Farmland bird diversity in contrasting agricultural landscapes of southwestern Poland

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HIGHLIGHTS

- Agricultural landscapes of Poland support dense populations of breeding birds.
- High bird abundances are strongly related to a diverse network of field margins.
- Noncropped habitats are more important for biodiversity than land-use diversification.
- Density of shrubby margins is a useful predictor of overall biodiversity in farmlands.
- Preventing landscape simplification should be a priority in complex agroecosystems.

ARTICLE INFO

ABSTRACT

Breeding bird communities were investigated in three contrasting agricultural landscapes of SW Poland to assess differences in abundance and determine the importance of field margins for bird populations. Counts were conducted in twelve 50-ha plots differing in landscape structure (density of all, permanent and shrubby field margins, and occurrence of high vegetation). Maps of bird distributions were used to analyze the associations of birds with four habitats: cropped fields, permanent fallows, field margins, mid-field woodlots. Ordination and classification techniques were applied to check between-plot differences in community composition. All landscapes supported high densities of total communities and farmland specialists. Species richness and bird densities were significantly related to field margin aggregations and arranged along a decreasing gradient of landscape heterogeneity: shrubby mosaic, open mosaic, open plain plots. Between-plot differences suggest that the occurrence of non-cropped habitats is more important for bird abundance than diversification of land-use. PCA and cluster analysis identified differences in species composition between the landscape types; and RDA revealed the significance of the shrubby and permanent margins for the community structure. The aggregation of shrubby margins seems to be a particularly useful predictor of bird abundance and overall biodiversity. Most species and breeding pairs were preferentially associated with margins, despite the habitat covering merely 4% of the area. The data confirmed that landscape heterogeneity with mosaic seminatural field margins is responsible for the persistence of internationally important bird populations in Poland. In such complex arable systems, preventing landscape simplification is the most effective method of biodiversity protection.

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1. Introduction

Due to environmental heterogeneity, farmed landscapes belong to the most biodiversity-rich landscapes in Europe. At the same time, in many taxa dramatic declines of farmland populations have been documented (de Heer, Kapos, & ten Brink, 2005) and persist despite huge policy and financial preventive efforts, such as

agri-environment schemes (AES) (Santana et al., 2014). Bird communities are commonly used to document these processes, and to quantify the health of overall farmland biodiversity. However, both the bird population metrics and extent of declines are highly uneven among regions, and those with retained traditional farming systems are of particular importance for agricultural biodiversity (Báldi & Batáry, 2011; Billeter et al., 2008; Kleijn et al., 2009; Tryjanowski et al., 2011). Therefore, it has been agreed that to protect biodiversity over larger (e.g., continental) scale conservation, methods should be better tailored to regional biodiversity indices and farming circumstances (Concepción et al., 2012; Jongman,

2002; Tscharntke, Klein, Kruess, Steffen-Dewenter, & Thies, 2005; Winqvist et al., 2011). Unfortunately, evidence regarding bird abundance and needs (i.e., the base for reliable recommendations) is also not proportional to biodiversity resources. The bulk of ornithological data and conservation proposals come from western Europe with many declining bird populations, whereas evidence from other biogeographic regions that are disproportionately richer in biodiversity, such as Central and Eastern Europe (CEE), are still insufficient, yet growing (Báldi, Batáry, & Kleijn, 2013; Herzon & O'Hara, 2007; Mander, Mikk, & Külvik, 1999; Reif, Voříšek, Šťastný, Bejček, & Petr, 2008; Sutcliffe et al., 2015).

The present study was conducted in one of such regions, in Poland, and examined how the communities of breeding birds respond to different levels of landscape complexity. The country is particularly suitable for this kind of analyzes, given a large area of farmland (>180,000 km^2), the existing types of agriculture, and an internationally important biodiversity (Kuczyński & Chylarecki, 2012; Tryjanowski, Kuźniak, Kujawa, & Jerzak, 2009). At the same time, the agricultural land in Poland is subject to unidirectional, detrimental transformations driven by economic growth, but also by agricultural policy after entering the European Union (EU) (Sanderson, Kucharz, Jobda, & Donald, 2013). These changes are likely to increase and affect the biodiversity in a larger, regional scale; therefore, up-to-date ecological data from species-rich farmlands are required for evidence-based actions to be made.

