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# Organic farming favours bird communities and their resilience to climate change in Mediterranean vineyards



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# ABSTRACT

Farmland birds have suffered notable declines in Europe in recent decades, mainly due to agricultural intensification and climate change. Organic farming, which has been shown to enhance biodiversity, is increasingly being put into practice in European vineyards. Nevertheless, no previous studies have reported significant positive responses in avian communities to organic practices. On the other hand, cover cropping is a common practice in both organic and conventional vineyards and is thought to have positive effects on bird communities and, particularly, on insectivorous species that may help control pests in agroecosystems. In this work, we studied bird communities in Mediterranean vineyards in Catalonia (NE Iberian Peninsula) in both the breeding and wintering seasons, and tested the effects of two common management options - organic vs. conventional farming and herbaceous cover vs. bare soil - on bird communities. In particular, we focused on (a) insectivorous birds that may help control pests and (b) avian species negatively affected by climatic warming whose population fluctuations may reflect the resilience of these bird communities to future climate change. Organic farming had a positive effect on vineyard bird communities and, specifically, increased species richness and overall bird abundance. This farming technique also positively affected the abundance of both insectivorous species and species whose populations are declining due to climate change. The presence of inter-row herbaceous cover between vines also had positive effects on bird community parameters, specifically in spring and in organic vineyards, when herbaceous cover favours species richness and the abundance of insectivorous species. However, further investigations are still needed to better understand the effects of different types of vegetation cover - i.e. plant origin and composition (e.g. sown vs. spontaneous vegetation) and proportion of vegetation cover (full vs. partial vegetation cover) - when employed as tools in wildlife conservation. This work provides useful information regarding bird conservation, which will help mitigate the effects of climate change on bird populations.

#### 1. Introduction

Traditional agricultural landscapes harbour high levels of biodiversity that are negatively affected by agricultural intensification (Firbank et al., 2008; Henle et al., 2008; Norris, 2008). European farmland birds are known to be undergoing a serious decline, mainly due to changes occurring in agricultural systems such as landscape simplification, increased mechanization or increased fertilizer and pesticide use, amongst others (Donald et al., 2001; Guerrero et al., 2012; Gregory et al., 2005). To reverse this situation, agricultural policies are increasingly promoting ecologically oriented farming methods whose aims include preserving biodiversity and conserving natural resources (Pfiffner and Balmer, 2011). Organic farming has been shown

to enhance biodiversity (Bengtsson et al., 2005; Fuller et al., 2005) and worldwide its surface area grew from 11 million ha in 1999 to 43.7 million ha in 2014 (Willer and Lernoud, 2016). Specifically, the surface area of organic vineyards in Europe increased from 87,577 ha in 2004 to 315,579 ha in 2014, and today over 80% of the world's organic vineyards are found in Europe; the countries with the largest surface areas of organic grape production are Spain, Italy and France, each with over 60,000 ha of organic vineyards (Willer and Lernoud, 2016).

However, despite the increase in organic grape production, few studies have dealt with the effects of organic farming on vineyard bird communities, and none have found any significant positive response in avian communities to these farming methods (Assandri et al., 2016, 2017a, 2017b; Macià et al., 2012; Puig-Montserrat et al., 2017).

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Fig. 1. Location of the study area in Catalonia and the 33 transects in the study area. Organic with herbaceous cover (white circles), organic with bare soil (white triangles), conventional with herbaceous cover (black circles) and conventional with bare soil (black triangles) farming transects are shown.

Interestingly, Duarte et al. (2014) studied birds in three vineyards subjected to different crop management schemes. In one vineyard, herbaceous cover was managed to prevent excessive competition with the main crop by mechanical mowing whereas synthetic herbicides were applied in the second one. In the third vineyard, the soil was tilled to maintain bare soil. Despite the study's limitations of low replication and uncertified organic vineyards, they found that overall species richness and diversity was higher in vineyards where herbaceous cover underwent mechanical mowing, similar to organic farming, compared to those where synthetic herbicides were applied. It also showed that vineyards with bare soil had the lowest bird diversity, abundance and species richness of the three studied vineyards, which suggests that the implementation of herbaceous cover may be a viable technique in habitat management for conservation and production purposes.

Insectivorous birds are known to help control pests in agroecosystems (Barbaro et al., 2016; Pfiffner and Balmer, 2011). Duarte et al. (2014) also found a greater abundance of insectivorous passerine birds where the herbaceous cover underwent mechanical mowing, although it is not clear if this was due to the presence of herbaceous cover or a less intensive use of pesticides. Other authors (Arlettaz et al., 2012; Barbaro et al., 2016; Guyot et al., 2017) have found evidence that herbaceous cover would have a positive effect on bird communities and, in particular, on insectivorous species. A study by Barbaro et al. (2016) reported that the total abundance of insectivorous birds was 15% higher in vineyards with full grass cover than in vineyards with partial cover alternating with bare ground. Arlettaz et al. (2012) showed that the proportion of ground vegetation cover influenced the pattern of microhabitat selection by woodlarks, mostly insectivorous during the breeding season, with an optimum around 55% at the foraging patch scale. Guyot et al., (2017) reported that birds showed a marked preference for plots with vegetated ground in winter but chose plots with intermediate vegetation cover in spring and summer. According to these authors, such season-specific preferences might be related to species-specific life histories, that is, more insectivores, ground-foraging species are present during the breeding season than in winter, when granivorous species predominate (Guyot et al., 2017). This might also be associated with some granivorous winter birds diet changing to an insectivorous diet in the breeding season, since a protein-rich food is essential also for chick growth of granivorous bird

species (Guyot et al., 2017).

Furthermore, climate change is having a significant – both negative and positive – effect on bird populations (Devictor et al., 2012; Gregory et al., 2009; Scheffers et al., 2016). Based on a combination of observed population trends in 20 European countries over 26 years and climatic envelope models, Gregory et al. (2009) grouped 122 common bird species into those whose potential range is projected to increase or to decrease. According to this analysis, the number of bird species whose populations will be negatively affected by climatic change is three times greater than those that will be positively affected (Gregory et al., 2009). However, the influence of land cover on species' responses to climate change will probably differ depending on habitat type and composition (Jarzyna et al., 2016). Therefore, an understanding of these interactions will be vital for managing habitats appropriately if the negative impact of climate change on biodiversity is to be reduced by the implementation of adaptation strategies (Oliver and Morecroft, 2014).

Thus, in the current context of global climate change, knowledge of vineyard management practices are highly relevant factors when attempting to provide guidance on how to enhance bird conservation and abundance of insectivorous birds that may help control pests, and how to mitigate the potential effects of climate change on bird populations. Here, we focus on bird communities in Mediterranean vineyards in Catalonia (NE Iberian Peninsula) in both the breeding and wintering seasons and test the effects of two common management options – organic vs. conventional farming and herbaceous cover vs. bare soil – on bird communities and, in particular, on insectivorous birds and the birds that are negatively affected by climatic change according to Gregory et al. (2009).

## 2. Methods

## 2.1. Study area

This study was conducted in the wine appellation of origin Penedès (Fig. 1) in Catalonia. The main land uses in the study area are forests (34% of the whole area) dominated by Aleppo pine (*Pinus halepensis*) and holm oak (*Quercus ilex*) woodland, scrubland (17%), vineyards (15%), cereal crops (14%) and urban land and infrastructures (9%). Certified organic agricultural holdings represent about 24% of the

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