Agriculture, Ecosystems and Environment 161 (2012) 10–16

Contents lists available at SciVerse ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

The effects of land sparing and wildlife-friendly practices on grassland bird abundance within organic farmlands

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ARTICLE INFO

Article history:
Received 16 March 2012
Received in revised form 10 July 2012
Accepted 18 July 2012
Available online 13 August 2012

Keywords:
Agriculture
Avian
Bayesian
Great Plains
Heterogeneity
North America

ABSTRACT

Biodiversity is often greater in organic farm systems than non-organic. However, variation in land use within organic systems limits absolute statements about its value for species conservation. Thus, a need is evident to better understand what practices associated with organic farming benefit conservation. We modeled abundance, within organic systems, of six grassland birds of conservation concern as an outcome of applied wildlife-friendly and land sparing practices at multiple spatial scales. We used a Poisson-binomial model to estimate the relative effect of abundance drivers while accounting for detectability. At the field scale, species response to vegetation structure was mixed. At a local scale, Dickcissels were more abundant at points with greater percentage of alfalfa and soybean. Three species were less abundant at points with a greater percent of local woodland and there was no significant response to local linear grass. Grasshopper Sparrows were more abundant at points with more local block grassland. At a landscape scale, Western Meadowlarks and Ring-necked Pheasants were more abundant at points with a greater percent of grassland in the landscape. Results highlight the importance of a multiscale approach and demonstrate that effective management of species should consider costs and benefits of wildlife-friendly and land sparing practices.

1. Introduction

A variety of solutions have been suggested to identify a balance between biodiversity conservation and food production (Green et al., 2005; Fischer et al., 2008; Phalan et al., 2011). Among these, organic farming has been shown to benefit biodiversity, with richness and abundance of a variety of organisms greater on organic than non-organic farms (Hole et al., 2005). Organic farming, however, is a broad management system that can incorporate many applied practices that may or may not benefit biodiversity. The variation in organic systems reflects a focus in organic standards on actions prohibited rather than practices implemented (Shennan, 2008), different certification standards that generally lack clear guidelines in regards to biodiversity conservation, and individual farm systems that reflect a regions agroecology. The applied practices fall along a gradient between two conservation philosophies: land sparing in which land for conservation is held separate from crop production and wildlife-friendly farming that integrates biodiversity conservation with agronomic production goals (Fischer et al., 2008). The variety of wildlife-friendly (e.g., crop diversity and field buffers) and land sparing (e.g., set-asides) practices currently applied within temperate organic farms ultimately limits the accuracy of broad statements describing organic farming as beneficial to biodiversity. Furthermore, the varied success of applied agri-environment schemes (Kleijn et al., 2006) and proposition that organic agriculture can mediate the tradeoffs between food production and conservation in agricultural areas where low intensity farm systems are economically viable (Gabriel et al., 2009) suggest data are needed for accurate predictions about the outcomes for biodiversity from the increasingly widespread adoption of organic farming.

In our study region, the Central Great Plains of North America, wildlife-friendly farming practices available to organic farmers include diverse crop rotations with high and low intensity crops, increased heterogeneity, and linear grasslands, woodlands, and shrubs embedded within the farm in gradients of varied sizes, shapes, and extents. Land sparing practices (i.e., larger contiguous patches of protected or set-aside habitats (Phalan et al., 2011)), included managed pasture and set-aside lands primarily composed of grassland, though riparian woodlands are also important landscape elements.

Grassland birds are among the species in greatest conservation need in North American agricultural landscapes (Askins et al., 2007; Sauer et al., 2008). While most grassland species are not yet formally threatened or endangered, current population trends

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http://dx.doi.org/10.1016/j.agee.2012.07.021

Table 1
Description, classification, and summary statistics for mirco, local, and landscape variables from organic farms in Nebraska surveyed 2007–2009.

