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Species richness and composition of bird communities in various field margins of Poland

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ABSTRACT

A study was conducted to determine the occurrence of bird species in relation to 70 field margins of an agricultural landscape in SW Poland. Three types of margins were divided according to the volume of tall vegetation, i.e. herbaceous, shrubby, and tree lined. Fifty breeding bird species were recorded, with a mean density of 33.2 pairs/km. The dominant species were non-threatened and were characteristic of forests or of the field-forest mosaic. Tree lined margins showed the highest abundance and bird species richness. Shrubby margins supported the second highest, while open habitats ranked last. Abundances in ecological guilds were affected by the margin type, the presence of field roads, and especially the presence of ditches in the margin structure. Redundancy Analysis showed clear differences in bird communities between the discernable types of field margins. Species richness increased in the combinations of various margin types. In heterogeneous farmland environmental policy should aim at maintaining various types of field margins at high density in the agricultural landscape.

1. Introduction

It is commonly accepted, that an increase in the heterogeneity of the agricultural landscape has a positive influence on agroecosystem biodiversity (Benton et al., 2003; Fuller et al., 2004; Tscharntke et al., 2005). On many farmlands, perennial field margins play a key role as the most common semi-natural habitats (Marshall et al., 2002). In spite of the important environmental role, a large-scale elimination of field margins has been taking place in intensively farmed regions, like Western Europe, for the last few decades (Le Cœur et al., 2002; Robinson and Sutherland, 2002). In contrast, large parts of Central and Eastern Europe have a rich network of semi-natural field margins that have been maintained as remnants of traditional farming. These margins are one of the main reasons why biodiversity is higher in Central and Eastern Europe (Donald et al., 2001; EEA, 2004; Reif et al., 2008).

About 60.7% of the area of Poland (312 679 km^2) is covered by farmland (Central Statistical Office, 2009). It is a country which has one of the largest reserves of environmental diversity in the European agricultural landscape, and it supports very large populations of farmland specialists, like *Ciconia ciconia* (38% of the total EU27 population), *Perdix perdix* (32%), *Emberiza hortulana* (28%) or *Alauda arvensis* (21%) (BirdLife International, 2004). More than 1.5 million ha, equal to nearly 10% of all Polish farmland, have been classified as important bird areas. Nearly half of the more than 2.5 million farms are still smaller than two ha (Central Statistical Office, 2009). Locally, the traditional model of field division has also been conserved, i.e. perennial field borders (mostly grassy, sometimes with shrubs or trees, e.g. fruit trees). Poland probably also has the largest area (1.5 million ha) of fields drained by well-vegetated, open field drains, in Northern and Western Europe (Herzon and Helenius, 2008). The network of field borders, unsurfaced roads, drainage ditches, and scarps results in a higher density of field margins than in other parts of Europe. In the last few years, however, these farmlands have been severely threatened by abandonment, afforestation, subsurface drainage, or agricultural intensification (Keenleyside et al., 2006; Pullin et al., 2009; Stoate et al., 2009). Some ecological processes and key habitats specific to the Polish agricultural landscape have only recently been studied more intensively (for a review, see Tryjanowski et al., 2009), so they may disappear before a more detailed documentation has been collected.

The first aim of this paper was to compare breeding bird distributions in three types of margins distinguished on the basis of the vertical structure of vegetation. The second aim was to provide evidence for shaping the agricultural landscape

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in favour of optimal biodiversity protection. We hypothesize that: (i) species composition and bird population indices are affected by field margin structure, (ii) diversity of field margin types in farmland is beneficial for bird species richness.

2. Study area and methods

Field research was carried out in Lower Silesia (SW Poland), in the patchy agricultural landscape dominated by small fields of up to several hectares. A single study plot was a field margin *sensu* Greaves and Marshall (1987), i.e. the area between neighbouring fields, usually with a functional component (road, ditch), and adjacent strips of spontaneous semi-natural vegetation. This study involved 70 field margins. In each of them, a 500 m section was designated for bird counting and analysis of vegetation structure. The sections were not adjacent to each other. The maximum distance between sections was 35 km. The study plots were selected to reflect the most common model of field margins in the Polish agricultural landscape. The studied margins included: a ditch (37), road (12), ditch + road (12), unused railway tracks (3), unused railway tracks + road (1) and five field borders without any additional function. The mean width of the field margins was 11.7 m (range 4.9–29.0 m, SD = 5.1).

The margins were covered with lush, usually multilayered vegetation. Most of the recorded plant species were native. Those that were aliens (archaeophytes and neophytes) amounted to 19.5% of the 411 vascular plant species recorded within the field margins (Dajdok and Wuczyński, 2008). Some margins were completely dominated by the common reed *Phragmites australis*.