The landscape complexity in this study has been expressed through the common presence of field margins which are an important feature of the Polish agricultural landscapes. Indeed, in birds recent country-scale evidence indicates that among nine measures of agricultural management the woody edge habitats in Poland, such as tree lines and hedgerows, were the most consistent predictor of overall species richness and richness of target groups, such as species of conservation concern and farmland specialists (Sanderson, Kloch, Sachanowicz, & Donald, 2009). Several habitat-scale studies also confirmed that field margins in Poland are inhabited by rich and diverse communities of birds and other taxa, including regular occurrence of threatened species (Łęcki, 2004; Szymański & Antczak, 2013; Wuczyński, Dajdok, Wierzcholska, & Kujawa, 2014). However, the importance of field margins in a broader landscape perspective has rarely been studied. Thus, there are insufficient data quantifying the proportion of bird communities supported by margins, and overall habitat associations of farmland birds (Herzon, Auniņš, Elts, & Preikša, 2006; Skórka, Martyka, & Wójcik, 2006). Actually, this is the first study I know of that assesses the importance of field margins for bird populations in different farmlands of CEE. The under-representation of such information in recent literature also stems from the fact that many modern landscape assessments use remote sensing data which lack of detail (Hazeu et al., 2014; Kosicki & Chylarecki, 2012). Fine-scale linear landscape elements (hedgerows, forest strips, live fences, drainage ditches, little streams, roads, verges, footpaths, (Höbinger, Schindler, Seaman, Wrbka, & Weissenhofer, 2012)) and other key microhabitats are overseen in input datasets, limiting the accuracy of conclusions.

To assess the state and habitat associations of farmland birds, research on communities has principally focused either on broad scale assessments or on small-scale habitat studies. Studies at an intermediate spatial scale employing sample plots of several dozen ha are far less common (e.g. Heikkinen, Luoto, Virkkala, & Rainio, 2004). This scale allows the field work to be conducted with accuracy (e.g., using laborious but reliable mapping methods) and to count all species within the surveyed areas. As a result, there in a noticeable lack of recent studies in CEE comprising whole bird communities; most studies concentrate on selected species or ecological/taxonomic groups. Tryjanowski et al. (2009) reviewed the Polish literature on avian ecology and found merely 11 quality studies assessing the complete bird communities on sound agricultural landscape plots (>3 km^2).

The aims of this paper were to assess: (1) bird species richness and abundance in contrasting agricultural landscapes of SW Poland, (2) number of bird species, breeding density and community composition in response to the aggregation of different field margin types and, (3) the input of four major habitats in the studied landscapes to the whole bird community and the most numerous species, including the share of pairs breeding in field margins.

2. Methods

2.1. Study area

The study was conducted in diverse agricultural landscapes of the Lower Silesia region covering the SW corner of Poland. The region is not homogeneous regarding agricultural landscapes and farming intensity. Generally, farming in the Lower Silesia is more intensive than in Eastern Poland (that often resemble traditional farmlands), but not as much as in some Western European countries. The intensification processes are clearly visible in parts of the region, but many characteristics of low-intensity farming still retained in the other parts. SW Poland represents typical Central-European landscape, which has been confirmed by comparable values of indicators of land-use and agricultural production (see Wuczyński et al., 2014). These regional features allowed a comparative between-landscape study to be conducted within one geographical unit.

2.1.1. Landscape plots

Twelve study plots of ca. 50 ha each (603.2 ha). Three contrasting groups of plots were selected to reflect the prevailing types of modern arable farmland in Poland, and more generally in CEE (Fig. 1, Table 1, Appendix A):

Shrubby mosaic plots: Covered by small, privately-owned fields (0.1 ha up to 8.6 ha), a few mid-field woodlots and a few permanent fallows, and a network of linear, semi-natural field margins (described below). These heterogeneous plots reflected a model of traditional, low-intensity farming, which is disappearing in Europe but still exists in some Polish landscapes. According to recent terminology applied to agricultural landscapes, shrubby mosaic plots match the "High Nature Value Farmland Type 2" (i.e., "farmland with a mosaic of low intensity agriculture and natural and structural elements, such as field margins, hedgerows, stone walls, patches of woodland or scrub, small rivers" (Paracchini, Terres, Petersen, & Hoogeveen, 2007)).

Open mosaic plots: Similar to the shrubby mosaic plots according to ownership, land-use and field sizes, but almost lacking of high vegetation. Open mosaics are common especially in lowlands of central and eastern Poland.

Open plain plots: Intensively used, covered by a few large arable fields and, consequently, with a very low aggregation of field margins and almost devoid of other non-cropped habitats. This type of farmland is rapidly increasing after EU accession, especially in western Poland.

It is noteworthy that the open mosaic and open plain plots were combined in some analyzes. Each plot was digitally mapped using GIS, allowing for further spatial analyzes. Altogether, cropland (including 2.2% of grasslands) constituted 91.1% of the area, followed by 4.4% permanent fallows (covered by perennial vegetation), 4.0% field margins, 0.4% mid-field copses; mean area 0.36 ha, range 0.03–0.96 ha, $N = 7$; Fig. 1). The main crops were winter- and spring-sown cereals (ratio – ca 4:1, respectively, mainly wheat, barley, rye), oilseed rape, maize, and root plants (e.g., potatoes, sugar beets). Fallows, copses, and grasslands occurred almost exclusively