Agriculture, Ecosystems and Environment xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

How High Nature Value (HNV) farmland is related to bird diversity in agro-ecosystems – Towards a versatile tool for biodiversity monitoring and conservation planning

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ARTICLE INFO

Article history:
Received 3 July 2013
Received in revised form 4 April 2014
Accepted 5 April 2014
Available online xxx

Keywords:
High Nature Value farmland
Semi-natural elements
Agricultural landscape
Biodiversity indicator
Bird diversity

ABSTRACT

Within the European Union, national approaches of a 'High Nature Value (HNV) farmland' indicator have been developed to inform about the potential of agricultural landscapes to maintain biodiversity. We assessed how bird species abundance, richness and community composition, particularly of specialist species, were associated with the German HNV farmland indicator as an area-based aggregate and with its particular components which were semi-natural landscape elements and agricultural patches with characteristic plant species mapped in representative sample plots.

The aggregated HNV indicator score showed a weak but positive relationship with generalist bird species only, while specialist species were associated with individual HNV farmland features characterizing wet grasslands and open farmland. Bird community analysis revealed three groups of HNV farmland features representative of particular landscape types: (1) complex landscapes with vertical woody structures such as hedgerows or small woodlands, (2) wet grasslands and (3) open agricultural land of low land-use intensity. Large portions of unexplained variance, however, indicated that the small-scaled HNV farmland features recorded without considering the landscape context may not have fully captured all important drivers of bird diversity in agricultural landscapes.

To achieve a better representation of habitat requirements particularly of specialist bird species we propose surveying HNV farmland in a landscape context and calculating landscape-specific scores for highly structured, wetland-dominated and open landscapes of low land-use intensity. As compared to the aggregated indicator, the small-scale HNV farmland survey data would more efficiently enfold its potential for tailoring conservation schemes specifically to a given landscape type and its associated bird species.

1. Introduction

The question how conservation schemes could be targeted more specifically to address the causes of the continuing decline of different taxonomic groups in farmland is a key issue for nature conservation in managed landscapes (MacDonald et al., 2012; Woodcock et al., 2013). Within such schemes in agricultural landscapes it has been proposed that maintaining or increasing the proportion of semi-natural landscape elements and areas with low management intensity is beneficial for species of conservation concern (Bengtsson et al., 2005; Benton et al., 2003; Billeter et al., 2008).

Accordingly, the European Union's conservation policy adopted an indicator to identify and monitor changes in High Nature Value (HNV) farmland that referred to farming systems which include semi-natural habitats, low intensity farming and diverse, small-scale mosaics of land-use types (Andersen et al., 2003; Beaufoy et al., 1994). We investigated how the German HNV farmland indicator corresponds to bird diversity in agricultural landscapes and how the information on HNV farmland could be applied for bird conservation planning.

EU member states have been required to monitor changes in HNV farmland by the Common Monitoring and Evaluation Framework within the European Union's Rural Development Program,

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http://dx.doi.org/10.1016/j.agee.2014.04.012
0167-8809/

but the details of how to implement such an indicator was at the discretion of each state (CEC, 2006). For example, the French HNV farmland indicator aggregated statistics of agricultural holdings (e.g., crop diversity, farming practices of low intensity and density of landscape elements) at the municipality level, thus operating at a large spatial scale (cf. Pointereau et al., 2007). Analysing HNV farmland and Breeding Bird Census data from France, Doxa et al. (2010) showed HNV farmland to support bird communities containing more habitat specialists than those in non-HNV farmland. Contrary to the French implementation, HNV farmland in Germany has been identified at a higher spatial resolution, utilizing the plots of Germany's National Biodiversity Monitoring programme on which surveys of breeding birds were also carried out (Mitschke et al., 2005). Within these 1 km^2 sample plots semi-natural landscape elements were defined as HNV farmland such as hedges, ditches, field margins etc., and fields or patches that contained characteristic plant species and were at least temporarily under some kind of agricultural land use, e.g., arable fields, grasslands, fallow lands and orchards (BfN, 2011). To report on the status of HNV farmland, the detailed information was aggregated into a single HNV farmland indicator score by summing the area covered by HNV farmland features across all feature types (PAN et al., 2011). Considering these differences in the implementation of HNV farmland indicator schemes between countries, providing the basis for evaluating the performance of different approaches is an important step towards a harmonized European monitoring framework.

Birds are widely used as biodiversity indicators because of their sensitivity to environmental changes and relatively good data availability (EEA, 2009). Agricultural intensification has been identified as one of the major drivers of bird population decline in agro-ecosystems during recent decades (Donald et al., 2001; EEA, 2009; Krebs et al., 1999). Besides changes in farming practices, agricultural intensification is accompanied by the simplification of landscapes and the loss of semi-natural habitat (Tscharntke et al., 2005; Verhulst et al., 2004). This has not only resulted in a general loss of bird species but also in biotic homogenization, with generalist species becoming more dominant while specialists are diminishing (Davey et al., 2012; Karp et al., 2012). Thus, a comprehensive indicator of the landscape's potential to sustain biodiversity has to reflect not only species richness per se, but also responses in richness and abundances of specialist and generalist species to landscape properties.

