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Agricultural landscape composition as a driver of farmland bird diversity in Brittany (NW France)

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ABSTRACT

In agriculture-dominated landscapes, agricultural intensification and associated landscape homogenization have caused large declines in farmland biodiversity. This study was aimed at determining how agricultural landscape composition drives community diversity and composition of farmland birds in the characteristic *bocage* landscape in Brittany (NW France) on a broad scale. Using bird atlas data from the region (2004–2008; 10×10 km), we analyzed the importance of different components of agricultural landscape composition (types of crops, amount of semi-natural covers and elements, and artificial lands) on the alpha diversity and beta diversity of farmland birds of different functional groups, defined depending on the degree of farmland specialization and ecological requirements.

Agricultural landscape composition features explained a small amount of variation in alpha and beta diversity, particularly for specialists and residents. Cereal crops were negatively correlated with alpha diversity of all the functional groups considered whereas rotational grasslands were negatively associated with migrant and insectivorous alpha diversity. Although shrublands are not common in Brittany, they were positively associated with the occurrence of some species and particularly with alpha diversity of all the functional groups but specialists and residents. At the spatial grain of analysis, community composition was mainly driven by a gradient of alteration of the *bocage*.

To conclude, we claim for the consideration of regional idiosyncrasies in far-reaching planning schemes to prevent future biodiversity loss in agriculture-dominated landscapes due to agricultural intensification. In view of the observed large-scale trends gathered from atlas data analysis and the small amount of explained variation, we also advocate for subsequent finer scale bespoke surveys to determine the biodiversity status associated with the valuable *bocage* agricultural landscape.

1. Introduction

Both habitat heterogeneity and land-use practices influence patterns of biodiversity in agricultural landscapes (Billeter et al., 2008; Filippi-Codaccioni et al., 2010a; Fischer et al., 2011; Chiron et al., 2014). Agricultural intensification and its associated habitat homogenization have been shown to cause many detrimental effects on biodiversity in Western Europe (Benton et al., 2003). Therefore, enhancing habitat heterogeneity for biodiversity conservation is a current paradigm, which seems to depend on the degree of agricultural intensity being apparently more beneficial for high- than for low-intensity agricultural systems (Batáry et al., 2011). In addition, there is an increasing need to consider species-specific requirements which influence their response to agricultural intensity and/or landscape heterogeneity (Fahrig et al., 2011).

Spatial heterogeneity of agricultural landscapes is a result of the relative proportions and configuration of agricultural (crop) and/or semi-natural covers. Benefits of landscape heterogeneity due to the semi-natural component have already been described in many contexts (Devictor and Jiguet, 2007; Michel et al., 2007; Billeter et al., 2008; Tellería et al., 2008 but see Chiron et al., 2010;

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Filippi-Codaccioni et al., 2010b). However, additional insights into the influence of heterogeneity of agricultural covers and practices (i.e., the agricultural component of landscape heterogeneity) on biodiversity are still needed (Baudry et al., 2003; Fahrig et al., 2011) since enhancing agricultural landscape heterogeneity for preserving biodiversity without stopping crop production is a major challenge considering the increased demand for food. Alternatively, restricting human requirements for land may also be important to limit impacts on biodiversity (Phalan et al., 2011).

In Europe, declines in bird populations in the last few decades have been shown to correlate well with agricultural intensification (Chamberlain et al., 2000; Donald et al., 2001). Birds are good biodiversity indicators, having many key ecological functions (Sekercioglu, 2006; Whelan et al., 2008). The European Farmland Bird Indicator (an aggregated index of population estimates of a selected group of breeding bird species dependent on agricultural land for nesting or breeding) is considered a useful surrogate for trends in other elements of biodiversity in agricultural landscapes (Gregory et al., 2005), and is recognized as such by the European Union (Eurostat, 2012). The consideration of farmland bird responses depending on habitat breadth should add more insights to the impact of agricultural intensification and landscape homogenization on farmland bird diversity. Nevertheless, increasing awareness has been put into the need of some specialist farmland birds for large extensions of open-habitat characterized by low intensity crop systems (Filippi-Codaccioni et al., 2010a; Fischer et al., 2011; Pickett and Siriwardena, 2011; Chiron et al., 2013, 2014; Teillard et al., 2014). Agricultural intensification and landscape homogenization detrimental effects on farmland birds may also depend on migratory status (Vorísek et al., 2010; Pickett and Siriwardena, 2011), nesting strategy (Bas et al., 2009) and other ecological requirements such as breeding diet (Cardador et al., 2014, 2015).

