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High nature value farmland increases taxonomic diversity, functional richness and evolutionary uniqueness of bird communities

Federico Morelli*

Czech University of Life Sciences Prague, Faculty of Environmental Sciences, Department of Applied Geoinformatics and Spatial Planning, Kamýcká 129, 165 00 Prague 6, Czech Republic

Faculty of Biological Sciences, University of Zielona Góra, Institute of Biotechnology and Environment Protection, Prof. Szafran St. 1, PL-65-516 Zielona Góra, Poland

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ABSTRACT

In an attempt to mitigate the decline of biodiversity, the European Union introduced the high nature value (HNV) farmland concept into the Common Agricultural Policy (CAP). The rationale was to reinforce biodiversity conservation through the maintenance of traditional low-intensity farming systems. HNV farmland is in fact defined as a system which includes semi-natural habitats, low intensity farming and diverse, small-scale mosaics of land-use types, comprising hotspots of biological diversity. However, until now few studies have focused on the degree to which HNV farmland as defined and identified through a set of farming practices and/or farmland typologies is successful in supporting biodiversity.

The values of taxonomic diversity, functional diversity and evolutionary distinctiveness of breeding bird communities between HNV and non-HNV farmland were compared in Central Italy.

Bird species richness and functional richness were higher in HNV than in non-HNV farmland. HNV farmland supported bird communities 27% more unique in terms of phylogenetic diversity than non-HNV farmland. A combination of land cover composition (land use coverage) and configuration (spatial arrangement of patches) differentially affects each component of bird diversity. Variation in species richness was explained by land use composition (31%) and shared contribution between land use composition and landscape metrics (13%). The functional diversity of bird communities was little explained by changes in land cover of farmland (less than 14%). As a conclusion, I highlight that HNV farmland needs to be protected because it supports bird communities characterized by high overall bird diversity. Conservation planning should pay attention to the relative association of farmland features with each component of bird diversity.

1. Introduction

Agricultural habitats constitute one of the most common ecosystem elements throughout the world, including Central Europe (Bignal and McCracken, 2011; Pain and Pienkowski, 1997), and represent one of the most common habitats for many bird species in Europe (Donald et al., 2006; Siriwardena et al., 1998; Tryjanowski, 1995). However, in the last few decades, an unprecedented decline in biological diversity was recorded, an effect that was particularly noticeable in birds (Donald et al., 2006). The loss of biodiversity is of critical concern, and some studies suggested that biodiversity play a role in long-term ecosystem functioning (Groombridge and Jenkins, 2002; Pereira et al., 2012). Furthermore, the loss of biodiversity can negatively impact on humanity in many different ways (Cardinale et al., 2012; Newbold et al., 2016). Thus the conservation of biodiversity in the countryside is essential not only for intrinsic reasons, but also for very pragmatic reasons related to human benefits (Kleijn et al., 2009; Rosin et al., 2016).

In an effort to protect farmland biodiversity the definition of high nature value (HNV) farmland was introduced (Bartel, 2009; Pointereau et al., 2010). The term HNV was presented by Baldock et al. (1993) and Beaufoy et al. (1994), and more recently Andersen et al. (2003) proposed a conceptual definition of HNV farmland as 'those areas in Europe where agriculture is the dominant land use and where agriculture supports or is associated with either a high species and habitat diversity or the presence of species of European conservation concern or both'. The HNV farmland indicator was implemented as an indicator under the EAFRD (European Agriculture Fund for Rural Development) Implementing Regulation (Regulation No 1974/2006/EC) to incorporate environmental concerns into the EU Common Agricultural

* Address: Czech University of Life Sciences Prague, Faculty of Environmental Sciences, Department of Applied Geoinformatics and Spatial Planning, Kamýcká 129, 165 00 Prague 6, Czech Republic.

E-mail address: fmorellius@gmail.com.

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Policy (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:368:0015:0073:EN:PDF).

Subsequently, HNV farmland has been considered as high priority agroecosystem within the EU Rural Development Programme, requesting to each EU Member State to identify the extent and status of their HNV farmlands and also to track trends over time (EC, 2005; EENRD, 2009).

HNV farmland is present in all European countries which include semi-natural habitats, low intensity farming and diverse, small-scale mosaics of land-use types (Aue et al., 2014).

HNV farmland comprises hotspots of biological diversity in rural areas, which may correspond to diverse landscape mosaics (Benton et al., 2003; Kleijn et al., 2011; Morelli, 2013a). This is due mainly to the effect of natural and semi-natural features, that are intrinsic characteristics of HNV farmland, increasing landscape heterogeneity and increasing niche availability for many animal species (Fahrig et al., 2011; Kisel et al., 2011).

In this context, the European Commission recognized clearly the importance that the Common Agricultural Policy (the CAP) has for safeguarding HNV farming, linking agricultural practices with biodiversity conservation (Strohbach et al., 2015). Currently, 25 European countries are implementing the HNV concept for the classification of their farmlands (Benedetti, 2017a,b). However, even if HNV areas in agricultural landscapes are proposed as systems maintaining or being beneficial for conservation of biodiversity, only a few studies have focused on exploring separately the association between high nature value farmland and different components of biodiversity. The majority of studies addressed correlations with taxonomic diversity, species abundance, specialization or population trends in bird communities (Aue et al., 2014; Doxa et al., 2010; Morelli, 2013b; Plieninger et al., 2013). Some results showed also that HNV farmland can alleviate the process of biotic homogenization in bird assemblages, a problem strongly related to intensive land management (Doxa et al., 2012).

