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THE GREAT BUSTARD *Otis tarda* IN SPAIN: PRESENT STATUS, RECENT TRENDS AND AN EVALUATION OF EARLIER CENSUSES

Juan C. Alonso

Museo Nacional de Ciencias Naturales, CSIC, José Gutiérrez Abascal 2, 28006 Madrid, Spain

&

Javier A. Alonso

Departamento de Biología Animal I, Facultad de Biología, Universidad Complutense, 28040 Madrid, Spain

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Abstract

We estimate the size of the Spanish population of great bustards Otis tarda *at around 17,000–19,000 birds, using the results of the most recent counts available. To evaluate the reliability of earlier censuses and estimations, we compared the results of the first census carried out in 1981–82 with more reliable counts made at specific intensive study areas during 1987–88 and 1993–94. For these comparisons we selected five test areas where experienced observers had been studying great bustard populations during several years. All counts and sex-ratio samples recorded during 1987–88 and 1993–94 were similar between these two years and much higher than those obtained during 1981–82 at the same areas. This supported our conclusion that many individuals, particularly females, had been missed during the 1981–82 census. Extrapolating the results from test areas to the whole of Spain, we again obtained 17,000 birds as an estimate of the Spanish population. Since 1980, when the species was legally protected, numbers have probably remained stable in most areas, while the smallest marginal groups have tended to disappear. Copyright © 1996 Elsevier Science Ltd*

Keywords: great bustard, *Otis tarda*, status, Spain.

INTRODUCTION

The great bustard *Otis tarda* is considered a globally threatened species (Collar & Andrew, 1988). Its palearctic distribution range, from the Iberian Peninsula in the west to Mongolia in the east, probably reached maximum extension during the 18th century, and then began to retreat due to habitat changes caused by human population growth, farming practices, and hunting pressure (Glutz *et al.*, 1973; Cramp & Simmons, 1980; Collar, 1985; Johnsgard, 1991). During the last few decades, many central European populations have suffered dramatic decreases, some of them being severely threatened with extinction (see, e.g. Sterbetz, 1980; Dornbusch, 1980; Litzbarski, 1993; Goriup & Batten, 1990; Fatér & Nagy, 1993; Kollar, 1991; Flint & Mishchenko, 1991). One of the most alarming declines has in fact occurred in the Hungarian population, the second most important in Europe (Sterbetz, 1980), where the numbers of great bustards have decreased from 8557 birds in 1941 (Fodor *et al.*, 1971) to 1100 birds in 1993 (Fáter & Nagy, 1993; S. Farago, pers. comm.). The Iberian population is the largest population, with more than half the world total number of individuals (Hidalgo & Carranza, 1990; Kollar, 1994).

Published information on the size of the Spanish great bustard population is however extremely confusing, due to the large differences in numbers cited. The first estimate of the numbers of great bustards in Spain was made in 1969, based on information from hunters, arriving at a total of 16,000–17,000 birds (Trigo de Yarto, 1971*a*,*b*). Later, other authors made their own estimates with data from conservation guards together with partial censuses of certain areas, arriving at estimates of 11,890 birds (Palacios *et al.*, 1975), and 11,282 birds (De la Peña, 1980*a*,*b*). In 1981–82, two national censuses were carried out simultaneously (respectively, ICONA, 1982; and CODA, unpublished; see results in Garzón, 1981; Purroy, 1981; Ena, 1984; Martínez, 1982; Hernández *et al.*, 1987; Ena & Martínez, 1988). Neither census covered the whole range of the species in Spain, but the result of one census (7090 birds) could be combined with data from the second for Cáceres province (1387 birds; Martínez, 1982), Aragón (80 birds; Purroy, 1981), Navarra (10 birds; Ena, 1984), Murcia (20 birds; Hernández *et al.*, 1987) and Andalucía (194 birds; Garzón, 1981) gives a total of 8781 great

bustards resulted for Spain. However, different authors have published quite different estimates, which served to add uncertainty rather than clarify the situation: 6000–8000 birds (Garzón, 1981), 8000–9000 birds (Purroy, 1982), 5000–8000 birds (Collar, 1985), and 11,500 (Hidalgo, 1990). Recently, our preliminary estimate of 13,500–14,000 individuals (Alonso & Alonso, 1990), based on the, at that time, latest available counts at some well-known areas, was cited by Tucker and Heath (1994) as the most accurate.

