



## Modelling future scenarios to improve woodland landscapes for birds in the Mediterranean



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### ARTICLE INFO

#### Article history:

Received 19 August 2015

Received in revised form 12 January 2016

Accepted 9 February 2016

#### Keywords:

Conservation

Cork oak woodlands

Landscape heterogeneity

Management

Olive groves

Riparian galleries

### ABSTRACT

Agro-silvo-pastoral systems occupy much of the Mediterranean region. Promoting landscape heterogeneity in these systems is a potentially valuable management strategy to enhance woodland biodiversity. We evaluated the effects on birds of managing patches of olive groves and riparian galleries to promote heterogeneity of these systems in Portugal.

For a large cork oak woodland we (i) used nesting season bird density estimates and habitat descriptors to generate suitability models for each studied species; (ii) identified areas suitable to establish new patches of riparian galleries and olive groves, and used this information to (iii) generate scenarios maps with different levels of cover of both habitats. Finally, (iv) the model of each bird species was applied over the future scenarios to estimate potential changes in its distribution and abundance.

Future scenarios with greater availability of riparian vegetation resulted in major increases in projected populations of seven of the 21 studied species, but gains with increases of olive groves were predicted in just three species. Bird species predicted to increase the most with the recovery of riparian vegetation are presently among the least abundant in the region. Restoring riparian galleries would be highly beneficial for birds, whereas promoting traditional olive groves would have lower conservation implications.

The methodology used proved helpful to select areas particularly appropriate for habitat management, generate simulated landscapes incorporating this management, and predict the population and spatial responses of species to these simulated scenarios, thus having a good potential to guide conservation management. Moreover, our results indicate that simple management measures should have substantial positive effects on the bird community of oak woodlands, without compromising the essential economic return of the system.

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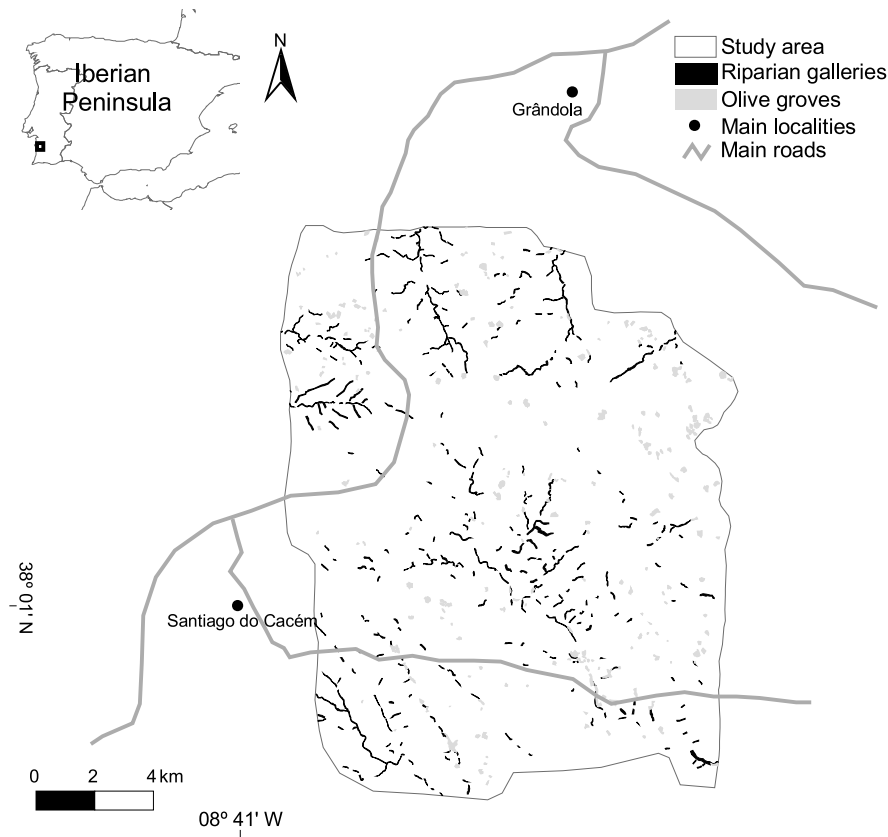
### 1. Introduction

