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# Higher breeding densities of the threatened little bustard *Tetrax tetrax* occur in larger grassland fields: Implications for conservation

João Paulo Silva [a,b,c,*], Jorge M. Palmeirim [a], Francisco Moreira [a,c]

[a] Centre for Environmental Biology, Faculdade de Ciências, Universidade de Lisboa, 1749-016 Lisbon, Portugal
[b] Centre for Applied Ecology, "Prof. Baeta Neves", Instituto Superior de Agronomia, Tapada da Ajuda, 1349-017 Lisbon, Portugal
[c] Institute for Nature Conservation and Biodiversity, Rua de Santa Marta, 55, 1150-294 Lisboa, Portugal

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ABSTRACT

Previous studies have found that densities of little bustard *Tetrax tetrax* breeding males tend to be higher in areas with smaller agricultural fields, presumably due to increased habitat diversity. However, exceptionally high densities have been found in large grassland fields in Portugal, which suggests that the influence of field size varies geographically, and that the role of this factor is not yet fully understood, despite its importance as a key management issue.

We studied how field size, together with vegetation structure, influences the presence and density of breeding little bustards in a region of southern Portugal. Fifty-four grassland fields were sampled in 2007 and another 29 in 2008, with sizes ranging from 23 to 172 ha. A total of 183 breeding males were found in 47 of these fields, reaching densities of up to 37 males/100 ha. A higher probability of occurrence of breeding males was found in larger fields with a vegetation height below 40 cm and field size alone explained 46% of the variability in male density. These results suggest that larger continuous areas of suitable habitat attract many males, most likely as a consequence of their lek mating system. We conclude that conservation efforts, in a landscape context of large farm sizes, should: (1) be channelled to farms with large fields; (2) ensure adequate livestock grazing to create suitable habitat and (3) promote management at a landscape level to ensure the most continuous grassland habitat patches possible.



## 1. Introduction

A significant proportion of Europe's threatened bird species are dependent on the mosaic of habitats created by extensive (i.e. non-intensive or traditional) cereal farming, sometimes called pseudo-steppes (Suárez et al., 1997). The little bustard *Tetrax tetrax* is a grassland bird that depends on these agro-ecosystems. It has suffered a major decline in most of its range since the beginning of the last century (Schulz, 1985a; Goriup, 1994) and is now classified as globally near threatened (BirdLife, 2008) and vulnerable in Europe (BirdLife, 2004). It is also considered a priority species for conservation under the European Bird Directive (2009/147/CE), which has lead to the designation of numerous key steppic areas aiming for its protection and therefore functioning as an "umbrella" species, benefiting the conservation of many other threatened birds. Agricultural intensification has for long been considered the main cause for its decline (Schulz, 1985a; Goriup, 1994), and this view has been supported by recent studies demonstrating that intensification results in habitat degradation and loss for the species (Martínez and Taipa, 2002; Morales et al., 2005, 2006; Osborne and Suárez-Seoane, 2007; García et al., 2007).

The Iberian Peninsula is critically important for the little bustard because it holds more than half of the world's remaining population of the species (Schulz, 1985a; de Juana and Martínez, 2001). Here the species occurs mainly in grasslands during the breeding season, usually either fallow lands resulting from the rotational crop system (Martínez, 1994, 1998; Campos and López, 1996; Delgado and Moreira, 2000; Morales et al., 2005, 2006, 2008) or non-intensive pastures (e.g. Campos and López, 1996).

This species exhibits an exploded lek mating system, with breeding males displaying in loose aggregations, which females apparently attend primarily for the purpose of mating (Schulz, 1985b; Jiguet et al., 2000). Because females are too inconspicuous to be detected in workable numbers, breeding population estimates are usually based on adult male densities (e.g. Silva et al., 2006). Breeding male densities vary considerably across the little bustard range in the Iberian Peninsula. In Portugal, the highest regional densities were found in Vila Fernando with 13 males/100 ha (Schulz, 1985b) and Castro Verde, with 10 males/100 ha (Delgado

* Corresponding author at: Centre for Environmental Biology, Faculdade de Ciências, Universidade de Lisboa, 1749-016 Lisbon, Portugal. Tel.: +351 217500000; fax: +351 217500028.
*E-mail address:* silvaj@sapo.pt (J.P. Silva).

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and Moreira, 2000). Similar values were recorded in Spain, with over 11 males/100 ha in parts of Extremadura (García de la Morena et al., 2006). Density has been found to increase with the amount of surface devoted to cereal farmland (Morales et al., 2005), landscape diversity (e.g. Martínez and Taipa, 2002; Morales et al., 2005; García et al., 2007), and the proportion of fallow land (Wolff et al., 2002; Morales et al., 2005; García et al., 2007).

Available information on the relationship between field size and little bustard densities is contradictory. Several studies conducted in Spain and France found higher densities usually associated to small fields and higher levels of land use diversity (Martínez, 1994; Campos and López, 1996; Salamolard et al., 1996; García et al., 2007). Contradicting this tendency, the highest breeding densities ever recorded for this species, occurred in large grassland fields in Southern Portugal (Moreira and Leitão, 1996). This suggests that the effect of field size on the occurrence and density of little bustard is not the same throughout the species range. Consequently, it is critical to further understand the role of this factor in different ecological contexts, because the management recommendations made based on the existent information may not be suitable for all the regions where the species persists.