With respect to the conservation status and trends of the Iberian population, most authors concluded, on the basis of previous censuses and estimates, that there has been a decrease in numbers in recent years (Garzón, 1981; Collar, 1985; Ena & Martínez, 1988; Hidalgo & Carranza, 1990; Peris *et al.*, 1992). Such belief was probably based on the confirmed decreases observed throughout the last few decades at other European populations of this species (see e.g. Glutz *et al.*, 1973; Collar & Goriup, 1980; Collar, 1985). In Spain, however, many of the published local data, and particularly estimates of total population size, are too confusing to enable comparisons and one has to be extremely careful while establishing reliable demographic trends. The species is very difficult to census at a national scale, due to the lack of sufficient expert observers who know both the species and the areas to be surveyed. The disparity in numbers probably reflects differences in census dates and methods, rather than true population trends.

In this paper we propose a new estimate of the Spanish great bustard population, based on the most recent local counts available. We also discuss recent population trends of the species in Spain, evaluating the national census of 1981–82 (Garzón, 1981; ICONA, 1982; Martínez, 1982; Otero, 1985) in the light of later counts made only by experienced observers at specific intensive study areas.

METHODS

We have reviewed all published and unpublished references on great bustard counts in Spain, and present a summary of regional or provincial censuses as an updated estimate of the current Spanish great bustard population. After publication of the 1981–82 national census results various research teams began studying local populations, obtaining markedly higher counts only a few years later, which made us doubt the reliability of the first census. To simultaneously evaluate the validity of this census and the trends of the population during the last two decades, we selected five test areas (Table 1, Fig. 1) where we compared the census results in 1987–88 and 1993–94 (from now on called respectively C2 and C3) with those obtained during the national census of 1981–82 (called C1). We used only those areas where experienced observers had been studying great bustard populations for several years and thus their 1987–88 and 1993–94 counts could be assumed to be reliable. All test-areas selected included one or more Important Bird Areas in Europe (Grimmet & Jones, 1989). Since they include different parts of the distribution range and together comprise around 40% of the Spanish great bustard population, our

Table 1. Comparison between numbers of Great Bustards censused in 1981–82 (C1), 1987–88 (C2) and 1993–94 (C3) at five test-areas in Spain, with female/male sex ratios

Test-area (km^2)	C1	Sex ratio (no. of birds)	C2	Sex ratio (no. of birds)	C3	Sex ratio (no. of birds)	C1/C2	C1/C3
León province (1300)	350[1]	1·14 (270)	438[2]	1·58 (279)	466[3]	1·70 (435)	0·80	0·75
Villafáfila area (971, Zamora province)	1203[1]	1·04 (1149)	2106[4]	1·80 (1990)	2063[5]	1·65 (2063)	0·57	0·58
Madrigal–Peñaranda (1108, Avila–Salamanca provinces)	388[1,6]	—	942[7,8]	—	1262[9]	1·31 (1245)	0·41	0·31
Madrid province (1340)	253[1]	1·84 (233)	642[10]	2·21 (609)	706[11]	—	0·39	0·36
Cáceres province (7500)	1387[12]	—	2718[13]	—	2604[14]	—	0·51	0·53
Global comparisons (12,219 km^2)	3581	1·15 (1652)	6846	1·85 (2980)	7101	1·53 (3743)	0·52	0·50
Total no. of great bustards in Spain	8781[1,6,12]		16,787[15]		17,412[15]			

[1] ICONA (1982); Otero (1985); [2] Lucio & Purroy (1990); [3] Purroy, pers. comm.; [4] Alonso *et al.* (1990*b*); [5] Alonso & Alonso, unpublished data; [6] San Segundo *et al.* (1987); Ena (1984); [7] Martín & Martín (1989); [8] Peris *et al.* (1992); [9] Martín & Martín (*pers. comm.*); [10] Alonso *et al.* (1990*a*); [11] GESNATURA (1994); [12] Martínez (1982); [13] Sánchez *et al.* (1989); [14] Sánchez *et al.* (1994), Hellmich (1994); [15] estimated in present study using C1/C2 and C1/C3 ratios of figures given in global comparisons.

