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Long-term trends in great bustard (*Otis tarda*) populations in Portugal suggest concentration in single high quality area

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Abstract

Areas of occurrence, population trends and extinction patterns for great bustard *Otis tarda* populations in Portugal are described for a 22-year period (1980–2002). The major population trends were a large decline in the 1984–1995 period, followed by a fast post-1995 increase. Most of this variation was explained by the trend observed in a single site, Castro Verde, where population has been increasing, in contrast with all other areas where populations have been declining. Eight local extinctions were documented, and probability of extinction increased fast below a threshold of 30 individuals in the initial (1980) population. Agricultural intensification, illegal hunting, road and power line building, and afforestations were the main causes of population decline and extinctions. The exceptional character of the Castro Verde population is explained by the maintenance of good habitat quality, the existence of a bustard conservation project and of an agri-environmental scheme promoting farm management compatible with bustard conservation. Stochastic computer simulations, using VORTEX, suggested that migration of individuals from other sites into Castro Verde was likely, as local productivity alone could not explain the observed population increase. The Portuguese population was estimated at 1150 birds in 2002, of which 912 were concentrated in Castro Verde. The present trend for the increasing concentration of the Portuguese population of great bustards in a single site might lead to increased probability of extinction, particularly due to environmental stochasticity.

Keywords: Agriculture; Great bustard; Population trends; Habitat management

1. Introduction

Over 50% of the world's population of the globally threatened great bustard (*Otis tarda*) is concentrated in the Iberian Peninsula. Recently, Alonso et al. (2003) re-evaluated the size of the Iberian population as ca. 24,500 individuals of which the vast majority (ca. 94%) occurred in Spain. Furthermore, these authors analyzed the main threats to the Spanish population and concluded that, although stable, this population is probably concentrating in high quality areas and disappearing from low quality ones. However, this study excluded the Portuguese population, for which the authors did not have detailed data on geographic distribution patterns nor population trends. Although residual in an Iberian context, the Portuguese population of great bustards was roughly estimated by Alonso et al. (2003) at 1435 birds, corresponding to the forth largest population in Europe after Spain, Russia and Turkey (Tucker and Heath, 1994). In this paper, we analyze trends in great bustard population size and geographic areas of occurrence (during the breeding season) in Portugal during a 22-year period (1980–2002). We specifically aimed to: (i) describe changes in geographical areas of occurrence and demographic trends across time; (ii) identify

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the main probable causes of observed population trends; (iii) evaluate the current size and conservation status of the Portuguese population; (iv) test the hypothesis that, similarly to Spain, there has been a trend for birds to concentrate in high quality areas and decline or going extinct in low quality grounds.

2. Methods

2.1. Bird counts

Great bustard counts were initiated in 1978 but the first couple of years were devoted mainly to identify all the areas of bustard occurrence in the country. Thus, only data after 1980, when standardized surveys were initiated, were considered in the present paper. Every year, counts were carried out during March and April, when the birds concentrate in display grounds (e.g., Alonso et al., 2000, 2001; Morales and Martín, 2002), using standard methods (e.g., see Alonso and Alonso, 1990 for details). Each area was traveled using four-wheel-drive vehicles along fixed routes, assuring that the entire area was searched and trying to avoid duplicated counts (not disturbing birds to prevent flight, and taking into account flocks that flew to non-censused areas). Counts were interrupted during the middle of the day, when bustards are less active and more difficult to observe (Alonso and Alonso, 1990). All observations were plotted on field maps. The criteria for detecting lekking areas, where birds concentrate every year (e.g., Osborne et al., 2001), was the presence of adult males. Counts were carried out every year except during the period 1996–1999 (with the exception of Castro Verde, where counts were also carried out in 1997 and 1999).

2.2. Areas of occurrence and population trends

For each count and site, all individual and flock locations were mapped in 1:25,000 scale maps. The geographic limits of each site were then defined by drawing line segments that connected the outermost points of observation. Intra-site distance between bustard observations was clearly smaller than inter-site distances, creating no problems in defining site boundaries. Population trends were analyzed at a national level and separately for each site of occurrence.

