



## Beautiful agricultural landscapes promote cultural ecosystem services and biodiversity conservation



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### ABSTRACT

Agriculture, during its millenarian history, had contributed to shape impressive cultural landscapes; however, in recent decades, many of these have been lost or degraded because of widespread intensification or abandonment. Low-intensive agricultural landscapes are of utmost importance for biodiversity conservation and the delivery of cultural ecosystem services.

We worked in a cultural landscape shaped by viticulture (in Trentino, Italy), which recently underwent a widespread intensification. We explicitly quantified two cultural services (aesthetic and cultural heritage values), and the biodiversity (bird species richness) associated with this landscape at 24 sampling sites. We then related these variables with the territory density of an indicator/flagship bird species, the common redstart. Finally, we assessed redstart ecological requirements at the territory scale. We aimed to define an appealing strategy combining biodiversity conservation and ecosystem service delivery in the cultural landscapes.

Redstart density was positively related with avian species richness and landscape aesthetic value, the latter being related with the cultural heritage value. Redstart occurrence was positively associated with hedge and tree rows, dry-stone walls, marginal habitats, and the compositional diversity of the land-cover.

We concluded that managing the agricultural landscape to maintain aesthetic and heritage values, which primarily means conserving and enhancing its key 'traditional' traits, would favour an indicator/flagship species and likely the wider bird diversity. It will also promote the heritage and recreational value of the landscape itself, underlining the importance of the synergistic integration of multiple conservation targets into a combined strategy.

### 1. Introduction

Cultural landscapes result from long-term, complex human-nature interactions (Tieskens et al., 2017) and stand “at the interface between nature and culture, tangible and intangible heritage, biological and cultural diversity” (Rössler, 2006). They are characterized by distinctive biophysical features, including substantial amounts of natural/semi-natural habitats, land-cover heterogeneity (Plieninger et al., 2006), relatively low nutrient inputs and low outputs per hectare (Signal and McCracken, 1996; Kleijn et al., 2009). These characteristics make cultural landscapes pivotal for biodiversity conservation (Antrop, 1997; Fischer et al., 2012).

Cultural landscapes also promote the delivery of cultural ecosystem services (Schaich et al., 2010; Tengberg et al., 2012), i.e. the “non-material benefits people gain from ecosystems”, such as spiritual, religious, aesthetic and cultural heritage values, recreation, and

ecotourism (Millennium Ecosystem Assessment, 2005). Cultural ecosystem services are fundamental for human life quality, but due to their intangible nature are often difficult to quantify and to incorporate into economic assessments and landscape planning (Daniel et al., 2012; Plieninger et al., 2013, 2015).

In its millenarian history, agriculture has contributed to create distinctive cultural landscapes (Zimmermann, 2006), to the point that ‘low-intensity farmland’ has been used as a synonym of cultural landscapes (Tieskens et al., 2017). In those areas, both biodiversity and cultural services have been favoured by a prolonged low-density settlement and low-intensity land use (Schaich et al., 2010; Gatzweiler and Hagedorn, 2013). However, in the recent decades, those systems and the species and services they harbour collapsed, because of the intensification of agricultural practices and the abandonment of marginal and less productive areas (Tscharntke et al., 2005; Beilin et al., 2014).

Conservation approaches based on ecosystem services delivery

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could broaden and deepen supports for biodiversity protection, potentially aligning conservation and production issues (Goldman et al., 2008). However, most of the current conservation practices and legislations are tightly focused on protecting species and habitats (Maes et al., 2012). This separation is problematic because, even if the relationship between biodiversity conservation and ecosystem service delivery is often positive (Harrison et al., 2014), some negative impacts of biodiversity conservation programs on wider ecosystem services were reported (Austin et al., 2016). Thus, the integration of these two conservation approaches into landscape planning, based on the possible synergies between biodiversity conservation and the delivery of a wider bundle of ecosystem services, should be pursued, also because it was proven to be more appealing for a variety of stakeholders (Ekroos et al., 2014; Brambilla et al., 2017). In fact, cultural services can help to raise public support for protecting ecosystems (Gobster et al., 2007; Schaich et al., 2010), and thus constitute an ideal framework to integrate ecosystem service delivery and biodiversity conservation into synergistic strategies (Mace et al., 2012).

In this work, we quantified two cultural services identified in the Millennium Ecosystem Assessment (2005), the aesthetic value and the cultural heritage value, provided by a traditional viticultural landscape characterized by various levels of recent intensification. Vineyards have been selected as a case study because viticulture contributed to model impressive cultural landscapes in the Mediterranean basin, such as the terraced vineyard systems supported by dry-stone walls (Petit et al., 2012), which support high levels of biodiversity and threatened species (Assandri et al., 2016; Guyot et al., 2017). In parallel, vineyard-dominated cultural landscapes (at least, the non-intensive ones) provide a variety of cultural ecosystem services, including aesthetic values, cultural heritage values and recreational and ecotourism opportunities (Winkler et al., 2017).

