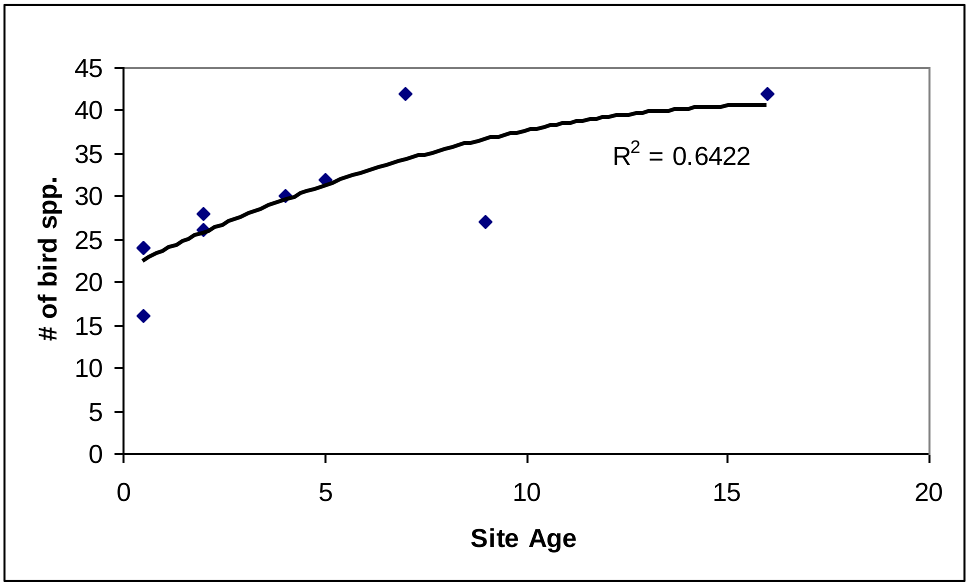

Figure 3. Polynomial regression showing combined total species richness data from the previous and recent surveys. Site age is the age since establishment at the time the survey was conducted.

DISCUSSION AND CONCLUSIONS

These results support the assumption that wildlife habitat can be improved by installing riparian buffers. The sites with little or no tree and shrub cover had lower bird species abundance, richness and diversity. In the highly modified and fragmented landscape of north-central Iowa, the installed riparian buffers incorporated in this study had higher bird abundance, richness, and diversity than the crop and pasture sites due to higher habitat heterogeneity. These sites vary in terms of width of riparian vegetation and degree of horizontal and vertical stratification. In general, bird species richness and abundance increase with amount and width of woody vegetation (Stauffer and Best 1980, Deschenes et al. 2003). Furthermore, different bird species exhibit affinities for different habitats (Dinsmore et al. 1984), which explains why certain species were more common on some sites rather than others. The narrow width of most of the buffers often attracts edge species because there is little interior for area sensitive species (Peak and Thompson 2006).

Total bird abundance was greatest in the riparian buffers, likely because of a greater availability of suitable habitat. The crop site had the lowest bird abundance. Because a large part of the landscape in Iowa is in row-crop agriculture, it is important to understand the habitat that it provides. Best et al. (2001) found that few species are residents of row-crop fields and many birds that use them only visit them for food and are more likely to do so when associated with an adjacent grass or wooded habitat.

Species richness was greatest in the 14 and 2 year-old buffers and so could support a wider variety of birds. Because habitat-use differs between species, the different aged buffers might have appealed to different species (Best et al. 1995). The pasture and crop sites did not have much horizontal or vertical stratification and so could not support as many different species.

The Shannon-Wiener Diversity Index had the highest values in the buffer sites. All three buffer sites were significantly different from the crop site. Only the 14 year-old buffer was significantly different from the pasture site. This may be because species richness was more similar among the 9 and 2 year-old buffer and pasture than when compared to the crop site.

The regression analysis shows that a large number of species initially colonized the sites, but as the sites aged, fewer species were added. If the data continues to follow this trend, there will be a point at which species richness does not increase. This makes sense because buffers are not wide enough or large enough to provide adequate habitat for some forest species (Peak and Thompson 2006) or may have too many trees/shrubs for some grassland species (Best et al. 1995). The data show that maximum species richness for the buffer sites might be at or near the 42 species that were observed.

By planting trees, shrubs, and/or grass along streams, there is an increase in potential habitat for many bird species. Under the current economic environment in agriculture, annual rental rates for most land enrolled in the Conservation Reserve Program (CRP) and similar programs are not competitive with present crop prices. For this reason, much of the land enrolled in such programs are reverting back to agricultural production (Secchi et al. 2008), eliminating important habitat for breeding birds and other wildlife. Yet, the benefits of such conservation lands, including riparian buffers, are more than monetary for the landowner. Riparian buffers can improve water quality (Schultz et al. 2004), aesthetics, and, as this study has shown, provide habitat for many bird species. When compared to the surrounding agricultural matrix, buffers increase landscape heterogeneity and provide habitat to a broader suite of birds than found in agricultural lands alone (Benton et al. 2003). Given that such buffers comprise only a small portion of the landscape, usually in areas that may pose difficulties for maneuvering large farm equipment, the environmental services they offer are likely to offset lost crop revenues associated with their deployment (Schultz et al. 2004).

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