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Research article

Assessing common birds' ecological requirements to address nature conservation in permanent crops: Lessons from Italian vineyards

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ABSTRACT

Viticulture has contributed to shaping cultural landscapes in several regions across all continents. Recent farming intensification is causing landscape homogenization and biodiversity loss in several of those areas, but knowledge about the impacts on biodiversity in vineyards is still scarce.

Simplified agro-ecosystems resulting from intensification host mainly generalist and common species, which still play a key role in the regulation of ecosystems and in the provision of ecosystem services.

We assessed the abundance of 11 common bird species at 47 linear transects in a vineyard-dominated landscape in Trentino (NE Italy), in both spring and winter, and analysed abundance variation in relation to three independent groups of predictors: landscape, management, and topographic-climatic variables.

In the majority of species (7), abundance was primarily or considerably affected by landscape attributes. However, an additional 5 species were largely affected by management practices, often with conspicuous seasonal differences. Overall, landscape and management heterogeneity positively affected the abundance of 6 species.

Vineyard cover (and in particular the new *spalliera* trellising system) was negatively related with the abundance of 6 species, with the strongest impacts occurring in winter. On the contrary, the cover of marginal habitats had major positive effects over 8 species.

Hedgerows, tree rows, and dry stone walls, as well as traditional *pergola* vineyards and landscape and management heterogeneity should be conserved or restored in viticultural landscapes to promote the abundance of common bird species. This strategy would ensure the maintenance of the ecosystem services they provide, while promoting the general sustainability of the agroecosystem.

1. Introduction

Agricultural-driven land-use intensification is the most important cause of terrestrial biodiversity loss at a global scale (Foley et al., 2011), and now the reduction of this trend, instead of its stabilization, must be the actual goal for conservation (Butchart et al., 2010).

Agricultural intensification acts at two distinct but interconnected spatial scales. At the local (field) scale, it involves the intensification of farming practices (e.g. increasing fertilizer and pesticide inputs, deep ploughing, and massive use of machinery). At the landscape scale, intensification creates homogenization and fragmentation through, for example, the conversion of perennial grassland-like habitats into arable fields, the increase of field size, the removal of marginal habitats, finally resulting in highly simplified landscapes (Fahrig et al., 2011; Tscharntke et al., 2005).

Agri-environmental schemes (AESs) aim to counteract the negative effects of agricultural intensification on ecosystems by providing financial incentives to farmers that adopt farming practices with lower environmental impacts (Kleijn et al., 2006).

Landscape structure can explain much of the patterns of biodiversity in complex landscapes (i.e. those with >20% cover of semi-

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natural habitats, Batáry et al. (2011)), whereas simpler landscape management practices could have important effects on biodiversity (Chamberlain et al., 1999; Schmidt et al., 2005). As a consequence, general (and not specifically landscape-oriented) AESs could be ineffective in complex landscapes, but pivotal in simpler ones (Batáry et al., 2011).

These simplified systems host mainly generalist and common species, defined as 'those that are abundant and widespread' (Gaston, 2010). Despite the low contribution to community richness, common species are exceptionally influential in determining many macroecological patterns and in providing ecosystem services (Gaston, 2011). As an example, birds provide fundamental services and economic benefits to humans, such as seed dispersal, pollination, and biocontrol (Sekercioglu et al., 2004; Whelan et al., 2015).

A small proportional reduction in the abundance of a common species can result in the loss of a large number of individuals, which then dramatically impacts ecosystems.

A lot of natural and anthropogenic factors could suddenly change a common species into a rare or threatened one (Gaston and Fuller, 2008), and today common species 'lie at the very heart of the biodiversity crisis' (Gaston, 2011). In Europe, avian abundance and biomass are declining due to the depletion of common species (Inger et al., 2014), with farmland birds being amongst the most threatened ones (Donald et al., 2006).

In temperate regions, permanent crops such as vineyards, olive groves, and fruit orchards could host relevant populations of several common bird species (Brambilla et al., 2013; Rey, 2011). These crops are undergoing severe intensification (Caraveli, 2000), but there is limited knowledge about their impacts on biodiversity, including farmland common bird species (Balmford et al., 2012). This is particularly concerning, because permanent crops have been excluded from the 'greening' obligation introduced in the recent Common Agricultural Policy (CAP) 2013 reform, which aims at reducing the impact of EU agriculture. This type of an exemption for permanent crops would hinder efforts to conserve biodiversity in these crops, which are often managed as highly intensive monocultures (Pe'er et al., 2014).

