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Bird communities in agricultural landscapes: What are the current drivers of temporal trends?

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ABSTRACT

Bird populations are declining in agricultural landscapes, which is ongoing for decades now. With standardized breeding bird observation data of five years within 2001–2014 from six sites in Central Germany we investigated whether trends in bird abundance are reflected by trends in species richness and whether these trends depend on the landscape context. We further analyzed whether trends and their dependencies on the landscape context differ among species groups according to their particular traits. For most of the groups (farmland birds, large birds, resident birds, short distance migrators, insectivores, granivores and birds of prey) we found declining trends in abundance. However, these trends were not reflected by species richness. In contrast to our expectations, high amounts of semi-natural habitats in the landscape did not buffer the overall negative trends. Surprisingly, bird abundance declined most in landscapes characterized by larger ranges in altitude and initially highest bird abundance in 2001. We conclude that flat landscapes in Central Germany have been utilized with high intensity already for a long time and they simply maintained their already low bird abundance. On the other hand, a recent increase in agricultural intensity in landscapes with marked altitudinal reliefs, and presumably less usability and productivity, causes the drastic declines in bird abundances. Since these strong declines are not related to habitat loss, we assume that changes in the management of agricultural fields are responsible.

1. Introduction

It is evident that birds are declining in agricultural landscapes since the last quarter of the 20th century (Donald et al., 2001, 2006), but knowledge about the underlying mechanisms and how to recover from often negative trends is still scarce (Benton, 2007). In Europe, agriculture is the dominating land use covering about 43% of the land (Eurostat, 2015) and in Germany the share is even higher (52%; Statistisches Bundesamt, 2014). While the share in land cover is impressive by itself, the dynamic component is the agricultural practice following feasibility based on technological progress triggered by economic incentives like e.g. subsidies for energy plants. From the past decades up to now, agricultural practice in the EU was characterized by intensification affecting the output per area and homogenization in terms of crops grown (Donald et al., 2006; Vickery et al., 2004). This sets the frame for the occurrence and abundance of species bound to open landscapes such as many birds. Birds are highly sensitive to agricultural intensification (Dormann et al., 2007; Billeter et al., 2008; Reif, 2013). Land transformation from semi-natural habitats to agricultural areas is usually thought to be one of the major drivers for these declines (Gaston et al., 2003). However, the rate of transformation already peaked around the 1950ies (Seppelt et al., 2014) but other drivers might gain importance. For instance, in the UK, several interrelated trends in agricultural practice have been identified with potential implications for bird populations: reduction of spring sown cereals, simplification of crop rotations, increased use of inorganic fertilizers and chemical pesticides and more intensive grassland management (Fuller et al., 1995). Further, climate change has also been shown to impact local bird communities over time (Devictor et al., 2008, 2012).

It has been suggested that increasing the amount of semi-natural habitat may act as buffer against other threats (Oliver et al., 2015) and current regulations of the EU Common Agricultural Policy (CAP) and the EU strategy for Green Infrastructure could be beneficial in this context. However, whether improving semi-natural habitats in intensively used agricultural areas is effective for a large number of species with considerably differences in their ecology still needs to be proven.

The response of species to environmental change largely depends on their traits (e.g. Öckinger et al., 2010; Webb et al., 2010), as the environment is thought to filter particular species according

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to these traits. In a recent paper Reif (2013) reviewed long-term trends in bird populations in relation to species' traits. These approaches provided important insights into the drivers responsible for long-term changes in bird abundance. The trait-based approach resulted also in the common farmland birds index, an European Union agri-environmental indicator focusing on species characteristic for agricultural areas. These species are bound to open habitats by feeding and breeding habits as well. Besides habitat-related trait groupings, like in farmland bird species, several other traits are relevant to assess responses to environmental change (see review in Reif, 2013). In terms of biomass of species, smaller birds are in general more abundant but also decline stronger than larger species (Inger et al., 2015). The migratory status of species is related to the sharing of resources like territories, as these are divided between residents and early or late incoming migrants. Changes in winter and spring temperature caused by climate change alter the proportion of migratory birds within communities (Lemoine et al., 2007). Further, different feeding guilds are likely to respond in different ways to land-use change (Litteral and Wu, 2012) since anthropogenic land use influences the availability of food for different feeding guilds like insectivorous or granivorous species.

Nowadays the value of long-term data sets for detecting trends in ecosystems and components like species is evident (e.g. Devictor et al., 2012), supporting other research and monitoring projects with a long term perspective. One of these initiatives in Germany is the TERENO (Terrestrial Environmental Observatories) project of the Helmholtz Association. One issue of TERENO is biodiversity monitoring of plants, pollinators and birds. In this study, we focus on local bird communities in 'normal' landscapes in Central Germany, which are typically dominated by intensive agriculture, since the soils are among the most productive in Germany and occur on very flat, easily manageable, plains. This provides a suitable testing ground for the effects of landscape properties or intensive agriculture on the temporal trends in bird communities.