2.3. Analyzing potential causes of geographic distribution and population trends

We collected information on major trends in agricultural land use, hunting activity, infrastructures and urban development for each of the bustard sites. Most of this information was based on personal observations during the counts, complemented with interviews with hunters, sheperds, farmers and local communities. Furthermore, we gathered agricultural statistics for broader regions ("concelhos"; $n = 22$) that included bustard sites (statistics specific for each site were not available). These were available from the Ministry of Agriculture for the years 1979 and 1999 (INE, 1979, 2001). The following variables were recorded for each of the years: utilized agricultural area (UUA), proportion (all proportions measured relative to the UAA for each year) of fallow land, permanent pastures (over 5 years, not included in a rotation scheme), cereals (over 90% were dry cereal fields, not irrigated), dry legumes (not irrigated), temporary fodder crops and irrigated crops. Data on livestock densities were also collected and expressed as livestock units (LU) per hectare of UUA (1 LU = 1 cow = 6 sheep or goat).

2.4. Data analyses

Population trends were estimated using a type of locally weighted least squares, the LOWESS method (Cleveland, 1979). For agricultural variables, differences between 1979 and 1999 were compared using the sign test (Siegel and Castellan, 1988). Logistic regression (Hosmer and Lemeshow, 1989) was used to assess the likelihood of local extinction as a function of initial (1980) population size. The performance of the model was assessed using the area under the receiver operating characteristics curve (AUC) (Pearce and Ferrier, 2000; Osborne et al., 2001). The model was then validated using a jackknife procedure (Pearce and Ferrier, 2000) and the corresponding AUC using the resulting predictions. The AUC and their standard errors were calculated using a non-parametric approach (Osborne et al., 2001). Linear regression (Glantz and Slinker, 1990) was used to express the rate of extant population change (1980–2002) to initial population size. SPSS software (SPSS, 1999) was used for all analyses.

Data analysis (see Section 3) showed that the recent national increase in the Portuguese great bustard population was due to a high population growth in a single site (Castro Verde). To explore whether local demography could explain by itself (without the possibility of bird migration from other sites) the observed increase in this site during 1995–2002, expected population trends were estimated with VORTEX, a computer programme using Monte Carlo simulations to model population sizes and probability of extinction (Lacy, 1993; Lacy et al., 2003). Most data needed for these models are not available for Castro Verde. Thus, a "default" scenario was built based on the data provided by Lane and Alonso (2001), with the following adaptations: (a) no inbreeding depression was assumed; (b) catastrophes were assumed absent during the study period; (c) offspring was considered starting at fledging; (d) male and female mortality between fledging and one year was considered similar and set at 90.0 (±6.30)%; (e) an arbitrary carrying capacity of 1500 birds was assumed. Only a single isolated population (Castro Verde) was assumed to exist. VORTEX was programmed to run 100 simulations over the 7-year period, for an initial population size of 390 birds (the value observed in 1995).

Sensitivity analyses have shown that chick productivity and survival, and adult mortality largely affect extinction probabilities in bustard populations (Lane and Alonso, 2001; Morales et al., 2004). Assuming that management actions in Castro Verde could have been reflected in these factors, other three scenarios were built, with increasingly favourable conditions for bustards: scenario 1 = increased reproductive success, with the proportion of successful females producing 1, 2 or 3 chicks being, respectively, 20%, 30% and 50%; scenario 2 = scenario 1 plus juvenile (age 0 to age 1) mortality reduced from 90% to 80%; scenario 3 = scenario 2 plus adult (male and female) mortality reduced by 2.5%. Estimations of variability in population parameters provided by Lane and Alonso (2001) were kept in all scenarios. Expected population trends along a 7-year period under these four scenarios were then compared with the observed values.

3. Results

3.1. Geographic distribution

The areas of occurrence of great bustards in Portugal, during the breeding season, are shown in Fig. 1. Castro Verde is the largest site (68,000 ha) and holds the majority of the Portuguese population (see below). During the study period (1980–2002), great bustards became extinct in eight sites mostly located in the northern part of their range.

