Abundance of Four Lark Species in Relation to Portuguese Farming Systems

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1. Introduction

Throughout much of Europe, farmland birds have declined more than those of other habitats, because of the abandonment of traditional farming systems and the simplification of remaining agricultural systems, including increased use of external inputs (Tucker & Heath 1994, Baldock 1991, Bignal & McCracken 1996). Traditional low-input agricultural systems survive in some parts of southern Europe, including Portugal, where the main arable region is Alentejo in the south of the country. However, such systems are not currently economically viable.

Tab. 1. Agricultural statistics for the three land-use categories considered in Alentejo, Portugal (source: Cordovil 1993).

	Intensive	**Extensive**	***Montado***
Mean farm size (ha) (all farms)	48	161	66
Crop area (%)			
Total annual crops	81	42	28
Winter cereals	45	40	21
Sunflower	20	0.3	0
Forage crops	6	2	7
Fallow	15	52	66
Perennial crops	11	0.8	2
Olive	10	0.8	2
Vines	1	0	0
Land area per tractor (ha)	58	125	194
Livestock (%)			
Sheep	68	78	83
Cattle	8	11	7
Pigs	22	8	5
Goats	2	3	5

Larks (Alaudidae) represent a passerine family that is strongly associated with farmland landscapes. In Portugal, the species present include Calandra Lark *Melanocorypha calandra*, Woodlark *Lullula arborea*, Short-toed Lark *Calandrella brachydactyla* and Skylark *Alauda arvensis*. Of these, Woodlark and Short-toed Lark are widely distributed as breeding species in Portugal, while Skylark occurs mainly in the north of the country and Calandra Lark mainly in the southeast (Rufino 1989). Iberian populations of all four species declined in numbers during the 1970s and 1980s and are currently the subject of European conservation concern (Tucker & Heath 1994). This study assesses the abundance of these species in December and April in relation to three arable systems in an agricultural landscape of Baixo Alentejo, southern Portugal.

2. Study area

The study area included parts or all of five administrative regions in Baixo Alentejo (Ferreira do Alentejo, Aljustrel, Castro Verde, Ourique and Almodôvar), an area

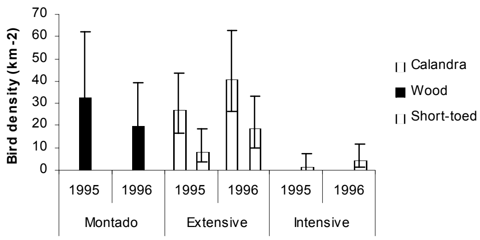

Fig 1. Densities (number km-2 with 95% confidence limits) of Calandra Lark, Woodlark and Short-toed Lark in April in relation to three Alentejo farming systems.

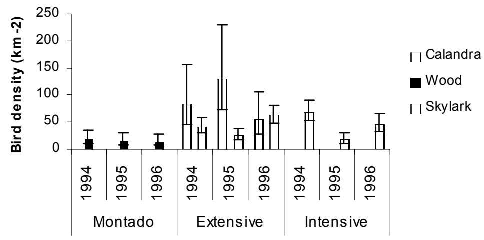

Fig 2. Densities (number km-2 within 95% confidence limits) of Calandra Lark, Woodlark and Skylark in December in relation to three Alentejo farming systems.

totalling 155 000 ha. Within this region, three land-use systems were recognised: intensive agriculture, extensive agriculture and *Montado* (Tab. 1).

The intensive agriculture category is characterised by a greater frequency (>55%) of heavy soils, much of the area being irrigated. Wheat *Triticum aestivum* and barley *Hordeum distichum* are the main cereal crops and silage grass *Lolium sp*, sunflower *Helianthus annuus*, sugar beet *Beta vulgaris* and oilseed rape *Brassica napus* are also grown. Wheat yields are 2.5-3.5 tonnes ha^{-1} without irrigation but can be almost doubled with full irrigation (P. Eden *pers comm* 1998). There are short rotations with little or no fallow (*e.g.* sunflower / 1st cereal / 2nd cereal). This system requires frequent use of fertiliser (130 units N_2 ha^{-1} (P. Eden *pers comm* 1998)) and herbicides, relative to the other land-use categories. With the exception of some olive *Olea europaea* groves, there is little tree cover.

The extensive agriculture category is characterised by thin soils and by the largest average farm size of the three categories (Tab. 1). There is no irrigation and the fallow area is relatively high. A typical rotation takes the form: plough fallow / 1st cereal / 2nd cereal / fallow / fallow. Fallow periods often last five years or more (Rio Carvalho *et al.* 1995). Wheat yields are 1.5-2.5 tonnes ha^{-1}, yields at the lower end of this range being more common (P. Eden *pers comm* 1998). Triticale *Triticum aestivum x Secale cereale* and oats *Avena sativa* are frequently grown in the extensive category and grazed or cut for silage. The incorporation of a fallow period into the rotation, and the relatively low potential yields are associated with considerably lower annual inputs than in the intensive category.

Montado (equivalent to the Spanish *Dehesa*) is characterised by thin soils and tree cover, dominated by holm oak *Quercus rotundifolia* and cork oak *Q. suber* at up to 20 trees ha^{-1} (mean=10.5 trees ha^{-1}, se=0.7). Like the extensive category, there is no irrigation and the fallow area is high. A typical rotation is similar to that of the extensive category, although the fallow stage is often longer and forage lupins *Lupinus luteus* may be included.

Sheep *Ovis aries*, cattle *Bos taurus* and pigs *Sus scrofa* are kept in all three land-use categories. Zero grazing is adopted on some farms in the intensive category but livestock normally graze fallows. Tab. 1 lists the proportion of crops and livestock in each category.