In agriculture-dominated regions such as Brittany (NW France), biodiversity response to landscape homogenization due to agricultural intensification has been shown to be taxon-specific (Burel et al., 2004). Therefore, the assessment of farmland bird response to agricultural landscape features may provide additional insights to the fate of overall farmland biodiversity in the region of Brittany. The characteristic landscape structure in the region is the *bocage*, which is composed of a mosaic of semi-natural grasslands and crops with hedgerows in the field boundaries that play many ecological roles (Baudry et al., 2000). The *bocage* has been in regression since the second half of the 20th century because of increasing agricultural intensification, which has favored more open landscapes with a decrease in hedgerow network length, semi-natural grasslands and an increase in crop areas. Widespread crops are rotational grasslands, maize and cereals, while vegetable crops are mainly cultivated on the north-western coast.

This study aims to determine how agricultural landscape composition (mainly crops and semi-natural covers and elements) influence farmland bird diversity in the agriculture-dominated region of Brittany. For this purpose, community composition data (presence/absence) were gathered from the breeding bird atlas of the region (2004–2008; 10 × 10 km) to depict broad-scale relationships between agricultural landscape composition and avian diversity (Donald and Fuller, 1998). At the large spatial grain of analysis, hedgerow network length also represented farmland configuration and agricultural practices were not considered but are partly implicit in the different features of agricultural landscape composition such as the type of crops (e.g., arable or not, rotational or semi-natural grasslands). The considered species represent different functional groups according to their specialization and ecological requirements during the breeding season. Our specific goals were to: (1) assess the role of agricultural landscape composition as a driver of species richness of different functional groups; (2) depict farmland bird species assemblages according to agricultural landscape composition; and (3) determine the degree to which farmland bird beta diversity in Brittany is driven by agricultural landscape composition. Apart from the expected positive association with semi-natural covers and elements, at the scale of analysis we expected fewer farmland bird species with increasing homogenization of landscapes (e.g., crop dominance or type of crop) and species-specific life trait responses. We also expect a large amount of unexplained

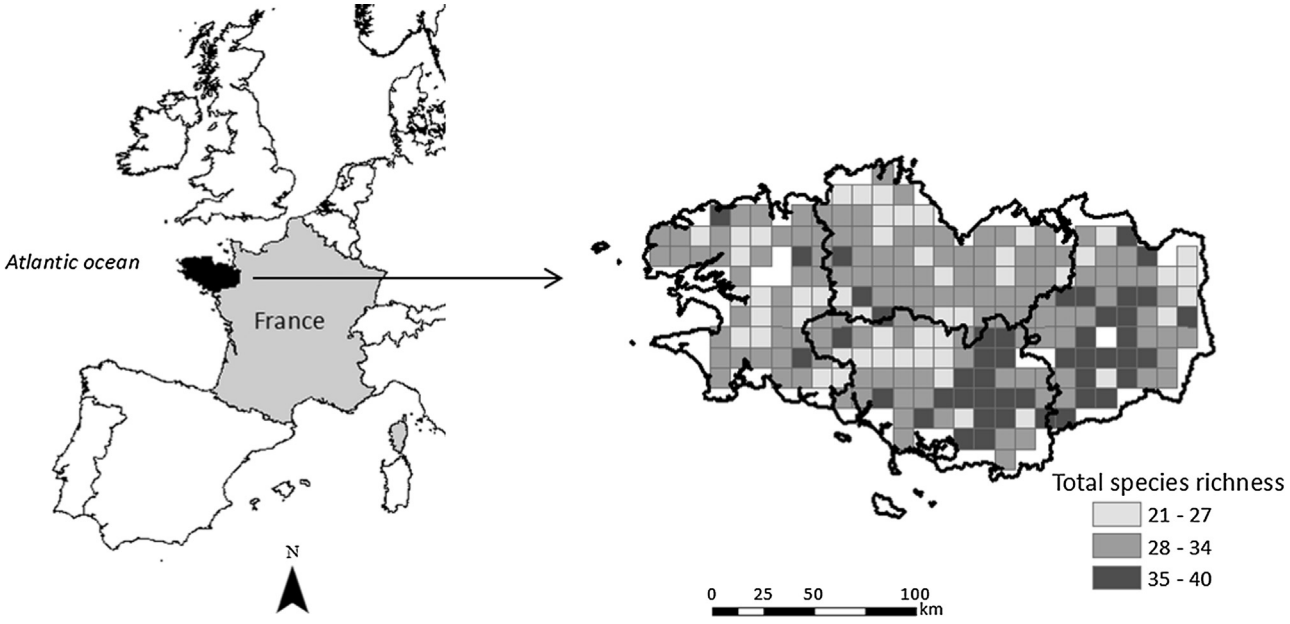

Fig. 1. Study area location (Brittany, NW France) and detail of the 223 UTM 10 × 10 km considered according to the criteria established to define agricultural landscapes (≥50% of their area is occupied by crops). Total farmland bird species richness is shown. The administrative boundaries within Brittany at the department level were also marked. From left to right: Finistère, Côtes-d'Armor (top), Morbihan (bottom) and Ille-et-Vilaine.