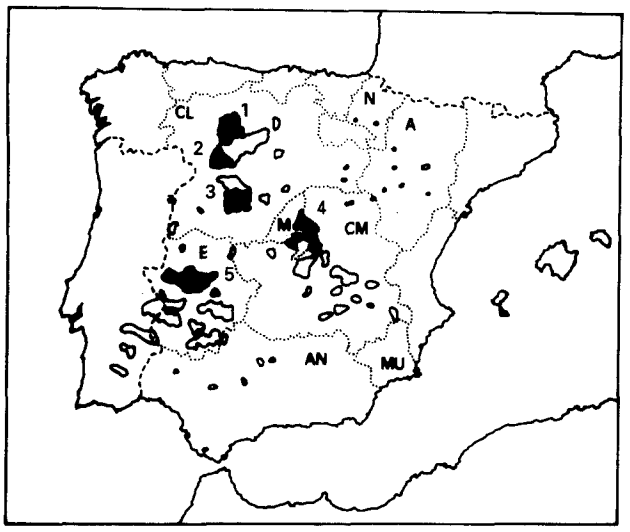

Fig. 1. Map of the Iberian Peninsula showing the present distribution of great bustards (encircled areas) and the test-areas used in this study (shaded): 1: León province; 2: Villafáfila-Villalpando area; 3: Madrigal-Peñaranda area; 4: Madrid province; 5: Cáceres province. The dotted lines show the limits between autonomous regions: CL= Castilla y León, N= Navarra, A= Aragón, M= Madrid, CM= Castilla-La Mancha, E= Extremadura, AN= Andalucía, MU= Murcia (see Table 1) (From data in ICONA, 1982; Martín, 1987; Alonso *et al.*, 1990*a,b*; Hidalgo & Carranza, 1990; Lucio & Purroy, 1990; Hellmich, 1991; Martín & Martín, 1994; Sanz-Zuasti & Sierra, 1993; ETI, 1994).

extrapolated estimate can be considered as representative for the whole country.

The census method in C2 and C3 consisted in surveying the area by car at low speed (20–30 km/h) and stopping frequently at predetermined vantage points, which reduced overall census speed to around 15–20 km/h. The censuses were carried out in February–March, when the concentration of great bustards at display grounds and its surroundings is highest (Alonso & Alonso, 1990, 1992), thus minimizing errors in counting. For Cáceres province, however, we used the winter census (January) rather than the spring census (March–April), because some spring counts were probably performed too late in the season to see all birds (J. Hellmich, pers. comm.; A. Sánchez, pers. comm.). Depending on the size of each area it was surveyed by one, two or more teams simultaneously, each consisting of two observers, and usually for 1–2 days per area. Experience has shown that maximum surface surveyable per day may lay around 70–100 km^2. Census itineraries were always the same at any given area to enable seasonal and interannual comparisons. These itineraries had been selected previously according to the experience of the observers, using all available paths to maximize detectability of the birds and minimize the probability of duplicated counts. The area surveyed in km^2 was only 0·8–2.2 times the length of the itinerary in km, with maximum bird observation distances from the car of 700–800 m. The timing of censuses was from dawn to dusk, with a mid-day interruption of ca. 4 h, when birds tend to lie down and remain less active, reducing their detectability.

This method contrasts with that of most 1981–82 counts, which were made by less experienced or novice observers, sometimes as late as in late April or even May when most females incubate, and mostly without mid-day interruptions. Furthermore, the ratio of km^2 surveyed per linear km covered was sometimes as high as 8·6 (see detailed critique of census methods and references in Alonso & Alonso, 1990, pp. 97–98).

Where sex-ratio data were available they were also used to evaluate the reliability of the census results, since it is known from absolute counts at well known areas that in this species there are more females than males, and females are more easily missed due to their smaller size, criptic plumage and elusive behaviour (see e.g. Alonso & Alonso, 1990; Hellmich, 1985, 1991).

We obtained two estimates for the total Spanish great bustard population extrapolating to the whole of Spain the differences obtained at the test-areas between the two more reliable sets of data (C2 and C3) and the counts of C1. We believe that both figures obtained can be considered as quite reliable estimates of the number of great bustards in Spain, provided that the sample for extrapolation comprised a large proportion of the population (see above) and that trends were consistent among all five test-areas studied.

RESULTS

Table 1 shows the results of the three data sets, obtained at the test-areas respectively in 1981–82 (C1), 1987–88 (C2), and 1993–94 (C3). Census results in C2 and C3 were much higher than those obtained in C1 at all test-areas. The sum of the bird numbers in all test-areas in C1 amounted only to 52% and 50% of those obtained at the same areas, respectively, in C2 and C3. Using these proportions and the total obtained during the national census of 1981-82 (8781 birds, see Table 1 and Introduction for references) we obtained our extrapolated estimates of 16,787 and 17,412 birds, respectively, for 1987–88 and 1993–94.

