Promoting biodiversity values of small forest patches in agricultural landscapes: Ecological drivers and social demand

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HIGHLIGHTS
• Ecologic and economic assessments conducted concomitantly, allowed a joint comparison.
• Patch size and tree species have the larger effect on plant species richness.
• Some key variables to improve biodiversity are not relevant to shape preferences.
• Some options preferred by people to increase biodiversity may be difficult to attain.
• Local population favoured policies improving biodiversity close to where they live.

GRAPHICAL ABSTRACT

ABSTRACT
Small forest patches embedded in agricultural (and peri-urban) landscapes in Western Europe play a key role for biodiversity conservation with a recognized capacity of delivering a wide suite of ecosystem services. Measures aimed to preserve these patches should be both socially desirable and ecologically effective. This study presents a joint ecologic and economic assessment conducted on small forest patches in Flanders (Belgium) and Picardie (N France). In each study region, two contrasted types of agricultural landscapes were selected. Open field (OF) and Bocage (B) landscapes are distinguished by the intensity of their usage and higher connectivity in the B landscapes. The social demand for enhancing biodiversity and forest structure diversity as well as for increasing the forest area at the expenses of agricultural land is estimated through an economic valuation survey. These results are compared with the outcomes of an ecological survey where the influence of structural features of the forest patches on the associated herbaceous diversity is assessed. The ecological and economic surveys show...
1. Introduction

In Europe, the conversion of forests into agricultural land and the intensification and specialization of agriculture since the 1950s has led to reduction and fragmentation of the original forest cover, to decreased landscape heterogeneity and ultimately, to a decline of species diversity (Foley et al., 2005; Hadad et al., 2015; Valdés et al., 2015).

Small forest patches embedded in agricultural (and peri-urban) landscape matrices in Western Europe are often overlooked in conservation programmes, although they play a key role for biodiversity conservation as they often are the only semi-natural habitats present in these landscapes. Furthermore, their capacity to deliver a whole suite of ecosystem services (ES) to society (e.g., recreation opportunities, food production, pest control) is increasingly recognized (Decoq et al., 2016; Foley et al., 2005; Valdés et al., 2015). Due to their small size, these patches are generally not legally protected against conversion to another land use or against any other form of degradation. Hence the need for policies that can maintain and restore biodiversity in these small forest patches.

Many of the benefits that biodiversity conservation policies provide are public goods not traded in markets. Hence, considering only financial costs and benefits of these policies may produce sub-optimal decisions in terms of their ability to optimize social welfare. Environmental valuation can help guiding the design of these policies by eliciting public preferences on different attributes of biodiversity (Fatemeh Bakhtiar et al., 2014; Christie et al., 2006), so these can be taken into consideration in investments and policy decisions (Stenger et al., 2009). Proposed measures should be both socially desirable and ecologically effective. This includes considerations on where - under landscape conditions, changes will be valued the highest, will be most expensive. Hence there is a need for integrated ecological - economic research in which the factors determining biodiversity patterns in these patches are identified together with the preferences of the local population for improved biodiversity and management measures leading to a better conservation status.

We hypothesize that social support may exist for preserving and enhancing the status of these small forest patches. However, social preferences may vary depending on the management measures undertaken and the type of landscape where these are applied (van Zanten et al., 2016). Also, we hypothesize that less public support and lower ecological effectiveness can be expected for biodiversity oriented measures in landscapes that provide more habitat and suffered less degradation (Domínguez-Torreiro et al., 2013; Horowitz et al., 2007).

Based on these hypotheses, this study has three main objectives:

1. to analyse the social preferences for biodiversity-oriented measures in small forest patches in agricultural landscapes, using both species and structural diversity indicators;
2. to analyse the ecological effectiveness of the proposed measures in these landscapes;
3. to determine whether the social preferences and effectiveness differ between landscapes with different degrees of agricultural management intensity.

To address these objectives, a joint ecological and economic assessment was conducted on small forest patches in Belgium (Flanders) and northern France (Picardie). In each study region, two contrasting types of agricultural landscapes were selected: open field (OF) and bocage (B). These landscape types result from different historical trajectories and show different biodiversity conservation levels; OF landscapes are characterized by large-scale, high input-based agriculture while in B landscapes a more small-scale, lower-input agriculture is practised. The connectivity between the forest patches in the B landscapes is considered to be higher due to the high number of treelines and hedgerows compared to the OF landscapes.

The social demand for enhancing key biodiversity components, forest structural components as well as for increasing the forest area at the expenses of agricultural land is estimated through an economic valuation survey. Results are compared with the outcomes of an ecological survey where the biodiversity levels in OF and B landscapes are assessed, together with the influence of structural features of these stands on the associated herbaceous diversity. This indicator is adopted due to its impact on multi-trophic interactions that seem to indicate its suitability as biodiversity indicator (Scherber et al., 2010).

This work contributes to the still limited number of studies addressing the role that forest patches in agricultural landscapes play in the conservation of biodiversity and in the provision of ES (Mitchell et al., 2014; Valdés et al., 2015), being one of the main novelties that ecologic and welfare economic assessments were conducted concomitantly, thus allowing a joint comparison of the key attributes that play a decisive role in determining biodiversity patterns, and their contribution to shape social preferences for these forest patches.

2. Methods

2.1. Study area

Both in Flanders and Picardie, two 5 × 5 km landscape windows (LW) with contrasting agricultural management intensities were selected (Figs. 1 and 2). One window in each region (hereafter ‘Open Field Landscape’, OF) was composed of isolated forest patches embedded in an intensively cultivated agricultural matrix dominated by arable land, with big crop fields (from one to several hectares) receiving high inputs of chemical fertilizers and biocides annually. The other window (hereafter ‘Bocage Landscape’, B) contained forest patches that were more or less connected by hedgerows, embedded in a matrix dominated by grasslands and small crop fields (usually <1 ha) that were less intensively managed and received far less inputs.

The forest cover represented 5.4, 6.4, 4.7 and 5.4% in the Belgian B, Belgian OF, French B and French OF LW, respectively, distributed...
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