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Combining habitat requirements of endemic bird species and other ecosystem services may synergistically enhance conservation efforts

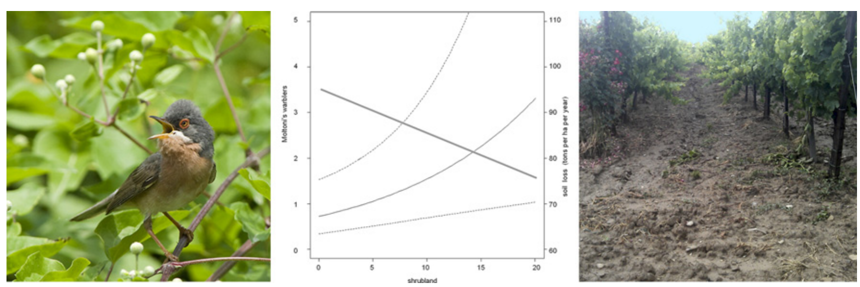
Mattia Brambilla [a,b,*], Luca Ilahiane [a,c], Giacomo Assandri [b,c], Silvia Ronchi [a,d], Giuseppe Bogliani [c]

[a] Fondazione Lombardia per l'Ambiente, Settore biodiversità e aree protette, Largo 10 Luglio 1976 1, I-20822 Seveso (MB), Italy
[b] Museo delle Scienze, Sezione Zoologia dei Vertebrati, Corso del Lavoro e della Scienza 3, I-38123 Trento, Italy
[c] University of Pavia, Department of Earth and Environmental Sciences, Via Adolfo Ferrata 9, I-27100 Pavia, Italy
[d] Politecnico di Milano, Department of Architecture and Urban Studies, via Bonardi 3, I-20133 Milano, Italy

HIGHLIGHTS

- Species conservation and ecosystem services are often regarded as alternative targets.
- Vineyards impact on biodiversity and are associated with high soil loss.
- Management options may be suited for both bird conservation and soil preservation.
- We developed both specific and integrated potential conservation strategies.
- Integrated conservation strategies can lead to win-win approach.

GRAPHICAL ABSTRACT



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ABSTRACT

Biodiversity conservation and the optimisation of other ecosystem service delivery as a contribution to human well-being are often tackled as mutually alternative targets. Modern agriculture is a great challenge for the fulfilment of both. Here, we explore the potential benefits of integrating biodiversity conservation and the preservation of wider ecosystem services, considering the conservation of an endemic species (Moltoni's warbler *Sylvia subalpina*; Aves: Sylvidae) and soil erosion control (a final ecosystem service) in intensive vineyards in Italy.

We modelled factors affecting warbler occurrence and abundance at 71 study plots by means of N-mixture models, and estimated soil erosion at the same plots by means of the Universal Soil Loss Equation. Shrub cover had positive effects on both warbler abundance and soil retention, whereas higher slopes promote warbler abundance as well as soil erosion. Creating shrub patches over sloping sites would be at the same time particularly suited for warblers and for soil retention.

We simulated three alternative conservation strategies: exclusive focus on warbler conservation (1), exclusive focus on soil preservation (2), integration of the two targets (3). Strategies assumed the creation of 1.5-ha shrub patches over 5% of the total area covered by plots and targeted either at wildlife or soil conservation. The exclusive strategies would allow an increase of 105 individuals and the preservation of 783 tons ha^{-1} $year^{-1}$, respectively. Each individual strategy would ensure benefits for the other target corresponding to 61–64% of the above totals.

The integrated strategy would allow for the achievement of 91–93% of the benefits (96 warblers and 729 tons ha^{-1} $year^{-1}$) of the individual strategies.

The integration of the two approaches could provide important synergies, allowing to broaden the effects of conservation strategies, such as agri-environmental schemes that could be drawn from our results (and which are particularly urgent for intensive permanent crops).

* Corresponding author at: Fondazione Lombardia per l'Ambiente, Settore biodiversità e aree protette, Largo 10 Luglio 1976 1, I-20822 Seveso (MB), Italy.
E-mail address: brambilla.mattia@gmail.com (M. Brambilla).

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1. Introduction

Biodiversity conservation and the optimisation of ecosystem service delivery (or ecosystem management) as a contribution to human well-being are often tackled as mutually alternative targets in landscape planning (Mace et al., 2012), which is frequently focused only on biodiversity or exclusively on (other) ecosystem services, even if the strict link between biodiversity and ecosystem functions is inextricable (Butler et al., 2007). Biodiversity can be a regulator of ecosystem processes, as well as a final ecosystem service itself or a good (Mace et al., 2012), and biodiversity conservation could contribute to (other) ecosystem service supply (Christie and Rayment, 2012), and vice versa (Goldman et al., 2008). Considering that biodiversity conservation schemes, aimed at preserving certain species or habitats, may have either positive or negative impacts on wider ecosystem services (Austin et al., 2016), it is essential to integrate biodiversity conservation and delivery of ecosystem services into an effective strategy for ecosystem management (Mace et al., 2012).