Here we analyze time-series data of local bird communities in six agricultural landscapes in Central Germany. In particular, we investigate (1) whether the same temporal trends occur in terms of both abundance and species richness. (2) We expect that landscape features affect temporal trends, in particular, that landscapes with higher proportions of semi-natural habitats can slow down declines, while declines are much stronger in intensively used landscapes. (3) Finally, we suggest that different groups of birds and their temporal trends are differentially affected by land use according to their ecological traits like habitat use (farmland birds), migratory status, feeding guild and biomass.

2. Materials and methods

2.1. Study area

The study sites are situated in Saxony-Anhalt (Germany; Fig. 1) and operated as part of the TERENO project (Terrestrial Environmental Observatories; www.tereno.net) as well as part of the German and European LTER (Long-Term Ecological Research) network. The sites are embedded in agriculturally dominated landscapes. The region is characterized by a high variation in land-use intensity (from flat regions with up to 98% agriculture and large fields to regions with high levels of altitudinal heterogeneity, high cover of forests or other semi-natural habitats, less agriculture and smaller fields) and some variation in climatic conditions. The main crops are winter cereals, oilseed rape, maize and to some extent potato, sugar beet and peas. Each site covers an area of $5 \times 5\,km^2$ of which $4 \times 4\,km^2$ is treated as core area for sampling. Sampling started in 2001 at the four sites Friedeburg (FBG), Schafstaedt (SST), Greifenhagen (GFH), Wanzleben (WAN) within EU FP5 project GREENVEINS. With the start of the TERENO project in 2009 and the following surveys in 2012, 2013, 2014 the sites Harsleben (HAR) and Siptenfelde (SIP) were added (Fig. 1), resulting in 1×4 and 4×6 data points, summing up to 28 data points in five years. The monitoring program was designed to sample every three years. The years 2013–14 were taken as an additional check for variation of counts between years, also giving the opportunity for early trend analysis.

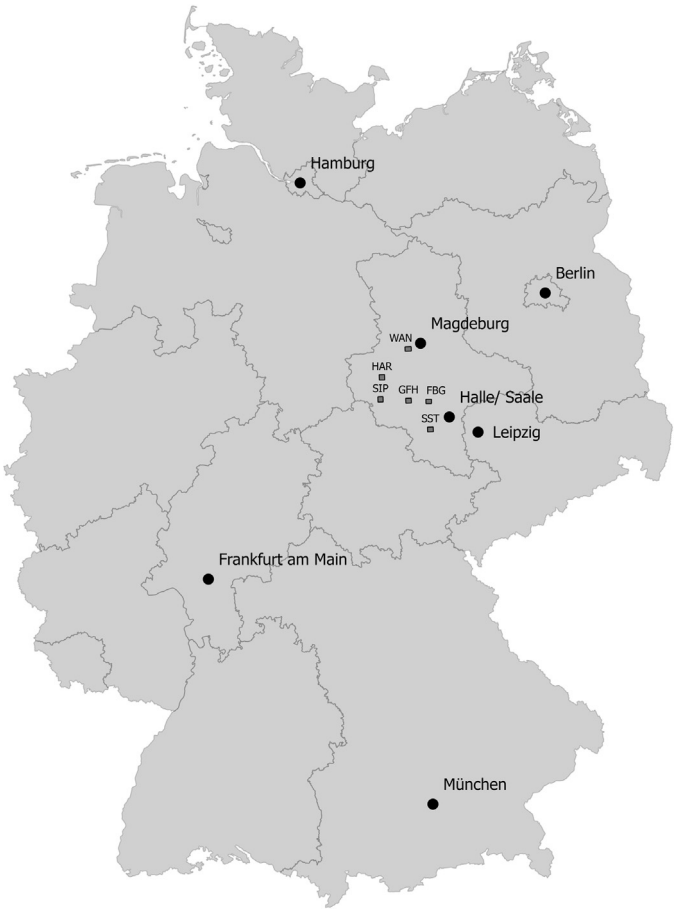

Fig. 1. Map of Germany with study sites Friedeburg (FBG), Greifenhagen (GFH), Harsleben (HAR), Schafstaedt (SST), Siptenfelde (SIP) and Wanzleben (WAN) in Saxony-Anhalt.

2.2. Bird observation

Bird surveys followed the point-stop method (Vorisek, 2008) which is most efficient when a large area has to be surveyed. According to the checkerboard grid design (Fig. 2), each of the 20 sampling points are always 500 m apart from each other, a precondition to avoid double counts in open terrain.

For reasons of accessibility, this ideal configuration had to be adopted in the field, always taking care not to count same specimens twice. A bird survey within one year was performed with three visits in the following periods: (1) 1–30 April, (2) 1–20 May, (3) 21 May–20 June. We surveyed only at favorable conditions (no rain, wind speed <4 Bft), starting at sunrise and ending about three hours later. Within this time slot we approached all points at a site. At each point all singing, calling and seen bird species were registered within a radius of 250 m for five minutes. All surveys throughout the years were performed by the same bird specialist. Based on the birds recorded in the field, the observed birds at each point were translated into territory numbers per species as an

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