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Alarming houbara bustard population trends in Asia

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Abstract

Relative abundance and density estimates of Asian houbara were assessed during the breeding season in two breeding grounds of migrant populations (China and south Kazakhstan) and in one breeding ground of a resident population (Oman), between 1998 and 2002. For the study period, the relative abundance was from 0.004 to 0.06 individual per km driven and density estimates varied from 0.01 to 0.2 houbara per km^2. Relative abundance and density of houbara declined by 63% and 69%, respectively in China, by 60% and 49%, respectively in Kazakhstan and by 50% and 75%, respectively in Oman. Overall, an average of 27–30% annual decline in both relative abundance and density was observed for the three regions. Despite being legally a strictly protected species in China, Kazakhstan and Oman, houbara are heavily hunted and poached on all their migration routes and wintering grounds. The current levels of hunting and poaching are not sustainable and without the immediate agreement and implementation of international conservation measures, the Asian houbara may face extinction in the wild in the foreseeable future.

Keywords: Houbara bustard; *Chlamydotis macqueenii*; China; Kazakhstan; Oman; Population decline; Hunting pressure

1. Introduction

Large-scale censuses are necessary to understand population trends and to help in the preparation of long-term management strategies for the sustainable use of species (Cody and Smallwood, 1996; Primack, 1998).

Traditional and favourite quarry of Arab falconers, the Asian houbara bustard (recently proposed as a full species, *Chlamydotis macqueenii,* previously subspecies *Chlamydotis undulata macqueenii* ; Knox et al., 2002), is a desert and steppe dwelling bird distributed from Mongolia to the Arabian Peninsula, through Central Asia (Collar's, 1980; Del Hoyo et al., 1996; Goriup's, 1997). The minimum population of Asian houbara bustard (hereafter "houbara") was estimated at 39,000–52,000 individuals, mostly breeding in Kazakhstan (30,000–40,000 individuals; Goriup's, 1997). Goriup's (1997) figures were mostly based on the now twenty years-old Collar's (1980) review of local verbal and literature information and on an extrapolation to whole Kazakhstan of the Gubin's (1992) ground and aerial surveys in the Kyzylkum desert, southern Kazakhstan. Surveys conduced by the National Avian Research Center (hereafter "NARC") during the late 90s in Kazakhstan, Mongolia and China extended the known distribution range of the species and suggested that the overall Asian population could be over Goriup's (1997) estimations (BirdLife International, 2003). Therefore, houbara population size and geographic range might well meet conservation standards, such as the ones used for the IUCN Red List where the species is classified as "lower risk/near threatened", and then not facing a high risk of extinction in the wild in the medium-term future (IUCN, 2003; see http://www.redlist.org).

According to BirdLife International (2003), source on which IUCN Red List houbara classification is based,

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no reliable data for rates of decline of houbara populations are available but "*given the substantial threats, declines are likely to be significant and possibly widespread*". The main threats would be habitat loss and degradation as desert areas are developed for agriculture and infrastructure projects (BirdLife International, 2003). However, a recent body of evidence already indicates that Asian houbara populations are declining dramatically due to poaching and excessive hunting with an extension of the range, but also of the season, of falconry activities (Combreau et al., 2001; Tourenq et al., 2004a; NARC, unpublished). Formerly practised on camel- or horse-back until the 1960s, falconry hunting parties, essentially by GCC citizens, are now highly mechanized and mobile (Bailey et al., 1998) and before 1995, very little, if any, hunting occurred in Central Asia. With the collapse of the Soviet Union, falconry parties spread from Kazakhstan to Turkmenistan. As a result, the hunting pressure on houbara by falconers has been increasing considerably all over its distribution range for the last twenty years (Combreau et al., 2001).