The sex-ratio (females/males) values obtained during C1 were notably lower than those obtained during later censuses at all test-areas for which data were available. The total numbers of females per male were 1·15 in C1, 1·85 in C2 and 1·53 in C3.

In Table 2 we summarize the most recent great bustard counts available for each Spanish province. The resulting sum for Spain, 16,988–18,825 great bustards, is very similar to both our extrapolated estimates for 1987–88 and 1993–94.

DISCUSSION

Current great bustard numbers in Spain

After C1 (the 1981–82 census), only two detailed accounts of the numbers and distribution of great

Table 2. Summary of most recent counts of great bustards in Spain

Region Province	No. of birds	Year of census	References	Current estimated no. of birds
Andalucía	**157–159**	1981	Garzón, 1981; Ena & Martínez, 1988	**200**
Cádiz	8–10	1987	AMA, Junta de Andalucía, in Hidalgo, 1990	
Córdoba	70	1987	AMA, Junta de Andalucía, in Hidalgo, 1990	
Huelva	20	1981	Ena, 1984	
Jaén	9	1981	Ena, 1984	
Sevilla	50	1981	Ena, 1984	
Aragón (3 provinces)	**36–73**	1986	Cabrera *et al.*, 1987	**80**
Castilla-La Mancha	**2804**	1994	ETI, 1994	**3000–3250**
Albacete	475	1994	ETI, 1994	550–600
Ciudad Real	79	1994	ETI, 1994	100–200
Cuenca	170	1994	ETI, 1994	200–250
Guadalajara	113	1994	ETI, 1994	150–200
Toledo	1967	1994	ETI, 1994	2000
Castilla-León	**7599–7847**	1981–94	Sanz-Zuasti & Sierra, 1993; L. J. Martín & I. Martín, pers. comm.; F. Purroy & J. Robles, pers. comm.; own unpublished data	**7300–8250**
Avila	433–440	1991–92	L. J. Martín & I. Martín, pers. comm.	500
Burgos	340	1981–82	Ena, 1984	100–150
León	466–502	1994	F. Purroy & J. Robles, pers. comm.	500
Palencia	800	1981–82	Ena, 1984	800–1000
Salamanca	617–822	1991–92	L. J. Martín & I. Martín, pers. comm.	700–800
Segovia	54	1981–82	Ena, 1984	150–200
Soria	16	1981–82	Ena, 1984	50–100
Valladolid	2523	1984	ICONA, 1984, in Hidalgo, 1990	2000–2500
Zamora	2350	1992	Alonso *et al.*, unpublished data	2500
Extremadura	**5720–7201**	1987–95	Sánchez *et al.*, 1989, 1994; Hellmich, 1994	**5500–6500**
Badajoz	3002–4403	1987–95	Sánchez *et al.*, 1989, 1994;	3000–3800
Cáceres	2516–3411	1987–95	Sánchez *et al.*, 1989, 1994	2500–2700
Madrid	**642–706**	1988–94	Alonso *et al.*, 1990*a*; GESNATURA, 1994	**700**
Murcia	**20**	1987	Hernández *et al.*, 1987	**20**
Navarra	**10–15**	1981	Elósegui, 1985	**15**
Total Spain	**16,988–18,825**			**16,815–19,015**

bustards in Spanish provinces have been published. The first, based entirely on the 1981–82 national census, totalled 8781 birds (Ena & Martínez, 1988; see also ICONA, 1982; Martínez, 1982). The second estimated the Spanish great bustard population around 11,500 birds (Hidalgo, 1990), still using 44% data from the 1981–82 census and 56% data from later counts (1983–88). In the present paper we suggest the figure of 17,000-19,000 birds as a more accurate estimate of the great bustards living in Spain.

To reach this figure we used two procedures. First, we summed up the most recent counts available from the different provinces. Most data (12 provincial censuses, totalling 12,832–14,825 birds) are from 1991–94; the rest are earlier counts (7 provinces, with 2657–2696 birds from 1984–87; and 8 provinces, with 1299–1304 birds from 1981–82). Below we discuss the reliability of these local counts in detail. Second, we extrapolated to the whole of Spain the differences obtained between recent censuses carried out by experienced observers at several selected test-areas (C2 and C3) and the numbers recorded at these areas during the national census in 1981–82 (C1). Using this method we again reached a figure of around 17,000 great bustards for Spain, equalling the lower limit of the sum of provincial counts.