The importance of using different components of avian diversity is due to these being complementary and useful for focusing on overall biodiversity of farmland: species richness is a fast and cost-effective indicator of diversity (Freemark et al., 2006), but some measures of functional diversity as functional evenness can provide indications of the potential resilience of species assemblages (Mason et al., 2005), while a recent study associated functional diversity of communities also to natural pest control services provided by birds (Barbaro et al., 2016). Furthermore, the phylogenetic diversity concept (and evolutionary uniqueness) expands our perspectives on biodiversity, including ideas such as evolutionary heritage, in order to assess conservation priorities (Faith, 2015, 1992). Finally, other recent studies pointed out how a combination of landscape heterogeneity, land use composition and vegetation structure can alter the diversity of bird communities in different environments (Morelli et al., 2017a,b; Schütz and Schulze, 2015).

The aim of this study is to explore the associations between high nature value farmland and different components of biodiversity: species richness, functional diversity and evolutionary uniqueness of bird communities. Secondarily, to explore farmland characteristics (land use composition and habitat heterogeneity) that supports each avian diversity component.

2. Methods

2.1. HNV farmland, environmental variables and bird data collection

The study was carried out in an agricultural area of ca. 2000 ha of the North Eastern Marche region, in Central Italy (centroid of study area: 43°46′N; 12°42′E), in farmland ranging from 0 to 650 m a.s.l., among low hills and the Adriatic coast. The climate in Central Italy is temperate and characterized by high spring and summer temperatures and a marked summer drought (Pesaresi et al., 2014). This area was selected because it contains a large variety of different farm types, and was also subject to previous studies (Morelli, 2013a; Morelli et al., 2013, 2014).

Data on bird species were collected using 80 standardized point counts randomly selected, carried out during the 2014 breeding season (April–June). Point counts provide good estimates of relative population density, constituting a standardized method in ecology (Bibby et al., 1992). All points, separated by at least 500 m, were visited once between 06:00 and 10:00 for 10 min from 20 to 30 April and once in the second half of May or first half of June, only under favorable weather conditions. All diurnal bird species detected visually and acoustically in a radius of 100 m from the observer were recorded. The bird community composition at each point count was estimated considering all bird species present at least during one visit.

The percentage of different land use types within the 100 m buffer around each sampling site was calculated using ArcGIS 10 (ESRI, 2012). Land-use categories of the land cover map of the Marche region were reclassified in larger groups, to obtain 8 land-use typologies, redenominated as: build up areas (which includes residential building, production facility, built with infrastructure and processing areas, roads), arable fields and orchards (which includes all cultivated and farmland categories), uncultivated fields, hedgerow, forest, scattered trees and shrubs. Furthermore, two measures of habitat heterogeneity, henceforth called landscape metrics, were calculated in each farmland: a) Land use diversity (lud) was calculated using the Shannon-Weaver diversity index on land use types (Shannon, 1948) and b) edge density (edge) was calculated as the sum of the perimeters of all polygons in the buffer zone (Kie et al., 2002). The selection of 100 m radius was based on the results of previous studies performed in the same area (Morelli, 2013a; Morelli et al., 2014).

Finally, each area visited was classified with a binary variable as HNV farmland (1) or non-HNV farmland (0), following the classification applied by Galdenzi et al. (2012) founded on a cartographic-based methodological approach to identify and classify HNV farmland, considering the current and potential vegetation cover data obtainable from different integrated vegetation maps, already applied in Morelli et al. (2014). As further confirmation, each visited farmland was assessed as HNV also during the bird point counts, considering the abundance of edge or marginal vegetation typical of HNV farmland (hedgerows, uncultivated, shrubs and isolated trees). The criteria applied to confirm a farmland as HNV was the coverage of edge vegetation higher than 25% within a 100 m radius buffer. The latter procedure was introduced in order to avoid problems related to the fact that many HNV indices are based on low spatial resolution data sources, e.g. Corine Land Cover (smallest patch size = 25 ha) (Bossard et al., 2000). Here, we used information collected at a small spatial scale (3.14 ha) to describe vegetation features of HNV and non-HNV farmlands.

From the 80 farms monitored in this study, 38 (47.5%) were classified as HNV following Galdenzi et al. (2012) and considering the land use composition and presence of edge vegetation verified during field work (see Fig. S1, ESM).

2.2. Biodiversity metrics and evolutionary distinctiveness in bird communities

In this study I calculated eight different measures of biodiversity based on bird communities: one related to taxonomic diversity, four related to functional diversity and one related to phylogenetic uniqueness. The bird species richness (BSR) was used as a measure of taxonomic diversity (Magurran, 2004). Species richness was expressed as the number of recorded bird species at each sampling site. Functional diversity indices were calculated for each bird community. The biodiversity metrics based on species-trait approaches focused on functional aspects of biodiversity, and constitute an additional tool to the traditional taxonomic approach (de Bello et al., 2010). In this study, functional diversity indices were calculated using the avian niche traits