Houbara from the Gobi desert to the Jungar basin in China migrate through Kazakhstan towards wintering grounds in Afghanistan, Iran, Arabian Peninsula and Pakistan. Populations in eastern Kazakhstan migrate towards Afghanistan and Pakistan through eastern Uzbekistan, Turkmenistan and Iran, whereas populations in western Kazakhstan, from Caspian to Aral Sea, migrate through Uzbekistan, Turkmenistan and Iran to winter in north Arabian Peninsula (Combreau et al., 1999; Combreau et al., 2001; Tourenq et al., 2004b). In the Arabian Peninsula also, populations of wild resident houbara are dispersed from Syria, Jordan and Egypt to Oman and Yemen, the latter two being said to host most of the remnant wild resident populations of the GCC region (Goriup's, 1997). China, Kazakhstan and Oman are thus key countries for the houbara bustard, and population trends measured there are a good indicator of the overall conservation status of the Asian houbara migrant and resident populations.

In line with the recommendations of the Specialist Survival Commission of the World Conservation Union (SSC/IUCN) and of the Steppe and Grassland Bird Specialist Group of BirdLife International (Goriup, 1997), NARC organised surveys of houbara during the breeding season in the Jungar basin, Xinjiang province of China, from south of Lake Balkash to the Caspian Sea in Kazakhstan, and on the Jiddat al Harasis desert plateau in Oman, where reproduction has been reported (Combreau et al., 2002; Tourenq et al., 2004a; Lawrence et al., unpublished). Resulting from collaborations with the Chinese Academy of Sciences in Urumqi, the Kazakh Scientific Centre of Quarantine and Zoonosis Diseases (hereafter KSCQZD) in Almaty and the Arabian Oryx Project of the Office of the Adviser for Conservation of the Environment in Oman (hereafter AOP), this paper presents the results of houbara surveys for the 1998–2002 period and alerts the international community on the observed drastic decline of the density of breeding Asian houbara throughout key areas of its distribution range.

2. Material and methods

2.1. Study areas

In China, our study area of c. 3000 km^2 was located in eastern part of the Jungar basin, Xinjiang Province of China (44°N–91°E; Fig. 1). Bordered by the Tien Shan Mountains to the south and sand dunes to the north, the study area is a high flat steppe plateau (850–1100 m above sea level) dominated with associations of *Anabasis* sp. and *Artemisia* sp. and ephemeral plants species in spring (*Plantago* sp., *Lepidium* sp., *Ceratocarpus* sp., *Tulipa* sp., *Scorzonera* sp. and *Corydalis* sp.; Combreau et al., 2002).

In Kazakhstan, study areas totalizing c. 10,869 km^2 were located in five geomorphologically distinct steppe-desert regions spread from east to west: South Balkash, Betpak-Dala/Muyunkum, Kyzylkum, North–East Karakum and North Caspian (Fig. 1). They covered a mix of sandy clay and gravel desert plains and mountain slopes with mainly associations of *Salsola.* sp. and *Artemisia* sp. in the Betpak-Dala/Muyunkum plateau, and *Anabasis* sp., *Artemisia* sp., *Haloxylon* and *Calligonum* spp. in other regions (S. Pole, unpublished; Tourenq et al., 2004a).

Our study area in Oman was the Jiddat al Harasis plateau in the Arabian Oryx Sanctuary managed by the AOP (19°N–57°E; Fig. 1). This desert limestone plateau (150 m above sea level) of c. 15,000 km^2 is bordered by the Rub al Khali sands in the west and by an escarpment in the east. Distributed over a patchwork of low-vegetated sandy depressions and gravely rocky surfaces, the vegetation includes *Stipagrostis* sp., *Ochthochloa compressa*, *Rhazya stricta*, *Periploca aphylla*, *Heliotropium kotschyi*, *Zygophyllum* sp. and three tree species: *Prosopis cineraria*, *Acacia tortilis* and *A. ehrenbergiana* (Stanley Price, 1989).