Vineyards are an example of permanent crops in which management practices have a direct effect on landscape structure and, in turn, on biological communities (Bruggisser et al., 2010; Nascimbene et al., 2013). In the past, viticulture had a preeminent role in creating an impressive cultural landscape (Cohen et al., 2015; Kizos et al., 2012), characterised by extensive and traditionally terraced areas (Petit et al., 2012). Nowadays, viticulture intensification is resulting in homogeneous monocultures (Martínez-Casasnovas et al., 2010), that create a substantial reduction in natural habitats in the Mediterranean Biome (Viers et al., 2013). In this context, the landscape-mediated effect of viticulture on biodiversity is likely to be relevant for conservation (Hilty and Merenlender, 2004; Isaia et al., 2006; Gillespie and Wratten, 2012), but it is far from being fully understood.

Within this study, we explored the effect of landscape and management characteristics of vineyards on several common avian species in an area largely dominated by viticulture. We investigated several landscapes across a gradient of progressive intensification to understand how landscape traits and management factors shape the abundance pattern of common birds.

We expected that some common species may be affected by the availability of marginal, natural, and semi-natural habitat remnants. This could particularly apply to species which cannot nest on vines or to species foraging mostly in other habitats or feeding on resources not available in or below/above vines. Other species may be tied to traditional elements of agricultural landscapes, for example hedgerows, dry stone walls, and isolated large trees, which provide nest-sites. Also, management practices may be expected to affect bird abundance, by for example regulating food availability (e.g. via an effect of the intensity of phytosanitary treatment on insectivorous species) or detectability (e.g. creating patches of bare ground where prey detection is enhanced, e.g. Schaub et al. (2010)).

2. Materials and methods

2.1. Study area

This study was carried out in the Trento Province (South-eastern Alps, Northern Italy; Fig. 1a–b), a mostly mountainous area where vineyards occur in the main valley floors and on the adjacent hilly sides from 65 to 750 m a.s.l. See Assandri et al. (2016a) for further details.

2.2. Model species, experimental design and bird counts

In this study we considered 11 common and widespread species in Italy (Nardelli et al., 2015). Three species are commonly found in the study area both in the breeding and wintering seasons: blackbird *Turdus merula*, great tit *Parus major,* and chaffinch *Fringilla coelebs*. Four species are much more frequent during the breeding season: song thrush *Turdus philomelos,* blackcap *Sylvia atricapilla*, serin *Serinus serinus,* and greenfinch *Carduelis chloris*. Four species occur exclusively or predominantly in winter: dunnock *Prunella modularis*, wren *Troglodytes troglodytes*, Eurasian robin *Erithacus rubecula,* and rock bunting *Emberiza cia*.

We counted these species along forty-seven 200-m long linear transects distributed across the entire area covered by vineyards (Fig. 1c; Assandri et al., 2016a) and within a 100-m buffer around the transect, thus each census plot covered 7.15 ha. To avoid double counting the same individuals, the minimum distance between neighbouring plots was 300 m. Further details on bird counts are given in the supplementary materials.

2.3. Environmental variables collection

Following our previous approach (Assandri et al., 2016a), we measured landscape, management, and topographic-climatic variables (Table 1) using the software QGIS (QGIS Development Team, 2016) and through accurate field validation for some variables.

Phytosanitary treatments are quite uniform since they are recommended by a central agricultural institute, but there are differences in the use of synthetic insecticides, fungicides, fertilizers, and herbicides, which are allowed in conventional fields but not in organic ones. We then quantified the amount of vineyards under conventional and organic management for each plot. Certified organic agriculture in our study area is limited (<3% of the vineyard area), but a specifically targeted design allowed us to include a mean (±SD) cover of organic vineyards equal to 13.9% ± 26.7 (range: 0–100%).

We further distinguished vineyards according to two trellising systems occurring in the area: i) *pergola*, the traditional system (about 80% of vineyards in the Province; Chemolli et al., 2007), consisting of tall (up to >2 m) and spaced vines (up to 5 m between rows) supported by poles and beams; ii) *spalliera*, the standard global system with lower vines supported by wires held between poles and with lower spacing (<2 m between rows).

Within these two systems, management is substantially the same, but mechanical harvesting and pruning are impeded by the *pergola* structure.

Topographic variables (mean elevation and slope) were derived from a 1-m resolution digital elevation model (DEM). We also