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# Between and within-year effects of haying on grassland bird populations and spatial dynamics

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ABSTRACT

In recent years, haying has extended to Iberian Mediterranean dry grasslands potentially threatening grassland birds. We evaluate the between and within-year effects of haying on grassland birds in Alentejo region, Portugal. Our main goals were: (1) to investigate variations on bird abundance and species richness in the fields hayed, with respect to past haying events occurred in a field and its surroundings and; (2) to investigate the shifts in bird abundance, species richness and spatial dynamics resulting from haying a field and its surrounding area in a given year. We conducted grassland bird censuses during the breeding season through point counts from 2012 to 2015. The relationship between bird abundance/richness and past haying events was investigated using Generalized Linear Models whereas within-year effects of haying were analysed using Generalized Additive Models. Bird abundance in a field was positively related with the surface hayed in the vicinity of that field in the previous year. However, contrasting yearly effects were found for non passerines. Also, some species prefer fields with less haying events or surface hayed, whereas others occur mostly in fields frequently managed for haying. Haying a field leads, in the short term, to its abandonment by birds, and thus to a decrease in bird abundance and, for some species, to spatial concentration in surrounding fields offering suitable habitat. We conclude that within-year effects of haying have higher impact on grassland birds than between-year effects. Maintaining haying at low levels by rotating haying yearly through the different fields in each farm and using partial haying may be an adequate way to ensure an effective management of grassland bird populations.



## 1. Introduction

Grasslands in Western Europe are mainly secondary and anthropogenic (both semi-natural and artificial). They have replaced forests after centuries of low-intensity agricultural use (Bredenkamp et al., 2002; Suárez et al., 1991). In the last decades, European grassland habitats have experienced strong changes resulting from shifts in agriculture priorities and European Union policies (Huyghe et al., 2014). In Mediterranean environments these changes have resulted mainly from land use modification (specially, due to olive plantation; see Beaufoy, 2001) and grassland management intensification (Correal et al., 2006). Iberian agricultural landscapes were during centuries predominantly used for extensive cereal production and sheep rearing, but in the last decades cattle farms have spread across Mediterranean landscapes favouring the appearance of different grassland management options. For instance, in south Portugal, bovine numbers experienced a 107% increase between 1989 and 2013 (INE, 2014). Also, the surface of the main crops used for haying (forage oats, grass-legume crops or pure legume crops) increased 34% between 1989 and 2009.

Under adequate soil and hydrological conditions, Iberian dry grasslands can produce moderate to high primary production for hay or silage (Carpintero et al., 1991; Hernández et al., 1994; Rodríguez et al., 2006; San Miguel, 2009). New infrastructures and technological solutions, such as irrigation perimeters, new fertilizers and more effective agriculture machinery have generalized the use grassland for hay and silage production. Nowadays, Iberian farmers are no longer willing to take risks because of the droughts that often occur under Mediterranean climate, storing biomass reserves that provide a feeding alternative in periods where grassland biomass production in farms is insufficient to ensure livestock needs, or when animal products are obtained from stabled livestock.

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In the Iberian Peninsula haying is not confined to cereal and legume forage crops or wet meadows, occurring frequently on semi-natural spontaneous dry grasslands (grazed or not). These semi-natural habitats hold important populations of threatened or near-threatened birds at European or global level, such as the great bustard (*Otis tarda*), the little bustard (*Tetrax tetrax*) or the Montagu's harrier (*Circus pygargus*). However, mowing machinery and mowing timings are likely to threaten grassland bird populations by causing reproductive failure through loss of nests and eggs, chick mortality or adult mortality (Grüebler et al., 2008; Vickery et al., 2001). Indeed, in temperate areas of central Europe and North America several authors suggested a link between important declines in grassland bird populations and changes in timing and frequency of hay (Green et al., 1997; Grüebler et al., 2008; Herkert, 1997).

Few links between hay management and changes in wildlife populations have been established (see Perlut et al., 2006) and the knowledge on the relative importance of the processes involved is deficient, particularly in Mediterranean environments. Furthermore, there is a general lack of evidence-based landscape-scale conservation strategies that consider alternative grassland management techniques, such as rotational mosaic mowing (Buri et al., 2013). Socher et al. (2012) showed that low-intensity mowing (once a year or less) favours plant species richness in a greater degree than grazing, although at higher cutting frequency, richness dropped dramatically, while higher grazing intensity had little effect on plant diversity. Differences in the management of cutting frequency and the amount of inputs may thus be responsible directly or indirectly not only for the observed variation in plant diversity, but also for the high spatial variability in arthropod abundance at the landscape scale (Badenhausser et al., 2009; Chambers and Samways, 1998; Humbert et al., 2009), which are important resources for birds in Iberian and other dry grasslands (see Faria et al., 2012).