2.2. Relative abundance and density estimations

Because our main objective was to get trends of houbara breeding populations, surveys were conducted during the houbara breeding season, when Asian houbara are not in their wintering quarters, considering the starting of the breeding season and taking into account the laying peak of this species that extend from March in Oman to end of April in China (Combreau et al., unpublished; Combreau et al., 2002; Tourenq et al., 2004a;

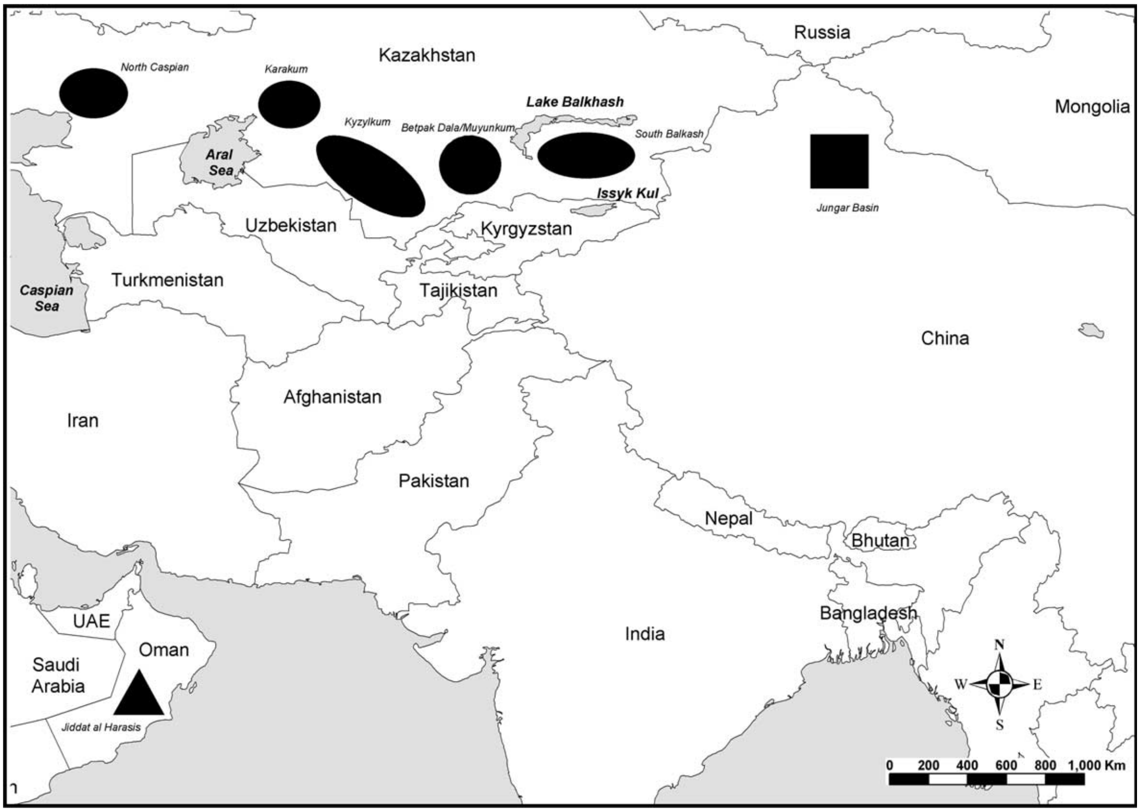

Fig. 1. Location of study areas in China (square), Kazakhstan (dots) and Oman (triangle).

Lawrence et al., unpublished; Table 1). Surveys were made on same areas and habitats season after season.

To assess the changes in houbara population abundances and densities over years and across the whole of the study areas, motor vehicle transects were considered as the most practical methods to cover the large area described in this study (Launay, 1999; Seddon and van Heezik, 1999). An index of relative abundance was then calculated as the number of houbara sightings (i.e. houbara seen walking or flushed) per km driven. Even if they may have some limitations (uncertainty about monotonic relationship between numbers of houbara seen and numbers actually present), relative abundance indexes given by regular transect surveys allow making inter-annual or inter-areas comparisons (Seddon and van Heezik, 1999). Study areas were patrolled at low speed (<30 km/h). Each car team was composed of at least two observers.