3.2. Demographic trends and population estimates

During the period 1980–2002 total population size ranged from 759 to 1151 birds, with a mean of 992 birds (Fig. 2). Three time periods with different population trends were identified: (a) an initial increase from 1980 to 1984; (b) between 1984 and 1995 there was a general trend for decreasing population size (although with large fluctuations), with a minimum in 1994. The large decline in population size in 1987, followed by a moderate increase, can be explained by the pattern observed in two specific areas (Vila Fernando and Elvas) (see Section 3.3), (c) after 1994, a rapid population recovery is evident. The variation in total population size, and particularly the increase observed after 1994, was largely determined by the trend observed for Castro Verde, which is the main area of occurrence and held more than 50% of the Portuguese population across the study period (range = 51.0–79.0%). Along with Castro Verde, only Campo Maior showed a clear post-1990 increasing population trend, although population decreased again after 1995. For the remaining areas the general trend was for decreasing population size, with eight documented extinctions during the study period (Castelo Branco, Safara, Sousel, Borba, Póvoa e Meadas, Monsaraz, Ferreira and Estremoz). In all the areas with the exception of Castro Verde the proportion of the national population of great bustards they contained declined across the study period.

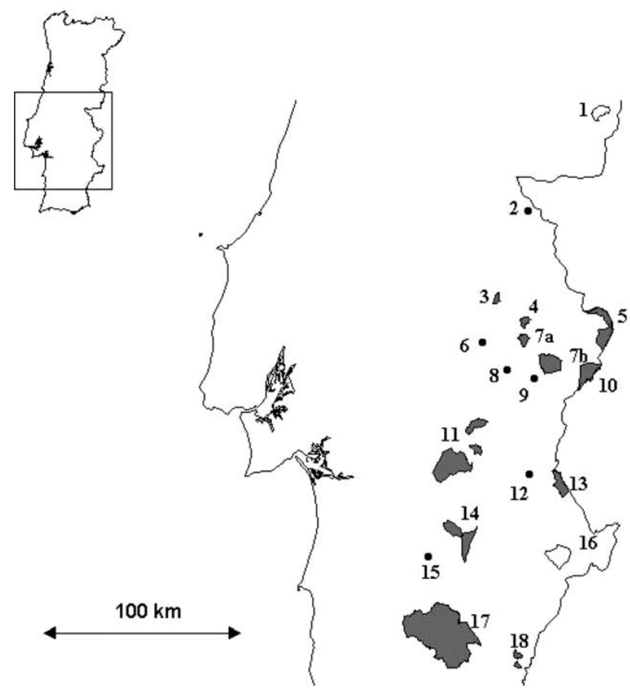

Fig. 1. Map showing great bustard (*Otis tarda*) distribution in Portugal in the period 1980–2002, during the breeding season. White polygons (2) and black dots (6) denote sites were the population became extinct during this time period. Site codes: 1 – Castelo Branco; 2 – Póvoa e Meadas; 3 – Alter; 4 – Monforte; 5 - Campo Maior; 6 – Sousel; 7a – Veiros (Vila Fernando); 7b – Vila Fernando (7a and b pooled due to evidence that they constitute a single unit, with frequent bustard movements between sub-sites); 8 – Estremoz; 9 – Borba; 10 – Elvas; 11 – Évora; 12 – Reguengos; 13 – Mourão; 14 – Alvito; 15 – Ferreira; 16 – Safara; 17 – Castro Verde; 18 – Moreanes (this area was not considered in data analysis as no counts were carried out before 1999. Current estimated population of ca. 10 individuals).

In Castro Verde ca. 50% of the national population was located in this area in 1980, but in 2002 this proportion increased to ca. 80% (Fig. 3). This shows a clear recent trend for the Portuguese population of great bustards to be increasingly concentrated in this site. The expected trends in the Castro Verde population during the period 1995–2002, as a result of the different modelled demographic scenarios, are shown in Fig. 4. When compared to the observed population trend, all scenarios yielded population increases lower than the