The numbers of great bustards censused in C3 at the test-areas did not differ much from those censused in C2. However, figures obtained during either of these two counts were higher than those obtained during C1. Three hypotheses could explain the differences observed: (a) an increase in numbers between C1 and C3 due either to annual recruitment of juveniles being higher than adult mortality, or to immigration into our selected test-areas being higher than emigration from them; (b) an underestimation of the bird numbers in the first census; (c) an overestimation in both latter censuses. Rejecting the last possibility as highly unlikely, we discuss the first two alternatives.

The first hypothesis also seems unlikely. It would mean that the population had increased notably (by 91%) in the 6 years between C1 and C2, and only very

slightly (by 3·7%) in the 6 years between C2 and C3. First, we cannot think of any reasons that could explain the remarkable increase in numbers during the first period and not during the last one. Second, such a high increase in only six years is virtually impossible in a species with an average annual recruitment rate of 7-9% juveniles into the autumn population (Lucio & Purroy, 1990; and own unpublished data obtained during 8 years, 1987–94, at Villafáfila). Even assuming that mortality and dispersal rates were nil from the age of three months, which we know is not true (Alonso & Alonso, 1992; see also Longhurst & Silvert, 1985; Lucio & Purroy, 1986, 1987), the population would have only increased from 8781 to 13,934 birds. The possibility that a one-way immigration into our test-areas had occurred seems unlikely, since these areas were chosen randomly within the distribution range of the species in Spain. This possibility would have implied an absence of juvenile dispersal during six years at all test-areas, and a simultaneous immigration of around 3300 great bustards into these areas from about 13000 km^2 surrounding them, assuming uniform bird densities in and around those areas. Only an absence of habitat transformations at our test-areas and a simultaneous dramatic change around them would have led to such a unidirectional mass migration, and that was not the case.

The hypothesis of an underestimation in the first census with respect to the two latter censuses seems the most plausible, and several arguments support it. First, the large area to be searched in the national census C1 during only a few weeks in spring by a relatively small number of observers, most of them unfamiliar with the areas, did not enable them to survey with sufficient accuracy. This could well have been the main cause of a serious underestimation in the first count. Second, observers did not always interrupt the survey at midday, when most birds lie down to rest and are less detectable. Third, the lower sex-ratio values recorded during C1 with respect to the other two counts at all test-areas suggest that a further probable cause of the differences observed was the undercounting of females during the first census. The explanation of this is the following. The species has been legally protected in Spain since 1980. Previously, the annual hunting bag amounted to *c.* 2000 birds for the whole country (Trigo de Yarto, 1971a: 2057 birds in 1969, 2036 in 1970). Since most of these birds were males, the sex-ratio recorded during C1 should have been more female-biased than that obtained in C2 and C3, respectively seven and thirteen years after establishment of legal protection. But data in Table 1 show quite the opposite, strongly suggesting that many females were probably missed in C1. In this first census several areas were indeed surveyed after mid April, when many females were already incubating and thus were surely missed (see ICONA, 1982; Otero, 1985). Assuming that the sex-ratio in 1981-82 should have been the same as that recorded in C2 (1·85 instead of 1·15 females per male), we could guess that about 2858 females were missed, and adding these females to the total of 8781 birds counted in C1, a new total of 11639 great bustards would be obtained. This, however, is still a much lower total than that estimated in this paper, suggesting that in addition to missing females, C1 also had an incomplete coverage. These and other mistakes commonly made while censusing this species can easily result in considerable underestimates of numbers, and invalidate any conclusions based on their results (see e.g. Alonso & Alonso, 1990; Hellmich, 1985, 1991).

Evaluation of local counts

The distribution of great bustards in Spain shows two main areas in northwest and southwest Spain and some minor areas over the rest of the country (see Fig. 1 and Table 2). In these marginal areas, available censuses are 8-14 years old, but comparing some of these local counts with earlier counts at the same localities, small if any changes are detected, sometimes suggesting a clear decline (e.g. in Murcia or Navarra regions, see Hernández *et al.*, 1987; Elósegui, 1985), sometimes perhaps suggesting merely the difficulty in censusing very small groups (e.g. in Andalucía or Aragón, Ena, 1984; Ena & Martínez, 1988; Cabrera *et al.*, 1987). In any case, however, these four regions together comprise only 200–300 birds, and the maximum possible error in censusing them would not substantially affect our estimated size of the Spanish population. A region with a moderate number of birds is Madrid, and here available censuses suggest stability in numbers during the last few years, as well as fidelity in sites occupied.

