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Farmland bird communities in an agricultural landscape in Northwest Russia: Seasonal and spatial patterns

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ABSTRACT

We conducted an inventory of birds in an agricultural landscape of 45 000 ha in the Northwest Russia, compared breeding densities of farmland species among existing fields types, and followed the seasonal pattern of field use by birds over a period of three months of May–July. We collected the data on transects in 2005, 2006, 2008, 2010 and 2011. We analysed seasonal and spatial patterns of field use by generalised additive mixed models and multivariate procedures. The results confirm the importance of the region's agrolandscape for migrating birds. We observed distinct species communities among field types, especially in arable fields during spring migration and in abandoned fields and pastures in late summer. Pastures, multispecies grasslands as well as abandoned fields exhibited a particularly high habitat value for farmland birds. Arable fields had low habitat values for breeding birds. Our study reinforces the importance of a mosaic of land uses within the agrolandscape not only due to the species-specific habitat selection by breeding birds but also intra-seasonal variation in field utilisation for both breeding and non-breeding purposes. The results indicate that extensive use of grasslands, retention of some of the abandoned fields as open fallows, and certain increase of production on cereal fields could be a nature-friendly alternative for increasing agricultural production in the region.

1. Introduction

In Europe, agricultural land occupies almost half of the total land area (Eurostat, 2012). Recognition of its role as habitats for non-production species is reflected in extensive research of species and communities associated with farmland. However, the research effort is disproportionally concentrated in Western Europe (Tryjanowski et al., 2011), where the plight of farmland biodiversity has been documented and publicised most strongly (Krebs et al., 1999). In countries with comparatively large areas being outside regular human disturbance (for instance, the USA, the former USSR), biodiversity of agricultural lands has been traditionally regarded of a low conservation priority. In recent years, there has been a growing interest in flora and fauna of agricultural landscapes in such regions (e.g. Freemark et al., 2002; Kamp et al., 2011), including the Russian Federation (e.g. Kuitunen et al., 2003; Oparin, 2008; Sviridova et al., 2008; Kutin and Konstantinov, 2008; Kondratyev et al., 2006; Broyer et al., 2010). These have established some patterns in the present habitat selection and population dynamics of birds for a number of agricultural landscapes in the Russian Federation. However, due the country's size, the regional variation is bound to be considerable. All the studies so far have been based on a restricted sample of fields from the agricultural landscapes or on a particular type of fields within them. The survey over the whole landscape has a potential to provide a complete picture of its use by birds over all the available range of field types.

There are at least two aspects of scientific and applied interest in investigating the ecological condition of agrolandscapes in the Russian Federation, especially in the regions bordering the European Union (EU). Firstly, even the basic knowledge about the composition and relative abundances of species utilising the fields provides a valuable benchmark to monitor the changes along plausible agricultural development. Understanding the region-specific biodiversity patterns in agricultural landscapes is also the first step in evaluating alternatives for the agricultural development in terms of nature conservation. Information may also provide a glimpse into a past situation in some of the Eastern European countries, where the respective data are missing, before the onset of agricultural intensification driven by the EU policies. Secondly, evidence from such agricultural landscapes may have relevance for improving an ecological state of farmland in the EU.

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In this study, we documented the distribution of birds on all fields over a large agricultural landscape in Northwest Russia and for the first time quantified species' relative densities according to field types and over an extended season over several years. Here we: (1) identify bird species utilising fields over the entire agrolandscape of the district; (2) examine the temporal dynamics of field use by bird species across a season ranging from the spring migration to the post-breeding movements, and (3) quantify the relative values of field types for the farmland bird community. We propose a number of ways that nature conservation can be taken into account while developing the agricultural production in the region.

2. Materials and methods

2.1. Study area

We carried out research in the Gatchina administrative district of Leningrad region in Northwest Russia (59°30′ N and 30°2′ E; Fig. 1). The region lies in the hemi-boreal zone of Europe occupying the area of 175 116 km^2. The Gatchina district is one of the region's largest districts and covers an area of 2900 km^2 (3.3% of the region). Its population is about 7% of that of the region. It is a flat landscape within typical moraine lowlands (elevation of 50–100 m) crossed by the river Oredezh. The soils are of a carbonate Ordovic type with intensive natural drainage (the northern part of the district) and sod-podzolic soils with poor drainage and excess wetness. Largest fields concentrate in the north within the most open landscape, while the fields in the south tend to be small and fragmented by forest (Supplementary material, Fig. 1). Forests make up 60% of the district's area, farmland 28%, settlements 6%, and wetlands 0.5%.