Considering that the agricultural field is the management unit for farm owners, we sought to determine to what extent field size, together with vegetation structure, influence little bustard male densities during the breeding season in grasslands of the Iberian Peninsula. Vegetation structure was also taken into account because it is a known factor influencing little bustard presence and abundance (Martínez, 1994; Moreira, 1999; Salamolard and Moreau, 1999; Silva et al., 2004; Morales et al., 2008). Human disturbance also affects habitat use by little bustards (Suárez-Seoane et al., 2002; Silva et al., 2004; Osborne and Suárez-Seoane, 2007), but was not analyzed in this study because purposely we only worked with fields that had low levels of disturbance, far from inhabited houses and paved roads. Type of grassland, i.e. fallow land or pasture, was also taken into account in the analysis.

## 2. Methods

### 2.1. Study area

Our study was carried out in an area of 360 km$^2$ in northern Alentejo, Portugal, in a landscape of agricultural fields and pastures interspersed with oak *Quercus rotundifolia* woodlands (Fig. 1). It is located in the meso-Mediterranean bioclimatic region (Rivas-Martínez, 1981), and has an undulating or flat topography.

Agricultural areas are dominated by pseudosteppes, including annual crops, ploughed fields, pastures and fallows. Pastures are most often stocked with cattle, and persist for a minimum of five consecutive years. Fallows are part of the crop rotational system, and they generally last two to three years before being ploughed to re-initiate crop cultivation. Large farms dominate the region, and more than 70% of the study area is covered with fields of over 20 ha.

The study area includes three important bird areas (IBA; Costa et al., 2003), which have recently been classified as special protection areas (SPA) under the Europe Bird Directive (Vila Fernando, S. Vicente and Torre da Bolsa). The classification is justified by their value for the conservation of steppe birds, mainly little bustard, great bustard *Otis tarda* and lesser kestrel *Falco naumanni*. These SPA are among the most important sites for the conservation of the little bustard in Portugal, due to their high densities of breeding males (Silva and Pinto, 2006). Outside these areas grasslands are also abundant and the management of the farms are similar to those located within SPA and therefore presenting potential breeding habitat for the little bustard.

### 2.2. Grassland field selection

A previous study identified fallows and pastures as the main breeding habitat of the little bustard in the region (Silva, 2005). A geographical information system (GIS) was used to map all fallow and pasture fields of the study area during the spring of 2007 and 2008, using 2003 aerial photographs and field checks.

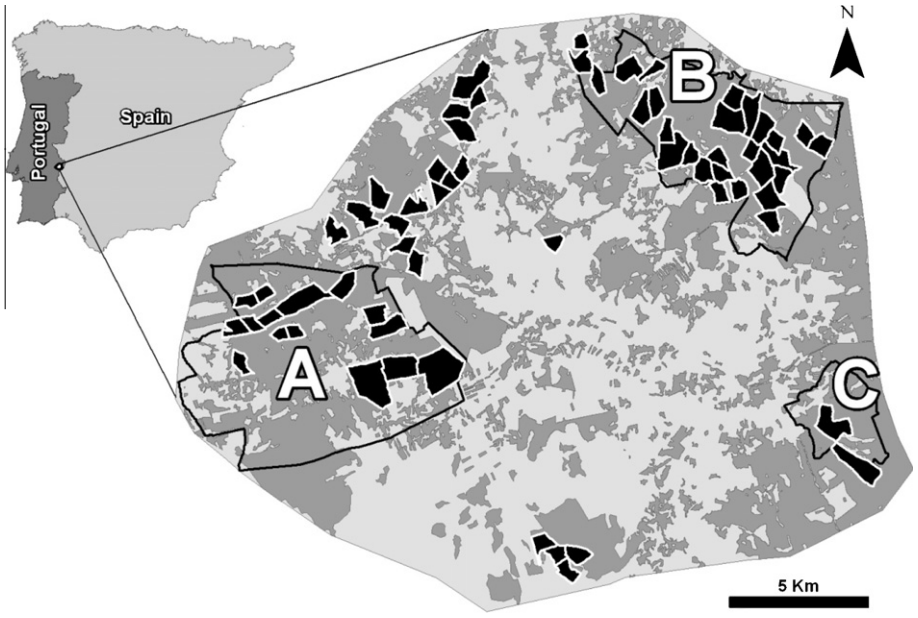


**Fig. 1.** Location of the study area in the Iberian Peninsula. Areas within black lines represent important bird areas (IBA): A – Vila Fernando; B – S. Vicente and C – Torre da Bolsa. Within the study area dark gray polygons represent agricultural and pastoral areas, while light gray polygons stand for non-adequate habitats, mainly forests, permanent crops and urban areas. Black areas represent the fields with over 20 ha, fulfilling the requisites to hold sampling stations favourable habitats, located at least 600 m from inhabited houses and paved roads.