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The abundance of a farmland specialist bird, the skylark, in three European regions with contrasting agricultural management

Jaroslav Koleček[a,b,*], Jiří Reif[a,c], Karel Weidinger[a]

[a] Department of Zoology and Laboratory of Ornithology, Faculty of Science, Palacký University in Olomouc, 17. listopadu 50, CZ-77146 Olomouc, Czech Republic
[b] Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, v.v.i., Květná 8, CZ-60365 Brno, Czech Republic
[c] Institute for Environmental Studies, Faculty of Science, Charles University in Prague, Benátská 2, Praha 2, CZ-12801, Czech Republic

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ABSTRACT

Advances in our understanding of recent farmland biodiversity loss have mainly come from studies in Western Europe. The application of such findings to other regions is questionable, however, and limits the outcomes of management actions. To bridge this knowledge gap, we focused on relationships between farmland bird abundance and sward height and crop type, counting breeding birds in three Central European regions with different agricultural histories and practices: the Eastern Czech Republic, Western Germany and Central Poland. We used the skylark (*Alauda arvensis*) as a model species due to its tight association with open habitats year-round and its commonness in European farmland. Skylarks were more abundant in Poland than in Germany and the Czech Republic, probably due to less intensive farmland management. Mean abundance declined with growing sward height from April to June and slightly declined with the number of fields surrounding study sites in all regions. Autumn- and spring-sown cereals hosted the highest abundance of skylarks in May, with lower abundance in maize, oilseed rape and meadows irrespective of region. This variation in skylark numbers suggests a temporal shift in abundance, probably reflecting movement between crops with optimal sward height. Taken together, these results indicate that skylark habitat use is somewhat conserved over regions and this knowledge can be used in management plans throughout Europe. However, the observed differences in skylark abundance between regions suggest that the regional-specific level of agricultural intensity may affect the delivery of conservation benefits from such plans.

1. Introduction

The European farmland landscape has undergone a rapid loss of biodiversity over the last few decades (Butler et al., 2007; Butchart et al., 2010). At the same time, most of our knowledge of the causes is based on studies from Western European countries (Tryjanowski et al., 2011), despite the fact that Eastern Europe is a continental biodiversity stronghold (Galewski et al., 2011). Due to large differences in farming practices and environmental conditions, it is important to explore whether the relationships between farmland biodiversity and its environment hold in different regions (Báldi and Batáry, 2011). This will enable a better understanding of which management options can be applied throughout Europe and which ones must be developed specifically for each region (Batáry et al., 2011), a crucial factor in halting further farmland biodiversity loss (Kleijn et al., 2011).

Farmland birds are important for the functioning of agricultural ecosystems (Breitbach et al., 2010), and their population trajectories are indicative of environmental health (Gregory et al., 2005). It has been shown that the switch from extensive agricultural practices to cultivating crops with tall and dense sward is among the major agents negatively affecting farmland bird abundance and species richness (Chamberlain and Fuller, 2000) due to reduced food availability and possibilities for nesting (Donald et al., 2001; Douglas et al., 2010). Despite this, there is a lack of comparisons of such relationships among European regions differing in agricultural practices (but see Guerrero et al., 2011).

We collected field data to analyze factors affecting farmland bird abundance in three Central European regions with different agricultural histories and practices: Eastern Czech Republic, Western Germany and Central Poland. In the Czech Republic, collectivization of agriculture under the totalitarian government

* Corresponding author at: Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, v.v.i., Květná 8, CZ-60365 Brno, Czech Republic.
E-mail addresses: j.kolecek@gmail.com (J. Koleček), jirireif@natur.cuni.cz (J. Reif), weiding@prfnw.upol.cz (K. Weidinger).

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before 1989 resulted in corporate farms of large sizes and intensive farming followed by advent of autumn-sown crops (Kuskova et al., 2008; Scrieciu, 2011). Although the intensity of agriculture decreased after 1989, farm size remained very large (Reif et al., 2008). Western Germany has a developed high intensity agricultural system, also represented by a large proportion of autumn-sown crops, with further intensification in the past few years, but with small fields and more heterogeneous farmland (Baas and Brücker, 2009; Kroll and Haase, 2010). In Poland, by contrast, extensive small-scale farming of a subsistence or semi-subsistence nature with prevailing traditional spring-sown crop management persists despite increasing intensity after entering the European Union in 2004 (Scrieciu, 2011; Sanderson et al., 2013). At the same time, all three study regions are located in the Continental biogeographical region of Central Europe, with very similar climatic conditions and biogeographical history (Liamine, 2008). Therefore, we assumed that differences in farmland bird abundance among the study regions mirror agricultural differences and not other confounding factors.

We used the skylark (*Alauda arvensis*) as a model species, since it is one of the most common farmland birds in Europe and also one of the species with the tightest association to open habitats year-round (Burfield and Van Bommel, 2004; Donald, 2004). It prefers extensive areas of homogeneous open habitats (Donald, 2004) and is known to be extremely sensitive to farmland management (Fuller, 2000; Donald, 2004; Wilson et al., 2009), and thus an ideal species for the purposes of this study.