Each vehicle was fitted with a GPS to record the track travelled. Tracks covered during darkness were not included in the analysis. This removed, for example, any pre-sunrise and post-sunset drives to and from fieldwork areas. For this purpose of defining when the light level was too low for houbara observation, "darkness" was taken to run from 10 min after sunset to 10 min before sunrise. Temperature, rain and wind conditions were noted. Being parameters that could modify birds' activity and hence their detectability (Bibby et al., 1993), we discarded houbara observations or survey effort made under extreme conditions (rain, strong wind). Observations were made from sunrise to sunset but were only really effective between dawn and 9:00 am, and between 5:00 pm and sunset. In-between these periods the heat haze, magnified in the telescope's field of view, obscured and distorted all but the foreground of the observable area. In addition, early morning and late afternoon are the periods of peak activity for houbara (Combreau and Launay, 1996), so survey work was concentrated at these times.

In Kazakhstan, transect routes departed from 12 KSCQZD field stations dispersed in 5 regions, in the framework of their routine monitoring of the level of zoonosis in the rodent populations through the study and prevention of outbreaks of the bubonic plague. Due to difficulties independent from the observers, such as the nature of the terrain, spring floods, mechanic and petrol provisioning problems, some routes could not be done exactly the same way each year, but each KSCQZD team made its best to drive at least 1,500 km pear season (mean = 1,436 km; SD = 521) in the same habitats (Tourenq et al., 2004a).

Using the survey sightings (groups of one or more houbara), density estimates were calculated with the software "DISTANCE" (Research Unit for Wildlife

Table 1
Relative abundance (A) of breeding houbara for two northern migrant populations (Jungar basin in China and southern Kazakhstan) and one resident population (Jiddat al Harasis in Oman)

Year	Period of survey	Region	S	L	A
China					
1998	20 April–10 July	Jungar basin	215	3689	0.060
1999	29 April–05 July	”	324	7549	0.043
2000	30 April–11 July	”	266	6407	0.041
2001	03 May–09 July	”	155	3502	0.044
2002	05 May–06 July	”	69	3184	0.022
South Kazakhstan					
1999	20 April–08 May	Bedtpakdala-Muyunkum	24 (17)	1825 (162)	0.014 (0.01)
	”	Karakum	10.5 (12)	1350 (70.7)	0.008 (0.01)
	”	Kyzylkum	27 (21.2)	1105 (134.3)	0.023 (0.02)
	”	North Caspian	8.5 (0.7)	1061 (87)	0.008 (0)
	”	South Balkash	11.7 (3.5)	1400 (425)	0.009 (0.004)
		Sth Kazakhstan total	15.9 (12.3)	1353 (341.2)	0.012 (0.01)
2000	20 April–05 May	Bedtpakdala-Muyunkum	18.5 (12)	1583 (2.8)	0.012 (0.01)
	”	Karakum	9.5 (9.2)	1350 (70.7)	0.007 (0.01)
	”	Kyzylkum	23.5 (6.4)	1011 (267.3)	0.023 (0.01)
	”	North Caspian	8 (7.1)	1025 (35.3)	0.008 (0.01)
	”	South Balkash	10.8 (8.5)	1466 (391.8)	0.008 (0.01)
		Sth Kazakhstan total	13.5 (9.1)	1317(320.3)	0.011 (0.01)
2001	20 April–20 May	Bedtpakdala-Muyunkum	17 (11.3)	1895 (517)	0.008 (0.003)
	”	Karakum	9 (7.1)	1350 (70.7)	0.007 (0.01)
	”	Kyzylkum	8.5 (5)	1350 (213)	0.006 (0.003)
	”	North Caspian	9 (10)	1025 (35.3)	0.009 (0.01)
	”	South Balkash	2.8 (3.4)	1841 (820.3)	0.002 (0.003)
		Sth Kazakhstan total	8.2 (7.5)	1550.5 (574.1)	0.006 (0.005)
2002	15 April–15 May	Bedtpakdala-Muyunkum	14.5 (16.3)	1915 (332.3)	0.007 (0.01)
	”	Karakum	6.5 (2.1)	1813 (264.4)	0.004 (0.002)
	”	Kyzylkum	9 (0)	1687 (548.7)	0.006 (0.002)
	”	North Caspian	5 (5.6)	1178 (181)	0.004 (0.004)
	”	South Balkash	3.8 (2.2)	2163 (1,147)	0.003 (0.003)
		Sth Kazakhstan total	7.1 (6.6)	1820 (726.8)	0.004 (0.003)
Oman					
1999	07–15 April	Jiddat al Harasis	26	1584	0.016
2000[a]	–	–	–	–	–
2001	17 February–02 March	”	38	2880	0.013
2002	07–16 April	”	20	2339	0.008