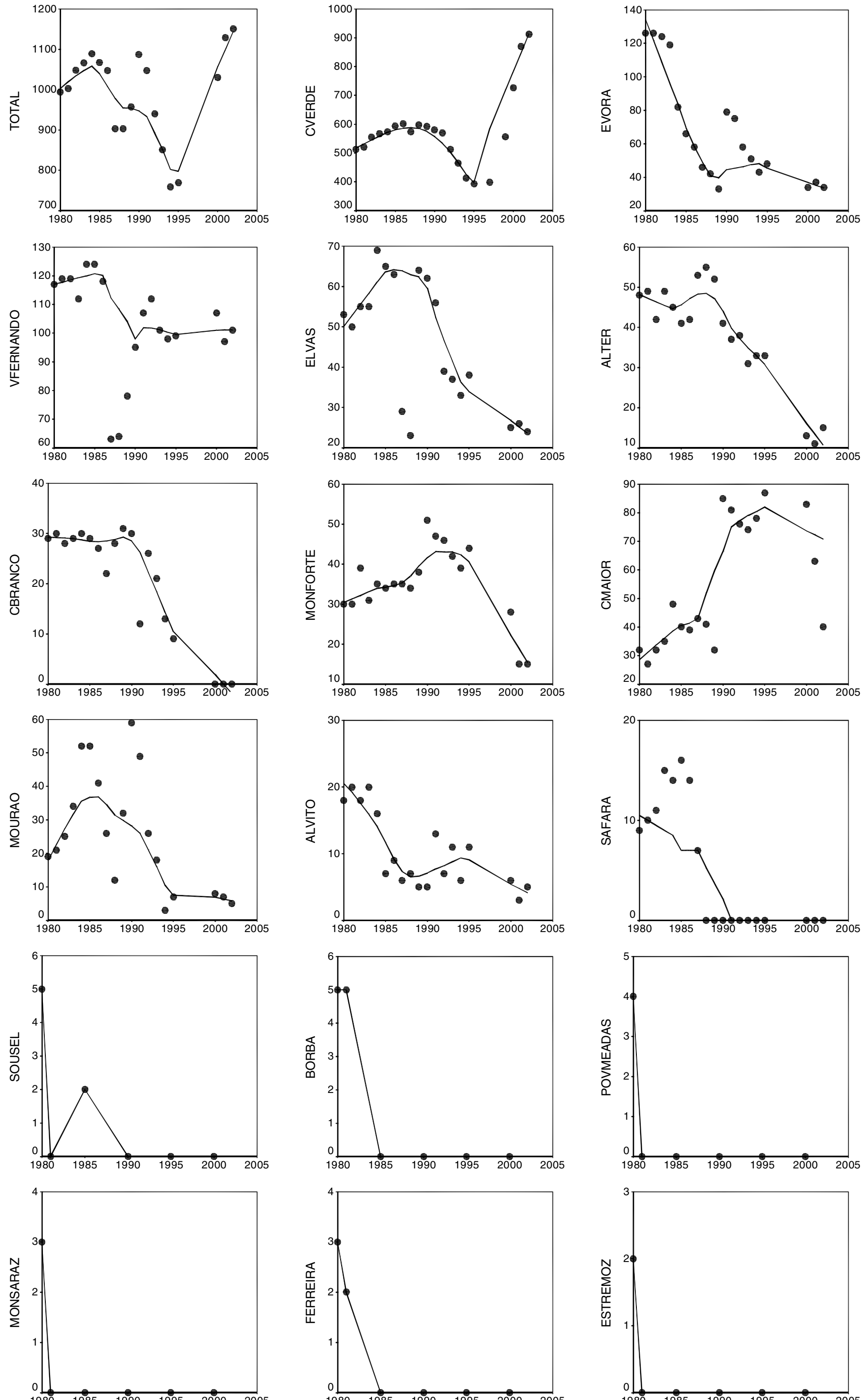

Fig. 2. Great bustard (*Otis tarda*) counts and demographic trends during 1980–2002 for the Portuguese population (TOTAL) and for each of the censused sites. The trend line was estimated by LOWESS. For site names and locations, see Fig. 1.

real one. Thus, local factors by themselves seemed not to explain the observed trend.

In 2002, the Portuguese population of great bustards was 1150 individuals. Population size in Castro Verde (912 birds) was nine times greater than in the second most important site (Vila Fernando; 101 birds). Campo Maior (40 birds) and Évora (34 birds) were the only remaining sites with over 30 individuals.

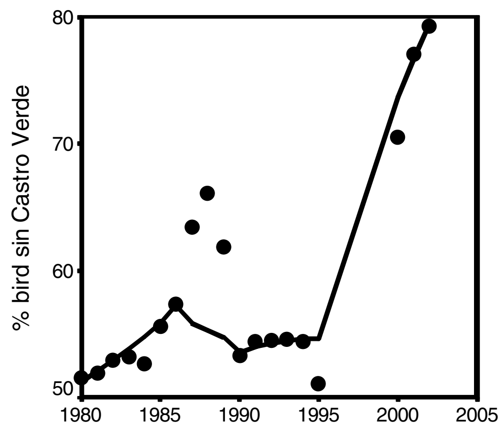

Fig. 3. Proportion of the total Portuguese population of great bustards occurring in Castro Verde as a function of time. The trend line was estimated by LOWESS.