Using data on abundance during the breeding season we estimated skylark density in individual crops in each region. We analyzed changes in abundance during the breeding season in relation to sward height and crop type. We also compared the relative effect of local field sizes on the abundance of skylark between these regions. Based on the widely documented skylark preference for relatively short vegetation (Donald et al., 2001; Toepfer and Stubbe, 2001; Eraud and Boutin, 2002), we predicted that (i) in all regions, the abundance of skylark would decline in focal crops with growing sward height during the breeding season. (ii) We also predicted that study sites surrounded by smaller number of large fields would show a higher abundance of skylark than those in landscapes containing more small-sized fields. (iii) Finally, we predicted that the region with more intensive farming practices (Western Germany) would show lower abundances of skylarks than the regions in post-communist countries (Central Poland, Eastern Czech Republic).

2. Methods

2.1. Study regions and sites

The study was conducted in three regions characterized by flat, open agricultural landscapes, each located in a different country: Eastern Czech Republic (CZ) in vicinity of the city Olomouc (49°35′N 17°16′E, 219 m a.s.l.), Western Germany (WG) close to the city Frankfurt am Main (50°7′N 8°41′E, 112 m a.s.l.), and Central Poland (PL) in the vicinity of the town Chocz (51°59′N 17°52′E, 91 m a.s.l.), about 80 km SE of Poznań. In each region we established study sites (18 in CZ, 10 in WG and 8 in PL) for bird surveys in two steps. First, we detected the largest agricultural areas (i.e., those not fragmented by forests or human settlements) with the focal crops present within each region. Second, we established study sites in these areas using belt transects (see Section 2.2) along the longest extent of a given agricultural area delimited by natural or anthropogenic barriers (e.g., forests, built-up areas, water bodies). At each site, the transect length varied between 1000 and 8900 m in fields with focal crops (median = 2643 m; up to 22 fields per transect; Table A1). Skylark counts were performed in fields with crops dominating at the study sites, i.e., autumn- and spring-sown cereals, oilseed rape, maize, and managed, non-grazed meadows (Table A1).

2.2. Bird census

To estimate skylark abundances in a high number of fields in a relatively short time we used the belt-transect method (see Bibby et al., 2007; for skylarks see Suárez et al., 2003; Hiron et al., 2012). Skylark counts were conducted during morning hours between dawn and four hours after dawn with favorable weather conditions (no heavy rain, strong wind or mist) in the peak of the skylark breeding season (April–June). One study site was surveyed per day. In CZ, 10 study sites were visited three times in 2010—once a month in April–June. The remaining 8 study sites in CZ were visited once in May 2012. In WG, 8 study sites were surveyed three times in 2011 (once a month in April–June), and the remaining two sites in WG were visited only once in May 2011. In PL, all 8 study sites were visited once during May 2012 (Table A2). The order of surveying study sites followed a random pattern and changed between visits (in the case of sites visited more than once).

Birds were always counted by JK walking slowly along transects. In each field, all skylarks seen or heard were recorded within 50 m of both sides of the transect (i.e., the total belt width was 100 m). Birds that had been flushed from the field when approaching were included in counts. Each skylark was recorded only once during one visit. Although we cannot exclude the double counting of some moving individuals, we suppose this effect to be minor given the general good visibility in these open landscapes and movement of the observer. For further analyses, territorial individuals (i.e., singing males) were considered as one pair, all others as 0.5 pair. The number of pairs detected along the transect leading through one field during one visit was summed and rounded up to the nearest integer, to be used in the statistical models. To estimate average raw densities we related abundances to the area of the belt in each field.

2.3. Habitat and farmland structure

Sward height (cm) was recorded for each field during each count from two 1 m $\times$ 1 m quadrants and was estimated as the mean sward height from ten positions in each quadrant (Table A3).

Farmland structure was analyzed using Google Maps (maps.google.com) and expressed as the number of fields (i.e., arable fields and meadows) in a belt covering 2 km in width along each census transect (see below). We counted the total number of fields, regardless of their area falling into the belt. The number of fields surrounding census transects differed markedly among individual regions—7 fields/km^2 in CZ ($\pm$3 SD, min. = 3, max. = 14), 43 fields/km^2 in WG ($\pm$18 SD, min. = 29, max. = 92) and 38 fields/km^2 in PL ($\pm$11 SD, min. = 24, max. = 54). Thus we centered the number of fields at each site on the regional mean in order to separate, by means of statistical analysis, the 'pure' effect of the number of fields from the influence of various other region-specific factors captured by the effect of individual regions.

2.4. Data analysis

We related the skylark abundance to various explanatory variables using statistical models assuming a Poisson error distribution and log link function (Crawley, 2012) in R (R Core Team, 2013). The response variable was always the number of counted pairs in each field (see Section 2.2). To control for the effect of unequal field size, the log length of a transect crossing each field was specified as an offset variable in all models (Crawley, 2012). This approach enables modeling and comparing skylark densities, and has already been used to analyze farmland bird abundance (Copland et al., 2012).