Means (±SD) for the five regions of southern Kazakhstan are given. S: houbara sightings; L: total transect length.
[a] No surveys this year.

Population assessment, University of St. Andrews, UK; http://www.ruwpa.st-and.ac.uk/distance). The use of DISTANCE sampling was validated on houbara by Seddon and van Heezik (1996, 1999). This method is said to be the most rigorous way to compare inter-annual trends in houbara populations providing surveys are conducted under similar conditions (season, time of the day, habitat coverage) from one survey to the next (Seddon and van Heezik, 1999). Briefly, DISTANCE uses the perpendicular distance object-transect line and the bearing angle from the transect line to the point at which individual houbara are first detected. As range-finding equipment was not available, we estimated the perpendicular distance houbara-transect lines using surrounding landmarks. The distances were regularly checked using car odometers.

Using this information, the program constructs a detection probability function $g(y)$, such as:

$$g(y) = \text{key function}(y)[1 + \text{series expansion}(y)].$$

Density estimates are calculated from this detection probability function. Models are tested and selected with Akaike's Information Criterion (AIC) and goodness of fit tests (Buckland et al., 1993). The most parsimonious models selected were Half-Normal key function with Cosine expansion. Assumptions of the model were that houbara directly on the transect route were never missed, that individuals were not counted twice, that the sightings were independent events, and that the probability of seeing a houbara decreased with its distance from the transect line. We assumed also that transects were placed in suitable habitats at random with respect to houbara distribution.

Low number of sightings of houbara within surveys in the five regions of Kazakhstan made fitting of detection functions difficult and resulted in low precision estimates (coefficient of variation >40%; Buckland et al., 1993). Therefore, we pooled data across regions to derive a single estimate of density for southern Kazakhstan for a given season. However, pooling across surveys assumes that the detectability does not differ between the five regions. To explore the validity of pooling data across regions of southern Kazakhstan, we first fitted the detection function to distance data pooled across regions and made separate analysis by regions. The sum of the AIC values across regions was greater than the AIC value from the pooled data indicating that the detection function did not vary between regions and that pooling was justified (Seddon et al., 2003).

3. Results

3.1. Relative abundance

In China, the total numbers of adult houbara sightings per breeding season fell from 324 in 1998 to 69 in 2002 while relative abundance, expressed as the number

Table 2
Density (D) per km^2 of breeding houbara for two northern migrant populations (Jungar basin in China and southern Kazakhstan) and one resident population (Jiddat al Harasis in Oman)