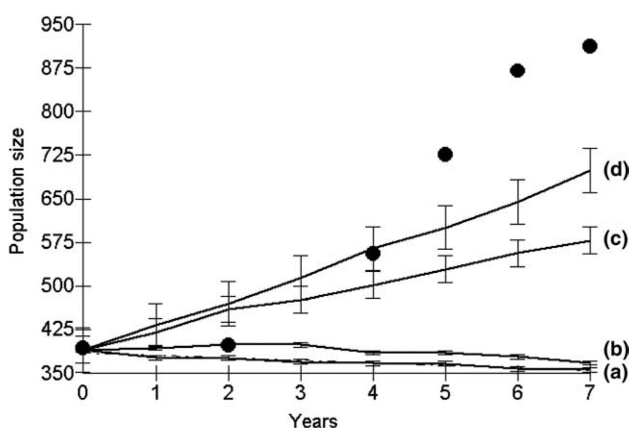

Fig. 4. Observed (black dots) and simulated (lines) population sizes (±SE) of great bustards in Castro Verde, from 1995 to 2002, from an initial population of 390 birds. Each line represents a scenario: (a) "default" scenario; (b) scenario 1, with increased reproductive success; (c) scenario 2, with increased reproductive success plus decreased chick mortality; (d) scenario 3, with increased reproductive success plus decreased chick mortality plus decreased adult mortality. For more details see methods.

3.3. Habitat changes and other potential causes of population decline

There were significant differences in agricultural land use in areas of great bustard occurrence across the 20-year period (Table 1), namely a large decrease in the amount of fallow, cereal and legume fields, and an increase in the proportion of permanent pastures, fodder, irrigated crops and livestock densities. The greatest proportional changes occurred for dry legumes (decrease), permanent pastures (increase) and irrigated crops (increase). In comparison with the global trend, Castro Verde region differed by its larger arable area, higher proportion of fallow land and cereal fields (although they also declined across the study period), an increase in dry leguminous crops and smaller amounts of fodder and irrigated crops (Table 1).

Table 2 presents a summary of a site-specific analysis of the main factors causing population reduction and extinction. The coincidence, in 1986, of a road building in Elvas and dam construction and fence implementation in Vila Fernando probably caused disturbance to great bustards in both sites, which was reflected by a large short-term decline that was expressed at the national level.

3.4. Patterns of extinction and extant population trends

The likelihood of extinction increased with declining initial population size (Fig. 5). The threshold where probability of extinction drastically increased was ca. 30 birds. Eight of the ten populations where initial population size was less than 30 individuals became extinct in the 22-year period. For populations that did not become extinct, there was an inverse relationship between initial population size and population trend (Fig. 6). Smaller populations suffered larger declines across the study period. Nevertheless, this trend lost significance if Castro Verde was removed from the analysis.

Table 1
Median values (and 25th and 75th percentiles) for utilized agricultural area, area occupied by each land use (expressed as proportion of UAA), and livestock densities (livestock units (LU) per ha UAA) in 1979 and 1999, in regions of great bustard occurrence ($n = 22$)

Variable	1979	1999	Difference 1979–1999 (P value)	1979 (C. Verde)	1999 (C. Verde)
UAA (ha)	36414 (20312–59864)	38653 (23314–60394)	0.286	50181	47710
Fallow land	0.333 (0.215–0.366)	0.172 (0.097–0.225)	<0.001	0.535	0.372
Perm. pastures	0.005 (0.001–0.025)	0.349 (0.201–0.452)	<0.001	0.006	0.118
Cereals	0.265 (0.202–0.329)	0.186 (0.149–0.283)	0.001	0.319	0.271
Dry legumes	0.015 (0.010–0.021)	0.002 (0.001–0.003)	<0.001	0.003	0.013
Fodder crops	0.023 (0.008–0.029)	0.047 (0.036–0.078)	0.001	0.020	0.013
Irrigated crops	0.016 (0.008–0.065)	0.056 (0.022–0.081)	<0.001	0,002	0,004
LU/ha UAA	0.220 (0.186–0.284)	0.314 (0.258–0.391)	<0.001	0,191	0,294

The statistical significance of the differences was assessed using the sign test. Same variables are shown for Castro Verde, the most important area for the species in the country.

