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Hedgerows diminish the value of meadows for grassland birds: Potential conflicts for agri-environment schemes

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ABSTRACT

Hay meadows and hedgerows have been declining for decades in Western Europe. Conservation policies promote their protection but agri-environmental measures for both can be implemented in the same area, possibly generating loss of efficiency. We recorded grassland passerine abundance in 99 sampling plots distributed in hay meadow habitat. Sampling plots were located across a gradient of hedgerow density in a floodplain system. As expected, abundance and species richness increased with grassland area. More importantly, hedgerow density was negatively related to both response variables when grassland area was controlled for. This result is important for habitat management. Subsidizing agri-environmental measures for hedgerows and grassland is of interest for biodiversity, but incompatibility between measures may occur at the parcel scale if one landscape component (hedges) splits another component (meadows) down to the suitability threshold for grassland species. To optimize the payoffs of subsidies, it can be effective and efficient to manage agri-environmental schemes at the landscape scale.
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1. Introduction

Biodiversity in agricultural landscape has been declining for several decades in many parts of the World because of agriculture development and intensification (Donald et al., 2001). Agri-Environmental Schemes (AES) have been implemented as a response to halt this process at the national or supra-national level (CEC, 1998). Unfortunately, measures have not always yielded the expected benefits (Baker et al., 2012; Whittingham, 2007), and decline is still observed for threatened (Kleijn et al., 2006) or common birds species breeding in agricultural landscapes (Australia: Olsen, 2008; North America: U.S. Committee, 2009; Europe: Gregory *and* Strien, 2010). Therefore, it is urgent to assess current AES, identify their weaknesses, and propose novel implementation that more clearly yield benefits on biodiversity and increase economic returns of public subsidies (Sutherland et al., 2006). Because habitat loss is considered as the first cause of biodiversity decline, priority has been set to saving habitats of ecological interest. It is probably not sufficient if other factors limiting population growth are not explicitly taken into account (Baker et al., 2012). Therefore, higher efficiency may be achieved by integrating plainly ecological processes in agri-environmental measures.

Many species are known to exhibit area sensitivity, i.e. occurrence or abundance is positively related to patch size of available habitat (Davis and Brittingham, 2004; Helzer and Jelinski, 1999; Schipper et al., 2011; Vickery et al., 1994; Winter and Faaborg, 1999). The size of the area to protect is considered in reserve planning (Arponen et al., 2007) but much less so in the implementation of environmental schemes where it has been simply advocated or entirely discarded respectively in the USA (NRCS (US Department of Agriculture), 1999; Ochterski, 2006) and in the EU. Ignoring the minimum spatial requirements of target species may have ecological and economical consequences. First, AES measures can be subscribed, within areas of high ecological interest, in patches too small to allow settlement, thus reducing the overall benefit for the population to conserve. Second, distinct AES implemented for different landscape components may be subscribed in the same parcel or patch which can potentially increase fragmentation of at least one component. Surprisingly, neither area sensitivity nor compatibility between different measures at the parcel scale – i.e. management unit – have received much attention when implementing AES. We addressed this issue in grassland passerines breeding in a large floodplain in Western Europe. Area sensitivity is a common limiting factor of grassland passerines in several areas of the World (Caplat and Fonderflick, 2009; Davis and Brittingham, 2004; Johnson and Igl, 2001; Winter and Faaborg, 1999).

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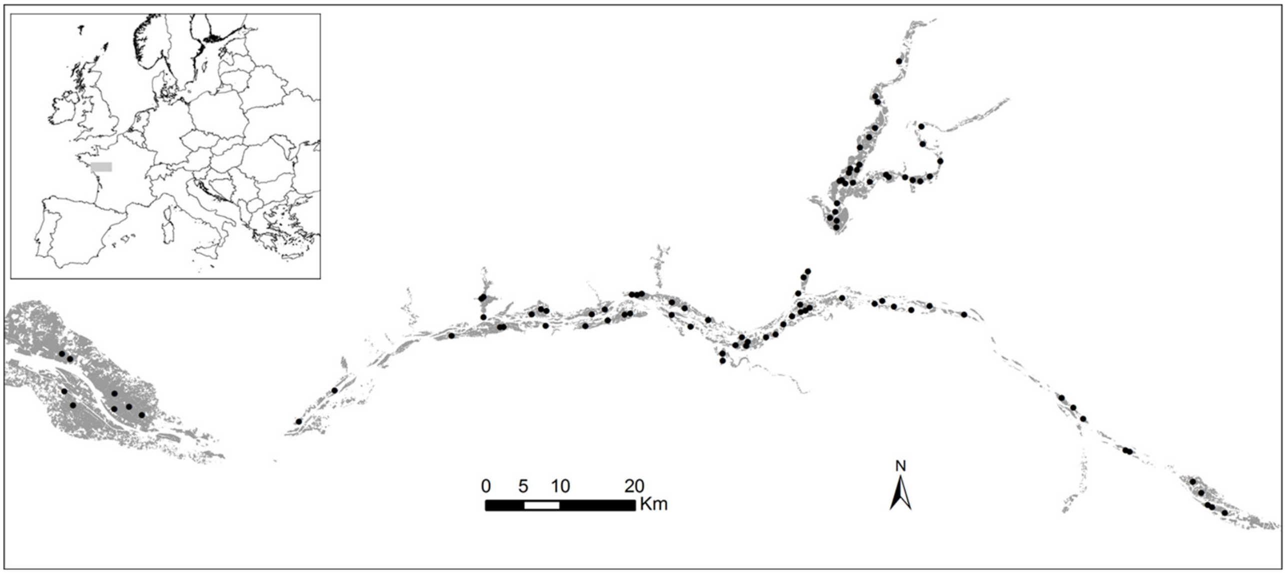