Biodiversity and other ecosystem services can be integrated into landscape and conservation planning by means of spatial conservation prioritization (e.g. Goldman et al., 2008; Geneletti, 2011). Several examples of trade-offs between regulating and supporting services (e.g. Geneletti, 2013) and between biodiversity and other ecosystem services have been reported (e.g. mammal conservation and carbon stocking, Budiharta et al., 2014), but the ones between biodiversity and many provisioning services are particularly challenging (Reyers et al., 2012) and have caused a dramatic loss of biodiversity during the last decades (Millennium Ecosystem Assessment, 2005) by means of the human land use associated with many provisioning services (especially agriculture; Tilman, 1999; Foley et al., 2005). Agricultural ecosystems (agroecosystems) support indeed essential provisioning services, but agriculture is also the cause of disservices (Power, 2010) and may have a strong impact on biodiversity leading to severe conflicts (e.g. Henle et al., 2008). These conflicts are expected to exacerbate in the next future as a response to the increase in global population and food demand. There is thus a need to increase food production and maintain it at that higher level through time, while ensuring environmental and social sustainability, conserving biodiversity and ecosystem services (Godfray et al., 2010; Tilman et al., 2002).

Modern agriculture is thus a great challenge to the conservation of both biodiversity and ecosystem services, with agricultural intensification thought to be the main reason for the dramatic population declines experienced by many wild species in the last decades in Europe (Chamberlain et al., 2000; Donald et al., 2001). Recent assessments at the European and global scale showed that farming is (and will be) the single biggest source of threat to bird species, especially in developing countries (BirdLife International, 2015; Green et al., 2005). Agriculture intensification and agricultural land-uses are thus at the heart of the current biodiversity crisis, as well as of the reduction of many ecosystem services different from provisioning ones (Foley et al., 2005; Tilman, 1999).

The aim of our paper is, therefore, to hypothesize potential conservation strategies in an agricultural landscape for wildlife and (other) ecosystem services within the same area, and to explore how the integration of biodiversity conservation and the preservation of (other) ecosystem services could lead to a 'win-win' strategy in landscape planning. We used as models two 'classic' examples: the conservation of a single wild species of particular concern on the basis of its habitat requirement and the soil erosion control (soil retention) in intensively farmed areas. We aim to evaluate whether species conservation and soil retention could be part of an integrated strategy, and how the latter would perform compared to individual strategies mutually focused on biodiversity or soil.

We focus on vineyards, which are characterised nowadays by a highly intensive management and almost invariably have a high impact on biodiversity (Viers et al., 2013), with reported impacts on several different groups (e.g. Schmitt et al., 2008; Trivellone et al., 2012; Assandri et al., 2017). In addition to such an impact on wildlife, vineyards in hilly areas are often also associated with very high risks of soil loss (Galati et al., 2015; Van der Knijff et al., 2000). Soil erosion is indeed a key factor for land degradation in general and in particular it has a severe impact on agricultural sustainability (Cerdà et al., 2010, 2009).

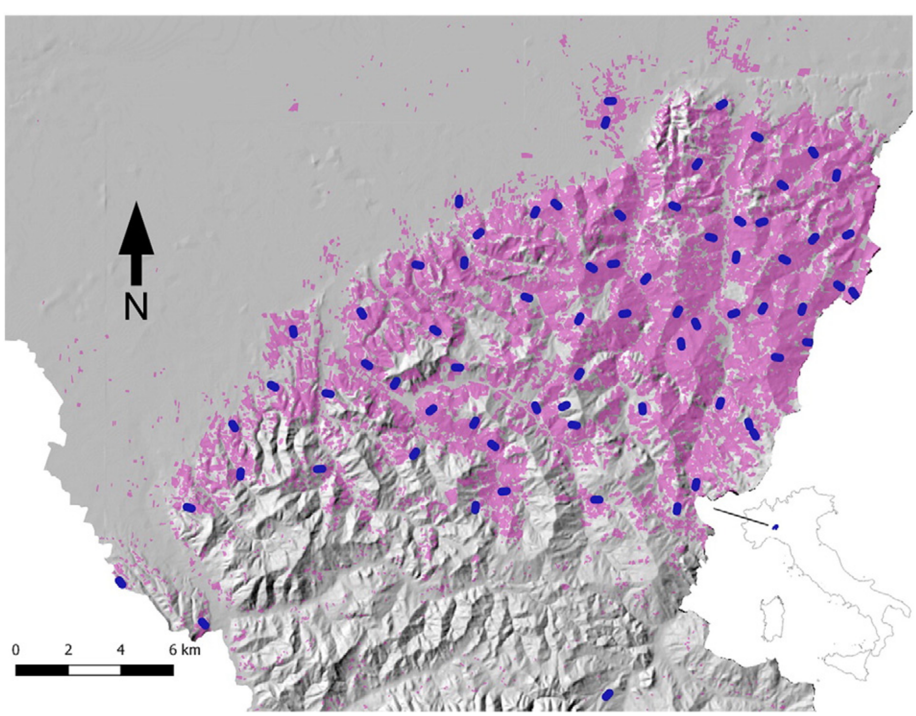

Fig. 1. Study area: transects are shown in blue, vineyards in violet (source: DUSAF 4 database; http://www.geoportale.regione.lombardia.it/). The inset shows the location of the study area in Italy.