Table 2
Causes of population decline/extinction for great bustard sites in Portugal in the period 1980–2002

Site number	Site name	Causes of population decline/extinction
1	Castelo Branco	Decline since early 1990s coinciding with the afforestation of areas of bustard occurrence with eucalyptus.
2	Póvoa e Meadas	Extinction causes unknown
3	Alter do Chão	Decline due to agricultural intensification (irrigation schemes including center pivots)
4	Monforte	Decline due to agricultural intensification (irrigation schemes including center pivots)
5	Campo Maior	The population suffered an increase in the early 1990s following movements of birds from Spanish areas (due to agricultural intensification in that side of the Spanish-Portuguese border). Movements from nearby Elvas region were also likely to have contributed to the observed increase. Since 2000, agricultural intensification in the Portuguese side of the border, with the implementation of center pivots and vineyards, as well as illegal hunting, have caused a recent decline in great bustard numbers
6	Sousel	Extinction causes unknown
7a + 7b	Vila Fernando	This site suffered great agricultural intensification (dam construction, new fences, increase of livestock densities) in the main breeding places since the middle of the 1980s (1986), which caused a temporary displacement of birds to non-censused areas. Numbers have increased again but never attained the previous levels
8	Estremoz	Extinction causes unknown
9	Borba	Extinction causes unknown
10	Elvas	Movements occur between Portugal and Spain, explaining some of the inter-annual fluctuations in the bustard numbers. Large decline in 1986 coincided with the building of a road in the lek areas. Numbers have increased again but never attained the previous levels
11	Évora	Strong decline due to the following threats: illegal hunting in the 1980s and 1990s; collision with power lines; road building; agricultural intensification and afforestation
12	Reguengos	Extinction causes unknown
13	Mourão	Movements occur between Portugal and Spain, explaining some of the inter-annual fluctuations in the bustard numbers. Decline probably due to agricultural intensification (large increase in vineyards and olive groves) and road building
14	Alvito	Decline possibly due to agricultural intensification (irrigated crops with center pivots and vineyards)
15	Ferreira	Extinction causes unknown
16	Safara	Extinction causes unknown
17	Castro Verde	Decline since early 1990s due to illegal hunting, afforestation and collision with power lines. This trend was inverted since middle of this decade with the start of the agri-environmental zonal programme of Castro Verde and the acquisition of key areas by the Portuguese League for Nature Conservation
18	Moreanes	No counts were made before 1999. Population trends unknown

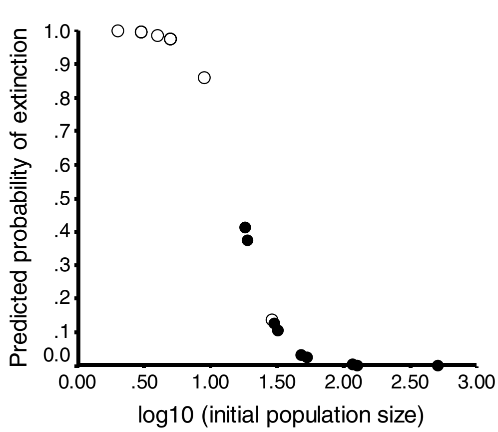

Fig. 5. Logistic regression model ($\chi^2 = 16.5$, $P < 0.001$; overall correct classifications = 94.1%) to predict great bustard local extinction as a function of initial (1980) population size. The model ROC plot had an AUC of 0.97 ± 0.035 ($P = 0.001$). The jackknifed ROC had an AUC of 0.88 ± 0.117 ($P = 0.009$). White circles denote sites whose populations went extinct during the 1980–2002 period.