On the other hand, viticulture intensification and expansion, favoured in Europe by the Common Agricultural Policy (CAP) and by the huge economic value of wine, are nowadays resulting in homogeneous monocultures, landscape simplification (Martínez-Casasnovas et al., 2010) and loss of natural habitats (Viers et al., 2013), with strong impacts on biodiversity and ecosystem services (e.g. Caprio et al., 2015; Assandri et al., 2017c; Winkler et al., 2017).

In addition to the ecosystem service assessment, we quantified bird diversity in the same cultural landscape and related these benefits with the density and the ecological requirements of a flagship/indicator species for vineyards, the common redstart *Phoenicurus phoenicurus* (Aves: Musciapidae) (Assandri et al., 2017b). We expected that landscape traits associated with extensive agriculture, which qualify the landscape as cultural (and likely affect its aesthetic and heritage value), could be the same factors promoting redstart occurrence and the maintenance of the wider bird diversity.

Our eventual goal was therefore to suggest an appealing strategy combining biodiversity conservation and ecosystem service delivery into an integrated plan for the cultural landscape.

## 2. Materials and methods

### 2.1. Study area and design

This study was performed in Trentino (south-eastern Alps, Italy; Fig. 1a), working along a landscape gradient, defined by environmental and agricultural management characteristics. Lowland areas (200–230 m a.s.l.) are mostly covered by intensive vineyards and infrastructures, which eroded the most of natural and semi-natural habitats (Assandri et al., 2017e). On mountainsides, specifically in Cembra Valley, the high acclivity limited mechanization and vineyards (still the dominant land-use up to 900 m a.s.l.) are grown thanks to a system of terraces supported by dry-stone walls. Natural (e.g. woodlands) and semi-natural habitats (e.g. hedgerows, natural field margins) regularly occur, resulting in a relatively high landscape heterogeneity.

These characteristics contribute to qualify the valley as a cultural landscape included into the National Register of Historical Rural Landscapes (Agnoletti, 2013).

Within this area and along this gradient, we selected 24 sampling sites, for a total of 400 ha (mean extent  $\pm$  SD:  $15.8 \pm 3.4$  ha; range: 10.8–22.8 ha; Fig. 1b).

### 2.2. Model species

Common redstart is widely distributed in Europe, where it underwent a sharp decline until the end of the last century, followed by a strong recovery (Birdlife International, 2004).

During the breeding season, it is mainly found in semi-open areas with sparse vegetation and mature trees, and increasingly in urban areas, where it easily finds cavities for nesting (Cramp, 1988; Droz et al., 2015). During the breeding season it is territorial, defending territories ranging from 0.14 up to 1 ha (Menzel, 1971; Glutz von Blotzheim, 1988). It is an insectivorous bird hunting from vantage points and catching about 50% of its prey (mainly Lepidoptera, Coleoptera, Diptera, Hymenoptera and Arachnida) on the ground (Martínez et al., 2010; Cramp, 1988). It is a long distant migrant wintering in sub-Saharan Africa (del Hoyo et al., 2005).

In the study area, it is commonly found in vineyards, with variable density depending on habitat and micro-habitat characteristics. According to this and to its breeding ecology (which make it quite sensitive to environmental changes), it was proposed as a “non-traditional” flagship species to promote biodiversity-friendly agriculture in vineyard-dominated landscapes (Assandri et al., 2017b).

### 2.3. Aesthetic quality and cultural heritage values

We quantified two cultural ecosystem services, the aesthetic value and the cultural heritage value, identified in the Millennium Ecosystem Assessment (2005). Many people find beauty or aesthetic quality in various aspects of the ecosystem, which is routinely assessed by perception-based surveys, where quantitative measures of aesthetic quality are derived by averaging choices, ratings, or other measures across observers (Daniel et al., 2012; Van Zanten et al., 2014).

We used photographic standardized questionnaires to attribute to each sampling site an aesthetic value (see e.g. López-Santiago et al., 2014). In the questionnaires (spread by internet, see Supplementary materials for details on dissemination and respondents), all the 24 sampling sites were depicted by a panoramic photograph showing the ‘best representation’ of the landscape. A preview of all the photographs together was firstly presented to the observers; then, photographs were presented again in a random way and observers were asked to rate each landscape from 1 to 10 considering purely aesthetic criteria. The aesthetic value of each sampling site was then calculated as the median score given by participants in the 382 questionnaires analysed.

The cultural heritage values were recognized as a cultural service because many societies place high value on the maintenance of cultural landscapes (Millennium Ecosystem Assessment, 2005), but its quantification is difficult (Daniel et al., 2012). Here we assessed whether the 24 landscapes selected for our study were perceived by the observers born in Trentino ( $N = 89$ ) as “traditional”, thus part of the cultural heritage of the region. As this index was strongly correlated with the aesthetic value ( $r_s = 0.69$ ,  $p = 0.002$ ), subsequent analyses were based only on the latter.

### 2.4. Common redstart ecological requirements and species richness assessment

#### 2.4.1. Common redstart territory mapping and species richness assessment

During the breeding season 2015 we conducted four sessions of territory mapping in each of the 24 sampling sites (census periods: 10.04–17.04; 05.05–12.05; 29.05–05.06; 27.06–05.07).

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