These complexities of grassland management are likely to determine different responses by bird species. In this study, we evaluate the between and within-year effects of haying on grassland bird diversity, abundance and spatial dynamics during the breeding season in Alentejo region (south Portugal). Our main goals were: (1) to investigate variations on bird abundance and species richness in the fields, with respect to past haying events occurred in a field (number, surface and year of last haying) and its surroundings in the previous year, assessing for differences related with contrasting weather conditions in each year, and with the type of hay, and (2) to investigate the shifts in bird abundance and species richness, due to field abandonment by birds and their subsequent spatial concentration resulting from haying a field and its surrounding area in a given year.

## 2. Material and methods

### 2.1. Study area

The study area is located in Évora region (Alentejo province, south Portugal; −7.884902W, 38.533521N), in the Mesomediterranean biogeographic region (Rivas-Martínez et al., 2004). Climate is generally dry, with average annual temperatures ranging from 9.6 °C in winter to 24.1 °C in summer and a annual rainfall average of 586 mm (1981–2010 period; IPMA, 2015a). This area comprises a mosaic landscape dominated by holm oak forested areas or 'montados' and grasslands. Soils are mostly acidic and of low average fertility (own unpublished data). Most important land uses are extensive livestock grazing (mostly cattle) and cereal/leguminous crops for hay production. Cereal crops for grain are nowadays less common due to recent conversion of farms for beef production. Irrigated pastures are also common in this region, although marginal in surface compared to dry grasslands. The mean field size in the study area was around 70 ha.

As mentioned above, there are no official mowing statistics for the region of Évora and therefore the only data available refer to the fields monitored by our team during these four years of study (Table 1). All mown fields during these four years were used for hay production. Both rainfall and temperature were very different between years (IPMA 2015b), potentially affecting the entire process of haying and bird distribution (Table 1).

The study area is partly included in the Special Protection Area for birds of Évora. It holds important populations of protected grassland bird species such as the little and great bustards, Montagu's harrier, black-bellied sandgrouse (*Pterocles orientalis*) and the calandra lark (*Melanocorypha calandra*). No special regulation on mowing is applied inside the Special Protection Area.

### 2.2. Data collection

We conducted grassland bird censuses through point counts during four consecutive breeding seasons from 2012 to 2015. Bird counts were made in the first three and a half hours after sunrise and in the last two and a half hours before sunset, in the last fortnight of April and repeated in the last fortnight of May. A radius of 250 m around the point count station and a count period of 15 min were assumed, recording for the location and number of individuals of each species displaying clear territorial or nesting behaviour and adjusting if necessary the geographical location of the territories. This procedure is particularly suitable in high density areas were birds spend most of their time chasing each other). The counting period length used minimises potential detectability problems due to between-field differences in

**Table 1**
Haying and weather statistics for the 2012–2015 period in Évora region.

| Statistics | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|
| Haying | | | | |
| Number of sampling fields | 45 | 45 | 47 | 39 |
| Fields with tall/dense vegetation with potential for haying | 10 | 17 | 23 | 16 |
| Fields partly or fully hayed | 3 | 12 | 15 | 11 |
| Haying start date | 16-May | 06-May | 06-May | 05-May |
| Weather | | | | |
| Winter[a] rainfall (mm) | 25.3 | 168.3 | 291.8 | 89.2 |
| Spring[b] rainfall (mm) | 46.9 | 225.3 | 160.0 | 77.4 |
| Winter average minimum temperature (°C) | 2.5 | 7.8 | 5.2 | 3.6 |
| Winter average maximum temperature (°C) | 14.9 | 11.0 | 14.5 | 14.2 |
| Spring average maximum temperature (°C) | 6.5 | 7.7 | 7.6 | 7.8 |
| Spring average minimumtemperature (°C) | 19.1 | 17.8 | 19.4 | 20.9 |

[a] Winter (December–February).
[b] Spring (March–April).