The herbaceous layer was mainly composed of perennial species. Among them, the most common grass species included *Elymus repens*, *Arrhenatherum elatius*, *Dactylis glomerata*, and *Alopecurus pratensis*, while the most widespread dicotyledons included *Urtica dioica*, *Artemisia vulgaris*, *Anthriscus sylvestris*, and *Aegopodium podagraria*. Herbaceous vegetation in the majority of the transects covered nearly 100% of the margin area, but its cover was inversely proportional to the density of trees and shrubs.

In the shrub layer, drier margins included spiny species, mostly *Rosa* spp. and *Crataegus* spp. The shrub species along ditches were mainly *Salix* spp. and *Sambucus nigra*. In some other field margins, *Prunus spinosa* formed dense thickets.

The tree layer included mostly *S. fragilis* and *S. alba*, *Alnus glutinosa*, *Fraxinus excelsior*, and *Quercus robur*. In some field margins, fruit trees were found, mostly *Prunus avium* or *Malus* sp. But no coniferous trees or shrubs were recorded.

For each 500 m section, the total volume of tall vegetation was calculated as V(m^3), from the formula: $V = L \times W \times H$, where L (m) is the total length of trees and shrubs along the whole section, which was measured by step counting. W (m) is the width and H (m) is the height of woody vegetation, measured at five points in each section: at 50, 150, 250, 350, and 450 m. Measurements were made for canopy outlines as follows: width was taken using a tape, while height of lower shrubs with a scaled stick, and higher shrubs or trees were measured using a SUNTO PM5/1520 Height Meter. The mean value of all five measurements was used in further analyses.

The data were analysed jointly for all 70 transects, and separately for the three types distinguished on the basis of tall vegetation volume:

(a) herbaceous (V range: 0–5 × 10^3 m^3, V mean = 1596 m^3, N = 21), with a well-developed herb layer but no trees and shrubs, or with scarce and low shrubs;
(b) shrubby (V range: 5–20 × 10^3 m^3, V mean = 9537 m^3, N = 29), with a moderate number of shrubs, sometimes forming low natural hedgerows, with infrequent trees. Three margins had remnants of fruit tree lines;
(c) tree lines, including tall natural hedgerows (V range: 20–128600 × 10^3 m^3, V mean = 53694 m^3, N = 20), most of them (17/20) formed spontaneously along watercourses, with tall vegetation along the whole section. There were many old trees, and a dense shrub layer.

2.1. Bird surveys

The territory mapping method (Tomiałojć, 1980; Sutherland, 2006) was used to characterize avian communities in field margins. In the middle of the breeding season of 2006 and 2007, three bird surveys were taken on days when there was no wind or rain. The surveys were done in the morning, from dawn till 10.00, during peak bird activity. The researcher walked along the whole 500 m section once, and counted the birds. Each bird encountered was marked on a map (scale 1:2000) based on orthophotomaps, using standard codes. Special attention was paid to simultaneous territorial records (e.g. singing) of males, and to direct evidence of breeding: found nests, birds carrying nesting materials, food, etc. Flights of birds over the margins were not registered. Counts were carried out by three experienced observers (the authors), who changed field margins randomly within each season. The changes were done to avoid errors associated with individual differences in bird detection. Each count took 20–60 min, depending on the vegetation structure. The shortest counts were done in herbaceous field margins, and the longest in tree lines.

2.2. Data analysis

The breeding territories of individual pairs were designated and counted based on cluster sightings. In doubtful situations, the range of possible values were noted, and the mean value was used for further analyses. For the species that nested within the field margin but foraged in the neighbourhood, all territories were treated as belonging to the transect. For each transect, the mean number of breeding pairs of all species, in both years, and the total number of species were calculated. *Cuculus canorus*, because of its unusual breeding system, was accounted for in the number of species but not in the number of breeding pairs. Map interpretation was done by one person only (AW) to minimise bias related to subjectivity.

Species were classified into four functional groups based on: preferred habitat (F = forest; M = field-forest mosaic; P = open areas; W = aquatic habitats), nest location (N1 = on the ground; N2 = in vegetation up to 1.5 m high; N3 = in tall vegetation above 1.5 m high; H = in tree holes), diet (I = insectivorous; G = granivorous; C = carnivorous; O = omnivorous), and migration status (R = resident or nomadic; K = short-distance migrant; T = tropical migrant) (Tryjanowski, 1999; Tworek, 2002).

Linear Mixed Models (LMM) were built to test the effect of the field margin type on bird species richness, number of breeding pairs, and the number of breeding pairs of each ecological guild. The year and features of the margin structure were included as additional explanatory variables. In the models, the year was used as a fixed effect. The margin type and the four functional components (the presence of a road, ditch, railway track, and a baulk – a field border without any additional function) were used as random effects. Due to the relatively small number of sample plots and the unbalanced design of the explanatory variables, the analysis was restricted to the main effects, without interactions. Components of variance were estimated by the expected mean squares method and the type I sum of squares. Normality of the distribution of the raw dependent variables was assessed using normal probability plots. Square root transformation was used when necessary. The species richness in each ecological guild, and the number of