The regions with the highest numbers of birds are Castilla y León, Extremadura and Castilla-La Mancha, which together hold 95% of great bustards in Spain. The most recent estimate of numbers in Castilla-La Mancha are based on a census carried out during spring 1994 by several observers (ETI, 1994). With the exception of two provinces (see Charco & Blanco, 1987; Martín, 1987), this region had not been censused since 1981-82, when the regional total was only 1856 birds (Otero, 1985). The difference of *c.* 1000 birds compared with current numbers corresponds only to the province of Toledo, and is attributable to missing birds in this province in 1981–82, according to the coordinator of the 1994 census, who assumes also that 2804 birds should be considered a minimum estimate for this large region (C. Martínez, pers. comm.).

In Castilla y León, some provinces have been regularly surveyed for several years by experienced observers and current numbers are well known and absolutely reliable; for others, only local incomplete counts have been done recently, which suggest similar or slightly higher numbers than those counted in 1981–82 (Burgos, Palencia, Segovia and Soria). For these provinces, estimations are based on a review by Sanz-Zuasti and Sierra (1993).

In Extremadura surveys of great bustard areas have been carried out in winter and spring each year regularly since 1985 (Sánchez *et al.*, 1989, 1994). Winter counts are made in mid-January, when maximum bird concentrations occur, resulting in yearly totals of 5720–7201 great bustards. Spring counts are made in late March-early April, with totals averaging only 3500–4000 birds. We think that the reason for counting just about half of the birds in spring is the late date of the census. By late March-early April many females have already copulated (see Hellmich, 1991) and dispersed from display areas to their nest sites, exhibiting an elusive behaviour that makes them difficult to see. Rejecting the possibility of a 70–100% overcounting of birds in winter, the only alternative explanation is that birds abandon the Extremadura region without an equivalent opposite movement of birds from adjacent regions, which seems rather unlikely. The remarkable site fidelity of male and female adult birds in late winter-early spring shown by a recent radiotracking study (Alonso *et al.*, 1995) also suggests that the number of birds in Extremadura must be closer to the winter counts than to spring counts, and thus we have used the former as a more reliable estimate for this region.

Population trend

We conclude that the size of the Spanish population can be estimated around 17,000–19,000 individuals, and that the 1981–82 census greatly underestimated the Spanish great bustard population. Our new estimate means also that published estimates of the species' world population (14,000–21,000, in Collar, 1985; 28,000, in Collar, 1991) have also to be updated. The similarity between the sum of the most recent local counts in Spain and our two estimates, based on reliable counts at several areas distributed over the species range in Spain and separated by a time-lag of 6 years, supports the validity of our estimate and the stability of bird numbers during the last few decades. We do not think that there has been a significant increase at a national scale between 1981–82 and 1993–94. Rather, we think that the first census underestimated the real population. Our data on the Villafáfila great bustard population over eight years, a 15-year series of censuses in León province (Lucio & Purroy, 1990; Purroy, pers. comm.), and counts in Extremadura since 1990, when all areas were already well enough known (Sánchez *et al.*, 1994), suggest that most great bustard nuclei are stable in Spain, perhaps with a very slight tendency to increase in some particularly well conserved areas (e.g. Hellmich, 1994; own unpublished data). Simultaneously, a decline has continued at some marginal areas, where the excessively fragmented sub-populations have already become extinct or could easily disappear in a few years.

Contrasting with current population stability at a national scale, a serious decline probably occured during the decades immediately before the species' legal protection, when it was subjected to high hunting pressure. The cessation of hunting has been insufficient to produce a noticeable recovery, probably because of continuing inappropriate habitat management in many areas, and the slow reproductive rate of the species. Much worse than any other factors endangering the future of the species in Iberia, and thus in the world, is the constant threat of present and future changes in agricultural practices or policy which could severely endanger some subpopulations. These are reasons why the future of the Spanish great bustard population is still uncertain, in spite of the numbers mentioned in this paper.

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