Many landscape properties mapped in the German HNV farmland survey are known to be important for bird diversity (Hinsley and Bellamy, 2000; Sanderson et al., 2009). Hedgerows, for example, provide shelter and nest sites (Hinsley and Bellamy, 2000), areas with ruderal or fallow vegetation offer food resources (Fuller et al., 2004), reed beds and ditches are habitat for wetland birds (e.g., Meyer et al., 2010) and open, low-intensity farmland is indispensable for many ground breeders (Kragten et al., 2008; Vickery et al., 2001). Considering the key importance of habitat heterogeneity for maintaining biodiversity in agricultural landscapes (Benton et al., 2003; Roschewitz et al., 2005), increasing the share of these semi-natural elements in agricultural landscapes may be expected to benefit birds, particularly specialist species with their more demanding habitat requirements (Chiron et al., 2010).

However, certain species require a specific composition of particular landscape elements and a specific landscape context in order to render a given landscape suitable as habitat (Batary et al., 2010; Devictor and Jiguet, 2007). For example, for a landscape to be suitable for red-backed shrike (*Lanius collurio*), it should include hedgerows or groves embedded in insect-rich grasslands (Brambilla et al., 2010). In contrast, grasslands or arable land should not be interspersed with vertical structures such as hedgerows if ground-breeding species such as lapwing (*Vanellus vanellus*) or skylark (*Alauda arvensis*) are to be supported (Fonderflick et al., 2013).

Table 1
Structural landscape elements and specific fields/patches were mapped as HNV farmland features in 1 km^2 sample plots in the survey. Structural landscape elements were assessed by feature-specific criteria while field or patches were identified by the number of characteristic, regional-specific plant species for each feature type (BfN, 2011; PAN et al., 2011).

HNV farmland features	Abbrev.
Structural landscape elements	
Rows of trees	TROW
Hedges	HDG
Complex elements composed of shrubs, embankments and boundary ridges	CPX
Water courses and small streams	WAC
Strips with ruderal weeds	RUD
Unpaved roads	UPR
Stone walls and exposed loess surfaces	SWS
Ponds, stagnant water	PND
Stands of sedges, reed and tall herbs	SDG
Ditches	DTCH
Fields or patches within fields	
HNV arable land with characteristic plant species	AR-P
HNV grassland with characteristic plant species	GR-P
Fallow land	FLW-P
Orchards	ORC-P
Wetland patches: vegetation types according to Annex 1 of the EU Habitat Directive	WET-P

Using the high resolution landscape information available within the German HNV farmland monitoring scheme and the detailed bird data available for the same sites, we aimed at elucidating (i) how the HNV farmland indicator corresponds to patterns of bird diversity in German agricultural landscapes, (ii) whether the HNV farmland indicator and the recorded HNV farmland features reflect the diversity of specialist species which are often of conservation concern and (iii) whether HNV farmland features can be assigned to specific landscape types to enhance the suitability of the indicator for bird conservation planning.

2. Methods

We used information on High Nature Value (HNV) farmland generated by the German HNV farmland survey (BfN, 2011) and data of the German Common Bird Census (GCBC) provided by the Federation of German Avifaunists (Dachverband Deutscher Avifaunisten, DDA). Both data types were recorded on 1 km^2 plots of the sampling scheme that has been devised for Germany's national monitoring programmes. Both types were available for a total of 441 plots (Mitschke et al., 2005).

2.1. High Nature Value farmland

In 2010 and 2011, HNV farmland was surveyed by experienced contractors in 903 sample plots according to a comprehensive instruction manual (BfN, 2011). HNV farmland was mapped within the area under agricultural use, whereas non-agricultural land-use types such as forests and urban areas were excluded from the survey. HNV farmland features were assigned to two basic categories (Table 1): (i) structural landscape elements such as rows of trees, hedges, ditches, small streams, ponds, etc., and (ii) fields or patches within arable fields, grasslands, fallow land, orchards or specific vegetation types according to Annex 1 of the EU Habitat Directive. Because the latter were wetland habitats mainly such as salt marshes and wet heaths these patches were denoted "wetland patches". Information on non-HNV farmland landscape properties was not available in the survey data, but because the minimum requirements for HNV status were quite low, it is reasonable to assume that that all structural landscape elements were captured. Fields or patches were identified as HNV farmland based on the

Please cite this article in press as: Aue, B., et al., How High Nature Value (HNV) farmland is related to bird diversity in agro-ecosystems – Towards a versatile tool for biodiversity monitoring and conservation planning. Agric. Ecosyst. Environ. (2014), http://dx.doi.org/10.1016/j.agee.2014.04.012