3. Methods

A total of 115 250 m transect counts, starting at 1 km grid intersections and stratified by land-use categories, were conducted along a random bearing (*Montado* n=42, Extensive n=42, Intensive n=31). Transect counts were conducted by a single observer in the first three hours after dawn, or the two hours before dusk in December (1994, 1995 and 1996) and April (1995 and 1996). Perpendicular distances from the transect line to each detected bird were estimated visually to the nearest 10 m. Detectability was assumed to be the same in each of the three land-use categories, even in *Montado*, because habitat structure is relatively open. The number of birds seen together at an observation was recorded.

Density estimates were calculated for each land-use category using line transect sampling and the computer program DISTANCE (Buckland *et al.* 1993, Laake *et al.* 1993). Analyses used clusters (<1 individual) as analytical units, and untruncated perpendicular distance data. A variety of recommended robust estimators implemented by DISTANCE was used, the final model selected in each case being the one with the lowest Akaike's Information Criterion value (Buckland *et al.* 1993). Differences in bird abundance between land-use categories were tested using two-way ANOVA (year×land-use) and LSD post-hoc tests (at $P<0.05$) log-transformed data.

4. Results

Densities of the four species are presented at Figs 1 (April) & 2 (December). Woodlark occurred only in *Montado* and Calandra Lark only in extensive farmland, in both April and December. Differences between land-use categories were significant for Woodlark in December ($F_{2,5}=210.4$, $P<0.001$) but not in April, and for Calandra Lark in both December ($F_{2,5}=15.0$, $P<0.01$) and April ($F_{2,2}=25.2$, $P<0.04$). Short-toed Lark occurred in both extensive and intensive farming systems, with a higher density in the former, although this difference was not significant. Skylark was absent in April and occurred at similar densities in both extensive and intensive systems in December.

5. Discussion

The international distribution of Woodlark is confined almost exclusively to Europe, between 12% and 34% of this population occurring in Portugal (Tucker & Heath 1994). This species occurs in several Portuguese forest systems, but within farming systems, the species is restricted to *Montado*. Large areas of *Montado* have been cleared since the 1930s, and continued local clearance of trees, such as that associated with the development of the Alqueva reservoir, is likely to have severe consequences for Woodlark and other species associated with *Montado* in Alentejo (Vieira & Eden 1995). Changes in scrub clearance frequency and practices, grazing densities and livestock types also influence tree health and habitat structure (Pinto-Correia & Mascarenhas 1999). Financial support is currently available for the re-establishment of *Montado* within Alentejo under EU Reg. 2080/92 so that the total area of *Montado* is currently not experiencing substantial change.

However, this is a long-term project, and the habitat is also threatened by the spread of a fungal disease that is causing widespread destruction of oak trees across the Iberian Peninsula (Brasier 1992).

Large- and medium-sized invertebrates such as grasshoppers (Orthoptera), spiders (Araneae) and caterpillars (Lepidoptera and Symphyta larvae) form an important nestling food source for each of the species considered here (Cramp 1988). Low pesticide inputs and continued incorporation of fallow periods into arable rotations are associated with higher densities of these invertebrates than in intensively managed agricultural systems in Alentejo (Stoate *et al.* 2000). This might explain the low breeding abundance of larks in intensively managed systems, for as Ewald and Aebischer (1999) have shown, there is a relationship between pesticide use, invertebrate abundance and breeding abundance of Grey Partridge *Perdix perdix* and Corn Bunting *Miliaria calandra* in the U.K. Like larks, Corn Bunting is also present at relatively low densities in intensively managed agricultural systems in Alentejo (Stoate *et al.* 2000).

Skylark is absent from all farming systems during April, confirming the breeding distribution of Rufino (1989). However, in December this species occurs in both extensive and intensive landscape categories. This may be explained by the species using cereal crop leaves as a winter food source, although Calandra Lark, which also feeds on cereal leaves (Cramp 1988), is absent from intensively managed systems. About one third of the European Calandra Lark population occurs in the Iberian Peninsula where the species is declining in numbers (Tucker & Heath, 1994). Moreira (1999), working in the same area, found that Calandra Lark was strongly associated with low vegetation on fallows within extensive farming systems. However, the ecological requirements of Calandra Lark in Portugal throughout the year are poorly understood and require further investigation if appropriate management is to be adopted for this species.

Short-toed Lark occurred in intensive agricultural systems, but was present at low densities and generally was associated with non-crop habitats such as tracks and other uncultivated areas. Moreira (1999) reported an association between Short-toed Lark abundance and bare ground within fallows. Like Calandra Lark, this species appears to benefit from the maintenance of extensive farming systems. This habitat supports more bird species of current conservation concern than does any other (Tucker & Heath 1994, Santos 1996, Araújo *et al.* 1996). Some of these species (*e.g.* Lesser Kestrel *Falco naumanni*, Great Bustard *Otis tarda*, Little Bustard *Tetrax tetrax* and Roller *Coracias garrulus*) are highly valued by birdwatchers, and a small-scale tourist industry is currently developing around the presence of these species on extensively managed farmland in Portugal.

Farm tourism is also developing in Spain (Garcia-Ramon *et al.* 1995) and provides an opportunity for alternative income for management of extensive farming systems, either directly through accommodation on farms, or indirectly, as in Alentejo, through EU Rural Development support for maintaining such systems. However, many steppe species are susceptible to disturbance and access requires careful management. This does not preclude the potential for combining public and private support for extensive farming systems that support larks and other species associated with extensively managed arable landscapes.

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