Fig. 1. Map of the study area. The grey zone corresponds to floodplain grasslands and black dots to the sample plots. The inset shows the location of the study area in Western Europe.

Environmental policies have been implemented partly to protect grassland species like the Corncrake *Crex crex* or the Whinchat *Saxicola rubetra*, which both continue to decline in western Europe (Fuller et al., 1995). It is thus striking that area sensitivity is still not implemented in such AES.

Permanent hay meadows have largely disappeared from Western Europe except from areas subjected to strong environmental constraints like frequent flooding or high elevation (Krause et al., 2011). Risks of productivity loss impair the development of intensive practices and maintain landscapes dominated by extensively managed grasslands. As a consequence, these areas still host grassland specialists (Gibbs, 2000) and shelter less specialized species vulnerable to other human activities like urbanization or intensive agriculture (Britschgi et al., 2006; Broyer, 2009; Godreau et al., 1999; Plantureux et al., 2005; Zahn et al., 2010).

In the floodplains in our study region the traditional hedgerow network still cover large areas (Forman and Baudry, 1984). Hedges are primary habitats for many species, provide refuge or complementary habitats to species vulnerable to intensive agriculture (Hinsley and Bellamy, 2000; Siriwardena et al., 2012), and offer ecosystem services like shelterbelt and shade for livestock, and wood resource (Baudry et al., 2000). For all these reasons, the maintenance and planting of hedgerows is subsidized by environmental policies (Kleijn and Sutherland, 2003). However, hedges can potentially cause habitat fragmentation for grassland species by increasing predation risk, smaller patches becoming unsuitable for breeding (Morris and Gilroy, 2008), or limiting the number of available territories in species that tend to aggregate (Ahlering et al., 2006). Furthermore, the possibility to receive subsidies for the protection of grassland birds and hedges on the same parcel may favour the densification of the hedgerow network, enhancing grassland fragmentation. In our study area, the size and patchiness of meadows is largely determined by hedgerows. Therefore, we predicted that increasing hedgerow density would reduce habitat suitability at the patch scale for grassland breeding birds. We analyzed the variation in abundance and richness of four grassland passerines breeding in hay meadows across a hedgerow density gradient. We expected a positive relationship between abundance, or richness, and the area of hay meadow, but a negative relationship with hedgerow density. We also searched the optimal spatial scale to detect area-sensitivity.

2. Methods

2.1. Study area

The study area extends over the lower 200 km section of the Loire river drainage in Western France (Fig. 1). Grassland is the dominant habitat type in the main channel and several major tributaries. Such an ecological continuity is now unusual in Western Europe. It provides an ideal setup to investigate the ecological factors affecting the distribution of grassland species. We focused on the four passerines that dominate a grassland bird community of seven breeding species in this area (Noël, 2003): the Whinchat *S. rubetra*, the Yellow Wagtail *Motacilla flava*, the Corn Bunting *Emberiza calandra*, and the Reed Bunting *Emberiza schoeniclus*. The other grassland species are too scarce to analyze their habitat requirements. These species are expected to benefit from agri-environmental schemes implemented to enhance their breeding success (no or little fertilization, delayed mowing).

2.2. Patch size, hedgerow length, grassland area and topographic wetness index

Land use is simple in the study area. Grasslands represent the main land use (75%) and all other habitats (poplar, crops, water course, hedgerows) are not suitable for the target species. Therefore, identifying grassland patches is straightforward in the study area. We used ArcGIS 10 and aerial photographs (BD Ortho® IGN) to quantify environmental predictors around each count point. We determined 3 buffer zones around each sampling point with a 100 m, 250 m or 500 m radius. We measured patch size and hedgerow density. We defined a patch as a continuous polygon of hay meadow. Patch size ranged from 1.3 ha to 265.3 ha (mean = 34.7 ± 50.3 SD ha). Hence a patch can cover several parcels in the study area, since practices are very homogeneous (no fertilization, grazing after mowing) and differences mainly concern the mowing date. We defined a hedgerow as an alignment of trees or shrubs bordering parcels.

We also estimated the effect of the Topographic wetness index (TWI). This index is a proxy of water accumulation (Beven and Kirkby, 1979) that we previously showed to affect the probability of occurrence of some of the target species (Besnard et al., 2013).

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