Year	Region	n	D	95% CI	%CV	Effort
China						
1998	Jungar basin	167	0.201	0.159–0.255	12	3689
1999	”	234	0.159	0.131–0.193	10	7549
2000	”	204	0.117	0.083–0.165	18	6407
2001	”	114	0.114	0.088–0.149	14	3502
2002	”	60	0.053	0.039–0.072	15	3184
South Kazakhstan						
1999	Bedtpakdala-Muyunkum	39	0.105	0.067–0.167	23	3651
	Karakum	13	0.029	0.011–0.071	44	2700
	Kyzylkum	30	0.090	0.055–0.147	25	2210
	North Caspian	15	0.029	0.013–0.064	38	2123
	South Balkash	25	0.059	0.035–0.099	26	4201
	Sth Kazakhstan total	122	0.057	0.046–0.072	12	14,885
2000	Bedtpakdala-Muyunkum	33	0.072	0.045–0.117	24	3166
	Karakum	13	0.013	0.006–0.029	40	2700
	Kyzylkum	25	0.094	0.055–0.160	27	2022
	North Caspian	13	0.037	0.017–0.081	38	2050
	South Balkash	29	0.049	0.031–0.077	23	5865
	Sth Kazakhstan total	113	0.062	0.047–0.081	14	15,803
2001	Bedtpakdala-Muyunkum	26	0.122	0.066–0.225	31	3791
	Karakum	17	0.033	0.017–0.063	32	2700
	Kyzylkum	12	0.040	0.018–0.087	39	2701
	North Caspian	18	0.043	0.022–0.084	32	2050
	South Balkash	9	0.009	0.003–0.023	46	7364
	Sth Kazakhstan total	82	0.033	0.025–0.043	13	18,606
2002	Bedtpakdala-Muyunkum	25	0.072	0.045–0.117	24	3830
	Karakum	11	0.018	0.008–0.041	39	3626
	Kyzylkum	13	0.023	0.009–0.054	43	3374
	North Caspian	9	0.023	0.007–0.072	54	2356
	South Balkash	14	0.011	0.005–0.025	37	8653
	Sth Kazakhstan total	72	0.025	0.019–0.033	14	21,839
Oman						
1999	Jiddat al Harasis	14	0.053	0.024–0.117	40	1584
2000[a]	–	–	–	–	–	
2001	”	19	0.036	0.019–0.067	32	2880
2002	”	12	0.013	0.006–0.027	38	2339

Densities for the five regions of southern Kazakhstan are given. n: number of detections (groups of one or more houbara seen), 95% CI: 95% Confidence interval, %CV: percentage of coefficient of variation, Effort: total length in km of transects.

[a] No surveys this year.

of sighting per km driven, fell by 63% from 0.06 to 0.02 individual per km driven for the same period (Table 1). For the all south Kazakhstan, between spring 1999 and spring 2002, the total numbers of adult houbara sightings fell from 175 to 85 while relative abundance fell by 60% (range: 49–76%) from 0.012 to 0.004 individuals per km driven. Higher decreasing rates were observed in South Balkash and Kyzylkum regions (76% and 71%, respectively). The total numbers of adult houbara sightings in the Jiddat al Harasis, Oman also declined, falling from 26 in 1999 to 20 individuals in 2002 while relative abundance fell by 50% from 0.016 to 0.008 individuals per km driven for the same period. Globally, for all regions an annual decline of 20% to 51% in the index of houbara relative abundance was observed.

3.2. Density estimates

In China, density estimates fell by 69% from 0.2 to 0.06 houbara per km^2 during the 1998–2002 period (Table 2). The global density estimates for southern Kazakhstan fell by 57% from 0.06 to 0.02 houbara per km^2 during the 1999–2002 period. An average decline of 49% (range: 32–81) per region was observed, with higher rates observed in South Balkash and Kyzylkum regions (81% and 75%, respectively).

In Oman, houbara density estimates declined by 75% from 0.05 to 0.01 individuals per km^2 between 1999 and 2002. All regions considered, an annual decline of 21% to 40% in houbara density was observed.

4. Discussion

Globally, the relative abundance varied from 0.004 to 0.06 individual per km driven and density estimates varied from 0.001 to 0.2 houbara per km^2 during the study period. Relative abundance indexes on breeding grounds were comparable to those measured in the Kyzylkum and Buzachi peninsula regions, Kazakhstan, by Aleeksev (1985); 0.008–0.021 for the whole 1956–1979 period and Gubin (personal communication; 0.006–0.144) respectively, and in Harrat al Harrah, Saudi Arabia, by Seddon and van Heezik (1996); 0.003–0.018.