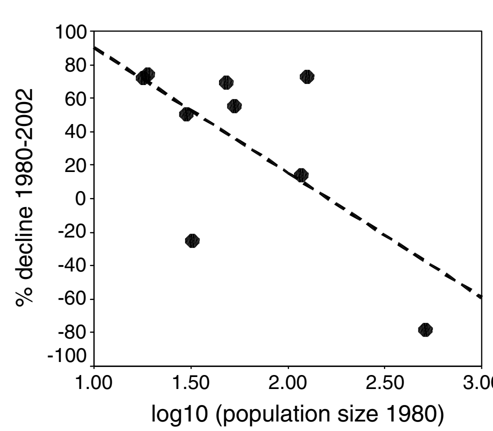

Fig. 6. Relationship between initial population size (1980) and % decline during 1980–2002 for all sites where great bustards occurred in 2002. Negative declines correspond to population increases. The linear regression equation is: $y = -74.6 \log 10(x) + 164.7$; $F = 5.19$, $P = 0.057$, $r^2 = 0.425$. However, Castro Verde is an influential point; if removed, regression line looses statistical significance ($P = 0.753$).

4. Discussion

4.1. Geographic distribution pattern

In their analysis of great bustard distribution patterns in the Iberian Peninsula, Alonso et al. (2003) did not include detailed data for Portugal. We identified 18 areas where bustards have occurred during the breeding season in the last two decades. With one exception, all these areas are located south of the Tagus river, in the Alentejo region. The data showed a fragmented distribution pattern, presumably determined by the availability of suitable habitat, with the most important area (Castro Verde) being on the southern edge of the distribution range. Along the 22-year period, there has been a reduction in the extent of occurrence mostly caused by several documented extinctions in the northern part of the range.

4.2. Demographic trends and extinction patterns

The main trend in the Portuguese population of great bustards was a large decline up to 1994–1995, when a minimum of ca. 760 birds were counted, followed by a fast increase up to the present. Habitat loss probably played a major role in this decline, as shown by changes in agricultural practices in the regions of great bustard occurrence during 1979–1999. Fallow, cereal and legume fields suffered large declines (30–87%), and these are important components of the great bustard habitat mosaic (Alonso and Alonso, 1990; Lane et al., 2001; Moreira et al., 2004). In contrast, fodder and irrigated crops, unsuitable habitats for great bustards (e.g., Morales and Martín, 2002), increased 104% and 250%, respectively. Permanent pastures (>6000%!) and livestock densities (43%) also increased. Permanent pastures might not represent unsuitable habitat for great bustards, but they probably replaced cereal, ploughed and fallow fields typical of the land mosaic of pseudosteppes (Suárez et al., 1997). Higher livestock densities may be associated to increased disturbance, overgrazing, and nest trampling (e.g., Kollar, 1996).

Besides habitat changes at a regional scale, mostly reflecting agricultural intensification, other factors might be put forward to explain observed local population trends. A site-specific analysis showed that the main factor threatening great bustard populations was agricultural intensification (in seven sites), illegal hunting (three sites), road building (three sites), afforestation (three sites) and power lines (two sites). The first two factors were also identified as the main causes of local extinctions in Spain (Alonso et al., 2003).

The Portuguese population size in 2002 was estimated at 1150 birds, less than the previous estimate of 1400 birds made by Alonso et al. (2003). These authors have used extrapolation, whereas systematic counts were carried out in the present study.

Probability of population extinction was dependent on initial population size, and our data showed that populations with less than 30 birds had a high probability of becoming extinct within 20 years. Even in the remaining populations, there was a trend for faster population declines in areas with smaller numbers of birds. If this pattern is to be continued in the near future and causes of decline not halted, of the nine remaining bustard populations in Portugal, six will become extinct in the next two decades (only Castro Verde, Vila Fernando and Campo Maior will potentially remain). The pattern of documented extinctions in Spain (Alonso et al., 2003) showed that not all populations necessarily had small sizes, and some populations of 100–200 birds went extinct in the period 1950–1980. However, seven out of 12 extinctions for which data on initial population size were available had less than 30 birds (Alonso et al., 2003; Table 2).

4.3. Why is the Castro Verde population increasing?

The recent increase in Portuguese great bustard numbers can be exclusively attributed to the increase observed in Castro Verde and the region has been holding an increasing proportion of the national population. What could be the reasons for this?