Agriculture is a dominant economic activity that is practised on the area of 450 km^2, of which 344 km^2 is arable (including sown grassland). The district is an important producer of food for Saint Petersburg (the region's capital of 8 million people), delivering 15% of the region's grain and 12% of its milk. Dairy is the main agricultural production line. During the study period, farmland consisted of 90 km^2 of arable crops, 230 km^2 of grassland used for hay, 50 km^2 of pastures, and 80 km^2 of long-term fallows and abandoned fields. Due to its proximity to Saint Petersburg, the district represents an agrolandscape under a transition to more intensified forms of agricultural production.

2.2. Data collection

We surveyed birds in 2005, 2006, 2008, 2010, and 2011. We collected three subsets of data. Firstly, in 2005 and 2006, we conducted an inventory of the whole agricultural area of the district – 45 061 ha and 1224 fields – using a modification of the transect count method (Bibby et al., 1992). We placed one or two transects across each field along its longest side at a distance of at least 500 m from each other so that all individuals of large species of birds (such as waders and birds of prey) could be detected. Two to three bird counters were surveying transects on any field day from 7 am to 11 am under appropriate weather conditions. They checked possible double detections of large birds at the end of fieldwork by comparing observations. We used a detection belt of 50-m for small passerines and 250 m for *Corvids* and non-passerines. We surveyed each field once over an extended period from mid-May to the end of July to record the use of fields before the initiation of breeding and after it. We used these data to identify bird species using the district's agrolandscape, and to select a representative sample of field types.

Secondly, we established three permanent transects in three landscape sub-areas. These crossed 32 arable fields (total transect length 19.4 km), 10 abandoned fields (4.9 km), 49 grasslands (34.8 km), and 16 pastures (16 km). We counted birds within the same belts of 50 m (for passerines) and 250 m (for non-passerines) 10 times, i.e. every 10 days from April 26 to July 28 in 2006. We aimed to explore the sequence and intensity of field use by birds starting with the arrival of breeding birds and up to the post-breeding movements of family groups. In the analysis, we used all observations of bird individuals, including foraging birds and fledglings.

Thirdly, in 2008, 2010 and 2011, we surveyed a random sample of the fields so that the field types were represented in relation to their occurrence in the district. In order to obtain more accurate estimates of the abundance of passerine birds, we run the counts twice a season with the central dates of mid-May and mid-June using the same transect method but with only one transect per field to insure independence of the samples. We surveyed a total of 230 fields in the area of 110 km^2 (Table 1) and over 215 km of transects in each of the three years. The final number of abandoned fields surveyed was slightly lower than the average in the district because we excluded the overgrown fields from the surveys. The numbers of field types also slightly varied year on year due to crop rotations (Table 1). We used the registrations of breeding individuals to estimate the relative differences in bird species' occurrence among the field types.

We mapped field types in each year during the field visits using land-use maps (1:10 000). We identified field types following the detailed characteristics of vegetation and field management at a particular time period as: root vegetables, spring and winter cereals, first-year sown grasses, monospecific grassland (grassland sown with legume-grass mixture), multispecies grassland (permanent hay fields that developed a diverse grass and forb swards), pasture, abandoned arable land, abandoned grassland. We distinguished two types of abandoned fields. Former arable fields were characterised by vegetation dominated by arable weeds (e.g. *Cirsium* sp., *Urtica dioica*), lack of sown fodder species and a well-established litter layer. Former grasslands were grasslands that lacked signs of management from the previous year (cut or grazed sward). If a field was returned to use in a survey year (mown or pastured), it was regarded as a grassland or pasture. We did not survey abandoned agricultural fields when a cover of scrub and trees exceeded 30% of the field area.

All fieldworkers – 13 people in 2005 and 2006, and three in 2008, 2010 and 2011 – were professional ornithologists or trained students. Prior to the survey, all of them underwent training in the count method and in describing agricultural habitats. All transects are stored in GIS system.

2.3. Data analysis

We used the data from the whole district inventory for compiling a list of bird species using the district's agrolandscape but not for purposes of testing patterns. We used the data from the permanent transects to model the seasonality effect (i.e. timing of the count on the permanent transects, one to 10) and field type (factor with four classes: arable fields, grasslands, pastures, and abandoned fields) and their interaction with generalised additive mixed models (GAMM) in R (R. Development Core Team, 2013). We pooled the original field types as: arable land (root vegetables, spring cereal, winter cereal, first-year sown grasses), grassland (monospecific grassland and multiple species grassland), pasture, and abandoned fields (abandoned arable land and abandoned grassland) to improve the sample sizes (Table 1). We used repeated measures set-up and Poisson distribution in R packages *mgcv* (Wood, 2013) and *nlme* (Pinheiro et al., 2013). We controlled the effect of overdispersion on estimated standard errors by using a quasi-GLM model (Zuur et al., 2009) and spatial variation in counts between fields by including random intercept to the models.