Scale/parameter	Land sparing or wildlife-friendly	Mean	SD
Microhabitat			
Bare soil	–	55.3	36.4
Total vegetation cover	–	40.3	30.9
Vegetation height	–	36.8	25.3
Veg. density	–	1.3	1.7
Local			
Linear woodland	Wildlife-friendly	2.9	8.2
Block woodland	Land sparing	3.9	14.5
Linear grassland	Wildlife-friendly	5.0	10.6
Block grassland	Land sparing	25.1	38.0
Shannon diversity index (SHDI)	Wildlife-friendly	0.8	0.4
Alfalfa	Wildlife-friendly	7.7	24.2
Corn	Land sparing	9.0	23.4
Small grain	Wildlife-friendly	11.3	26.9
Soybean	Land sparing	6.5	20.5
Landscape			
Grassland	Land sparing	28.0	16.4
Woodland	Land sparing	5.1	5.2
Shannon diversity index (SHDI)	Wildlife-friendly	1.7	0.2

warrant conservation concern. To address how practices associated with organic farming can compliment current conservation efforts we focused on the response of individual species of conservation need or recreation value rather than diversity metrics (e.g., species richness). While consideration of diversity metrics to evaluate conservation in agroecosystems has proved fruitful (e.g., Beecher et al., 2002), a need is evident (Phalan et al., 2011) to move the discussion about the tradeoffs of food production and conservation beyond aggregate measures of diversity and towards predictions of the response of individual species, in this case grassland birds. In turn, these data on individual species can be aggregated in setting targets and evaluating tradeoffs for multi-species conservation plans.

We focus on testing hypotheses derived from the gradients of land use and heterogeneity associated with organic farming at multiple spatial scales. Though theory regarding what practices, at what scale, and in what location a land use is considered wildlife-friendly or land sparing is still evolving (Fischer et al., 2008; Norris, 2008; Meehan et al., 2010; Phalan et al., 2011), in light of current dialogue, we classified model parameters in the framework of this active discussion. We identify land uses as wildlife-friendly or land sparing in the context of agroecosystems in the central Great Plains of the United Sates, an agroecoregion dominated by high-intensity row crop farm systems (Henebry et al., 2005). More specifically, we tested whether North American grassland birds were more abundant at points in organic farms associated with practices described as wildlife-friendly (e.g., narrow linear grasslands or tree buffers, heterogeneity, or low-intensity crops (Perlut et al., 2006; Mendenhall et al., 2011; Pickett and Siriwardena, 2011)) or as land sparing practices (e.g., contiguous blocks of non-crop habitat (Fischer et al., 2008; Phalan et al., 2011)). We measured availability of selected wildlife-friendly and land sparing practices (Table 1) within the farm and as part of the larger landscape around the organic farm. While we focused on the Great Plains, inference drawn from temperate North American prairies may provide applied conservation suggestions for other temperate grassland regions that have or are in the process of increasing agricultural output or considering organic farming as part of local conservation efforts.

2. Methods

2.1. Study region

The central Great Plains of North America historically transitioned from tallgrass prairie in the east to mixed and short grass farther west (Samson et al., 1998; Askins et al., 2007). However, land use and land cover of the region has undergone dramatic change in the last 200 years (Ellis and Ramankutty, 2008). Today, a limited number of agricultural land uses; in particular, conventional and genetically modified corn and soybean (Henebry et al., 2005) dominates the study area. As an alternate farming system, land dedicated to organic crop and livestock production is increasing. The total acreage of land managed under organic practices in the region, however, remains relatively small compared to other farm management systems (USDA, 2009).

2.2. Field sampling

We sampled 285 points embedded within 19 certified organic farms in the central Great Plains. We identified farm sites by soliciting participation from the organic farming community and by using criteria of current organic certification, row crops as part of the operation, and farm size ≥65.8 ha, large enough for sixteen sampling points. We located survey points on each farm by digitizing the farm perimeter and randomly selecting up to 16 points >200 m apart within each farm using HawthsTools extension (Beyer, 2004) for ArcMap (ESRI Redlands, CA). Trained field ornithologists visited each point four times between 14 May and 10 July during two of three years between 2007, 2008 and 2009. We applied unbounded point counts to maximize detections. While not as accurate for density estimates as other methods (e.g., fixed radius counts), in addition to maximizing detections, unbounded counts reduce bias with regard to bird-distance estimation, over-estimation at the perimeter of a count circle, and birds dispersing in response to the observer (Bani et al., 2006). In addition, while past analysis techniques were more limited by variations in detectability, we applied process–observation models (Royle and Dorazio, 2008) to more accurately account for variation in detectability caused by observer bias and reduced detectability due to wind (Quinn et al., 2011). Thus, by employing process–observation models we take advantage of the increased the number of observations in the data set, a valuable outcome when sampling low-density populations with low probability of detection. All counts were 5 min in duration and conducted within four hours of sunrise. We recorded average wind speed for ten seconds prior to each count using a Kestrel® 1000 Pocket Wind Meter (Boothwyn, PA). We did not conduct counts during times of high winds or heavy rain that limited visibility and we varied order and time of counts to limit bias.