Density estimates on breeding grounds were higher in China (range: 0.06–0.2 individual per km^2) than in Kazakhstan (0.02–0.06) and Oman (0.01–0.05). Densities values for the three regions are comparable to those estimated with the same method in Saudi Arabia by Seddon and van Heezik (1996); 0.03–0.10 houbara per km^2, but lower than these for other regions: 0.12–0.6 houbara per km^2 in Pakistan (Mian, 1989) and of 2–4 individual per km^2 in the Negev desert (Lavee, 1988). However, a comparison between our figures and those of Mian (1989) and Lavee (1988) needs to be treated with caution since they were not estimated with same methods.

Since our surveys were made during the breeding season when displaying males are more visible than secretive nesting females, our density estimates were biased in favour of males. Combreau (1999) suggested to bias census towards displaying males and use their number to infer the population density of breeding birds, knowing that there is a proportion of 0.51 in favour of males. If such method is applied to our data, the relative abundance indexes and density estimates for breeding populations could be nearly doubled.

Distance sampling methods show limitations especially when used to estimate population density and number of animals living at low densities, because of low detection rates per survey (Seddon et al., 2003). Because of the low number of houbara sightings, we could not estimate with accurate precision the densities for each survey in each region of Kazakhstan without the risk to get low precision estimates (i.e. coefficient of variation >20%; Buckland et al., 1993) such as these we obtained for Oman. Gathering more information with transect surveys would have been prohibitively time consuming and financially onerous in terms of petrol and associated vehicle costs. For example, only for Oman, the transect length to be surveyed would have ranged between 18,277 km in 1999 and 35,085 km in 2001, to get 300 sightings with a targeted coefficient of variation of maximum 10% (calculated from equation 7.1 in Buckland et al., 1993). Unfortunately, using more reliable methods such as mark-resighting, as suggested by Seddon et al. (2003), is difficult with houbara because of the cryptic behaviour of this species and logistic considerations for the capture and marking of individuals. Considering the limitations of our methods, we nevertheless were able to point out striking similar declines trends in breeding population density estimates in all the three regions. During the study period considered, both relative abundance and density decreased by 63% and 69%, respectively in China, by 60% and 49%, respectively in Kazakhstan, and by 50% and 75%, respectively in Oman.

Variations in houbara population numbers may be due to inter-areas and/or inter-annual variations of ecological (climatic conditions) or human-related factors (land reclamation, over-hunting; Goriup, 1997). Because of the scarcity and unpredictability of rainfall, ecological conditions are considered less favourable for houbara in the Arabian Peninsula than in other houbara breeding grounds (Seddon and van Heezik, 1996). Spring weather conditions (i.e. rainfall and temperature) in Kazakhstan, in China and in Oman did not differ considerably between years (S. Pole, personal observation; NARC, unpublished data; AOP, unpublished records; International Research Institute for Climate Prediction, US NOAA- Earth Institute, Columbia University, NY, USA, http://iri.ldeo.columbia.edu).

Destruction of the habitat, through land reclamation or overgrazing does not appears as a cause of the observed decline since human population density is low, as is the grazing pressure in the three areas concerned in this study (AOP, unpublished data; Combreau et al., 2002; Robinson et al., 2003).