The timing of population increase in Castro Verde coincided with two major events: (a) in 1993, the Portuguese League for Nature Conservation (LPN) started a LIFE-project to preserve steppe birds and their habitats. This allowed the acquisition of several farms (totaling ca. 2000 ha), which included all the main great bustard lekking grounds in the region. Several actions were taken, including the maintenance of large unfenced areas with fallow fields, improving feeding conditions for bustards by the use of legumes, raising public awareness amongst children, farmers and landowners, banning of hunting and control of human disturbance; (b) the start of the Zonal Plan in 1995, under the EU agri-environment measures (EEC Regulation 2078/92) (e.g., Kleijn and Sutherland, 2003). The uptake of this plan by farmers promoted several management actions, such as a rotational crop system including dry cereals and fallow fields, use of legumes as game crops, maintaining low livestock densities, limiting fenced areas, limiting implementation of irrigated areas, and limiting the use of agro-chemicals. It is likely that both the LPN project and the Zonal Plan favoured great bustards, leading to an increase in habitat quality and productivity of the local population. However, computer simulations provided evidence that demographic parameters could not explain the observed population trends, not even in a scenario of very high habitat quality favouring survival and breeding success. Thus, migration from other areas might have contributed to the Castro Verde population increase. This migration would be promoted by continued habitat loss and degradation in remaining areas. In these poor-quality sites the residual populations have low productivity (Pinto et al., unpublished), further contributing to a large local population decline and, consequently, a higher proportion of birds in Castro Verde.

4.4. Conservation implications

After a major decline in the period 1985–1995, the Portuguese population of great bustard is increasing. However, this increase is due to the trend observed in Castro Verde, the main area of occurrence, and contrasts with all the remaining areas where population is declining. If the current trend for local extinctions continues, during the next 20 years great bustards in Portugal might be confined to just three sites - Castro Verde, Vila Fernando and Campo Maior -, eventually only two as the latter is experiencing fast agricultural changes. In that scenario, the proportion of birds in Castro Verde will be even larger, and ultimately all Portuguese bustards will be confined to this single site.

The tendency for the concentration of the whole Portuguese population in a single site might lead to a loss of genetic diversity, as well as a higher vulnerability due to demographic and, particularly, environmental stochasticity (including catastrophic events) (e.g., Simberloff, 1998). It could be expected that, if habitat quality in Castro Verde is maintained and population continues to increase, it could act as a source (Pulliam, 1988) of individuals for other areas. However, due to their lek breeding system and strong breeding site philopatry, Lane et al. (2001) hypothesized that great bustards have poor capacity to colonize new areas, with dispersing individuals choosing settling places not based on habitat cues, but on the presence of other bustards (conspecific attraction) (Lane et al., 2001). This could explain the absence of bustards in apparently suitable areas in Spain, and the trend for population increase in good areas versus decline in poor quality ones (Lane et al., 2001; Alonso et al., 2003), as seems to be happening in Portugal. If this is the case, natural re-colonization of previous areas of occurrence in the country is unlikely, even if habitat is improved in those locations. Thus, the maintenance of the smaller marginal populations might be crucial for the long-term survival of this species in Portugal. Priority should be given to those sites that still hold populations larger than 30 birds, namely Vila Fernando, Évora and Campo Maior.

In spite of the apparent population increase and habitat quality in Castro Verde, there are early signs that this might start changing quite soon. The conservation of great bustard habitat in Castro Verde is largely dependent on the maintenance of traditional agricultural activities, which have been promoted by the Zonal Plan. This Plan embraces an area of ca. 60.000 ha. From 1995 to 1999, farmers joined the Plan enthusiastically, peaking in 1999 when 61% of the area of the Zonal Plan was subjected to agri-environmental management (Lampreia, 2003). However, delay in subsidy payments followed by a substantial decrease in financial support (reaching 40%) caused a decrease in farmers' uptake, which continues up to the present. In 2003, only 34% of the area had adhered to the Plan (Lampreia, 2003). As farmers stop joining the Zonal Plan, other type of agricultural management is introduced, and current agricultural changes include increased livestock densities, increased fence density and larger amount of pastures. Furthermore, afforestation of former agricultural land is spreading due to its economic profitability. Thus, we have some concerns that the current trend for population increase might be reversed in the next couple of years.

In summary, conservation priorities for great bustards in Portugal should consist in (1) assuring the maintenance and effectiveness of the Castro Verde Zonal Plan; (2) maintaining and if necessary restoring habitat for great bustards in Vila Fernando, Évora and Campo Maior; habitat restoration might have to include transforming irrigation schemes and recent afforestations back to extensive cereal cultivation, as well as promoting correction measures for powerlines (existing lines should be marked or buried).

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