There is a growing concern with the maintenance of the biodiversity value of rural areas (Balmford, Green, & Phalan, 2012; Benton, Vickery, & Wilson, 2003; Fahrig et al., 2011; Polyakov et al., 2013) and consequently there is a need to develop management

strategies conciliating conservation with economic exploitation in agricultural landscapes. Biodiversity rich agro-silvo-pastoral systems that result from the alteration of Mediterranean woodlands cover much of the Mediterranean basin. The most extensive of such systems are *montados* or *dehesas* (hereafter *montados*), which consist of open woodland dominated by cork oak (*Quercus suber*) and/or holm oak (*Quercus rotundifolia*) trees. In the Iberian Peninsula, where they are the most widespread type of woodland, they cover over 3.5–4.0 million ha (Pinto-Correia, Ribeiro, & Sá-Sousa, 2011). These semi-natural systems result from the selective clearing of Mediterranean forests, or from the intentional planting of cork and holm oaks (Blondel, Aronson, Bodiou, & Boeuf, 2010). They are mostly used for agriculture, forestry and grazing, and are recognized as an excellent example of balance between socio-

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**Fig. 1.** Map of the study area (*Serra de Grândola*, Alentejo, Portugal), showing the current availability of olive groves and riparian galleries, in a matrix of cork oak woodland.

economic development and biodiversity conservation (Bugalho, Caldeira, Pereira, Aronson, & Pausas, 2011; Díaz, Campos, & Pulido, 1997; Pinto-Correia & Vos, 2004). Silvo-pastoral systems similar to *montados* but with an overstory dominated by other Mediterranean oak species are present throughout much of Southern Europe, Northern Africa and the Middle East (Blondel et al., 2010).

Cork oak *montados* have been managed for centuries, but the economic importance of the different components of the system have changed through time (Koniak, Noy-Meir, & Perevolotsky, 2011; Pinto-Correia & Fonseca, 2009). In the last decades, management has generally targeted the increase in cork production (Costa & Pereira, 2007; Pérez-Ramos, Zavala, Marañón, Díaz-Villa, & Valladares, 2008), which provides most of the economic return of the system (Almeida & Tomé, 2010; WWF, 2006). In the last decades, many regions dominated by *montados*, as other Mediterranean habitats, suffered from the marked rural depopulation, which resulted in the abandonment of the small scale agriculture that used to be practiced alongside the large scale exploitation of the system (Pinto-Correia & Mascarenhas, 1999; Sokos, Mamolos, Kalburtji, & Birtsas, 2013). These changes in rural socioeconomic conditions, in part prompted by Common Agricultural Policies, lead to the uncontrolled growth of shrubs and the consequent increase in this system vulnerability to fire (Bugalho, Plieninger, Aronson, Mohammed, & Crespo, 2009). An example is the abandonment of the small olive tree orchards (*Olea europea*) that often dot *montado* landscapes. Many of them persist in spite of years of neglect, but their original structure is deteriorating due to factors like the invasion by understory shrubs (Duarte, Jones, & Fleskens, 2008). The olive tree is a domestic variety of the wild olive (e.g. Breton, Medail, Pinatel, & Berville, 2006; Kaniewski et al., 2012; Moriondo, Stefanini, & Bindi, 2008), an abundant fruiting tree in the original vegetation, and it has been demonstrated that small olive groves interspersed in the *montado* matrix can have a positive impact

on several taxa, including carnivores and birds (e.g. Leal, Martins, Palmeirim, & Granadeiro, 2011; Rosalino, Rosário, & Santos-Reis, 2009). Small olive groves and other orchards, particularly of orange trees, can also play an important role as a breeding habitat for many birds, including some species of conservation concern (Hanane & Baamal, 2011).

Riparian galleries are also common elements of *montado* landscapes, diversifying habitat availability and providing comparatively humid environments, and are known to have a positive influence on the biodiversity of these landscapes (Leal, Martins et al., 2011; Rosalino et al., 2009). However, they are frequently cleared by land owners or are subject to aggressive management practices (Aguar, Ferreira, Moreira, & Albuquerque, 2000; Bruno et al., 2014) that affect their value for biodiversity (Corbacho, Sánchez, & Costillo, 2003), such as strong cuts along large sections.

The available evidence indicates that preserving and promoting both riparian galleries and small olive groves, using regulations or incentives, may result in *montado* landscapes that potentially sustain a greater biodiversity. However, such local management decisions should ideally be based on quantitative predictions of their impact in the region where they are to be implemented. One of the techniques that has been suggested to make such predictions is the modelling of spatially-explicit future scenarios (Boatman et al., 2010). These models combine population simulators with maps describing alternative scenarios of future spatial distribution of landscape features (Dunning et al., 1995). Using spatially-explicit modelling, we studied the potential impact on birds of various options of development of *montados* that result in landscapes with varying amounts of olive groves and riparian galleries. We hypothesised that increasing the area covered by both habitats would diversify the availability of niches and resources, which would benefit some bird species. We used as a case study the bird assemblage of *Serra de Grândola*, a low mountain range located in southern

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