The dramatic decline that we have recorded is most likely a result of increased hunting pressure from falconry and poaching in many areas of the houbara bustard's range in Asia. Breeding houbara in China and Kazakhstan migrate through Kazakhstan, Uzbekistan, Turkmenistan, and Afghanistan to Iran and Pakistan where they winter (Combreau et al., 1999; Combreau et al., 2001; Tourenq et al., 2004b). Unsatisfying hunting bags in the south in the last 10 years have prompted falconers from GCC countries (Qatar, Kuwait, Saudi Arabia, UAE and Bahrain) to search for new hunting grounds further and further north, up to the breeding grounds of the migrant populations (e.g. Kyzylkum, South Balkash) and to hunt during the early breeding season (March) in Kazakhstan, Iran or Yemen (Goriup, 1997; Bailey et al., 1999; Combreau et al., 2001; Tourenq et al., 2004a; NARC unpublished). Therefore, during both their wintering, and autumn and spring migrations, houbara are under hunting pressure. To add to this, houbara are also heavily poached in Pakistan and Iran to be sent alive to the Arabian Peninsula for falcon training purposes (Bailey et al., 1999; Combreau et al., 2001); despite the fact that this species is listed on the Appendix I of the Convention on International Trade in Endangered Species (CITES) signed by most of the states of its distribution range (http://www.cites.org). The number of houbara taken by falconers and poachers in Pakistan alone was estimated at between 3000 and 14,000 individuals per annum (Goriup, 1997; Bailey et al., 1998). Solely for United Arab Emirates, it is believed that up to 7,000 live houbara enter the country illegally each year (NARC, unpublished). On the basis of ring recoveries and satellite tracking studies, Combreau et al. (2001) estimated that hunting and poaching pressure on wintering grounds could explain 73.5% of the observed mortality of adult houbara breeding in Kazakhstan and China. The dispersed, remnant resident population in the southern part of the Arabian Peninsula (Yemen and Oman) is particularly at risk of extinction. Omani houbara, in particular, are considered as one of the last residual nuclei of the resident population of the Arabian Peninsula that have survived the increased hunting pressure by falconers since the seventies (Collar, 1980; Combreau et al., 2000). Therefore, this thirty years hunting pressure in the southern Arabian Peninsula, combined with harsh ecological conditions and a low breeding success in the wild (less than 20% probability of one egg to produce a two months-old fledging chick; Lavee, 1988; Combreau et al., 2002; J. Judas, personal communication), has lead a severe decline in population density. Hunting bags of 300 houbara per day in the 80–90s have been reported for Yemen in areas which nowadays provide a hunting take of less than 10 birds (Tourenq et al., unpublished). In Oman where hunting of houbara has been illegal since 1976, large organised groups of falconers from outside the country hunted illegally in the Arabian Oryx Sanctuary in the 1980s and early 1990s. This was stopped, but during the late 1990s–early 2000s numerous small parties, again from outside Oman, were active in the Sanctuary, despite the reinforcement of security measures (AOP, unpublished; Lawrence et al., unpublished).

Mathematical models, based on satellite and ring recoveries, predict that at the current levels of hunting and poaching, 50% of the Asian houbara population will be lost by 2006–2007 (Combreau et al., 2001). Our data suggest that the rate of loss is more drastic with an average of 27–30% annual decline in both relative abundance and density in both migrant and resident populations. The current levels of hunting and poaching of the Asian houbara are then obviously not sustainable and will probably lead to the extinction of the species in the wild if pressures do not ease. In Kazakhstan, houbara hunting is permitted to falconers only during the winter season and only in restricted areas identified by the Ministry of Environment. In China and in Oman, houbara are a strictly protected species and hunting is strongly prohibited in the areas mentioned in our study. However, our data show that even in countries where houbara are legally secure, their populations are threatened either directly by poaching or indirectly due to increased pressures on their migration path and wintering grounds. A draft agreement between all range states from breeding grounds to wintering grounds, and an action plan encompassing all conservation efforts to be put in place under the aegis of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) is under discussion. However, before these agreements come into force, we predict another two or three years of severe decline. Therefore, the situation must be stabilised by (1) strict enforcement of CITES regulations by all states in the houbara distribution range to prevent smuggling of live houbara, (2) lobbying falconers on the dramatic decline of their favourite quarry, and to refrain from: (i) using wild caught houbara for falcon training purpose, and (ii) hunting on houbara breeding grounds during the breeding season.

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