

Rapid extirpation of a newly discovered population of Little Bustard *Tetrax tetrax* in “Central plateau” (Morocco): lessons for conservation

*La disparition rapide d'une population de l'Outarde canepetière *Tetrax tetrax* récemment découverte dans le Plateau Central (Maroc) : des leçons pour la conservation*

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Abstract. The Little bustard *Tetrax tetrax* is one of the rarest of Morocco's resident breeding birds and one of the country's most endangered bird species. A small population estimated to be less than 10 birds was discovered during 2017 spring when two displaying males were spotted in Adarouch on Morocco's central plateau. This is the first time that the little bustard was reported in this particular location which qualifies it as currently the southernmost in the world. However, after two consecutive observations in spring 2017 and 2018 in the Adarouch region, no bird was found again between 2019 and early 2020, despite intensive research. The main causes are probably the unexpected and rapid change in agriculture and pastoral practices occurred in late 2018 in the Adarouch grassland ecosystem. Further researches are urgently needed to identify other potential threats and to establish conservation measures for the remaining population of northern Morocco.

Keywords: Little bustard, grassland, fallow, extirpation, agriculture, pastoralism, conservation.

Résumé. L'Outarde canepetière *Tetrax tetrax* est l'un des oiseaux nicheurs les plus rares du Maroc et l'une des espèces d'oiseaux les plus menacées du pays. Une petite population estimée à moins de 10 oiseaux a été découverte au printemps 2017 lorsque deux mâles en parade ont été aperçus à Adarouch (Plateau Central du Maroc). C'est la première fois que l'Outarde canepetière est signalée dans ce site, qui est à la limite méridionale de l'aire de répartition mondiale actuelle de l'espèce. Cependant, après deux séries d'observations consécutives aux printemps 2017 et 2018 aucun oiseau n'a été retrouvé entre le printemps 2019 et début de celui de 2020 dans la région d'Adarouch, malgré des recherches intensives. Les principales causes sont probablement le changement rapide et inattendu des pratiques agricoles et pastorales survenues fin 2018 dans l'écosystème des prairies de l'Adarouch. Pour la population restante du nord du Maroc, des recherches supplémentaires sont nécessaires de toute urgence pour déterminer les autres menaces potentielles et pour établir des mesures de conservation.

Mots-clés: Outarde canepetière, prairie, jachère, disparition, agriculture, pastoralisme, conservation.

INTRODUCTION

Human actions inflate extinction rates and have eliminated top predators and other large-bodied species across the globe (Hayes & Hayes 2013, Rudolfo & Raven 2003). Current rates of extinction are about 1000 times the background rate of extinction and are poised to increase (Pimm & Peter 2000, Fagan & Holmes 2006). Habitat loss, and degradation of habitat quality from human activities are among the main threats to wildlife populations (Fahrig 2003, Mortelliti *et al.* 2010). Agriculture threatens biodiversity across the globe, particularly in Mediterranean landscapes, where human populations are high, habitat is easily converted and agriculture is prone to intensification (Caraveli 2000, FAO 2017). This process can also lead to population extinction in small areas (Evans *et al.* 2015)

In Northern Mediterranean, preserving semi-natural habitats dominates conservation priorities, yet across the south Mediterranean anthropogenic landscapes receive little public attention or conservation efforts (Underwood *et al.* 2009, Deinet *et al.* 2013). This is especially true of Mediterranean agro-ecosystems, where landscape structure is often maintained through complex human–wildlife and ecological interactions (Cox & Underwood 2011). Over the next year's demand to convert natural habitat and intensify agriculture will escalate, especially in developing Mediterranean countries (Williams 2011)

In Morocco, biodiversity loss and extirpation due to persecution, illegal hunting and habitat loss started at early

XXth century leading to large and/or medium bodied animal extirpation (Bons & Geniez 1996, Aulagnier *et al.* 2016). Currently, several taxa are in the top list of species on the verge of extinction in Morocco including large steppe birds (Thévenot *et al.* 2003, El Agbani *et al.* 2011).

The Bustard (Otididae) an obligate grassland bird family highly specialized with k-selected traits and an open nesting system (Lack 1954), rendering them vulnerable to extinction when faced with environmental changes or direct threats. For example, Little Bustard *Tetrax tetrax* (LB) is listed as Near Threatened (NT) because it is probably experiencing a moderately rapid overall population decline, driven by rapid shrink in the west of its range, owing mainly to habitat loss and degradation, as well as low-level hunting pressure (Birdlife 2016).

LB ranges from Morocco and Iberian Peninsula eastward to China and Mongolia (del Hoyo *et al.* 1996) showing patched areas of distribution throughout this geographical scope. It is a steppe and steppe-like specialist bird that favors relatively open short grass habitats, rich and mosaic semi-natural pastureland, fallow land and low-intensity cultivated areas with vegetation over 20 cm high (del Hoyo *et al.* 1996, Santos *et al.* 2016). During the breeding season, short grassland with high plant species richness appears to be favored for foraging and displaying but the males seek shelter in tall grass and females spend much time in dense short-grass cover for breeding (del Hoyo 2006, Sylva *et al.* 2014). In summer time, animal food become scarce and little bustard occurrence is mainly determined by the presence of green plants, which represent food availability (Silva *et al.* 2007). In Winter time,

LB shows preference of habitats where predators are lacking as well as recent fallow (stubble) characterized by relatively sparse, short vegetation and avoiding disturbed areas (Silva *et al.* 2004).

During the non-breeding season, both males and females perform short distance dispersions between France and Spain and to some extent as far south as to northern Morocco, or migration to winter grounds especially through Turkey, Caucasus and Iran for the Russian and Central Asian populations (del Hoyo *et al.* 1996). The species is omnivorous and feeds on fruits, shoots and flowers, and terrestrial invertebrates (del Hoyo *et al.* 1996). According to Thévenot *et al.* (2003), LB preferred habitats in Morocco are plains and plateaus with steppe vegetation and *Ziziphus* scrub, fallow, cultivation of barely and areas of thin limestone soils covered of *Asphodelus*.

The objective of this paper, is to 1) shed light on a discovery of a relict population of one of the most threatened and rapidly declining species in Morocco, 3) identify local causes of bird extirpation and propose actions for the conservation of the population based on our results. We anticipate that the results of this investigation will serve as an invaluable basis for monitoring and conservation of the last LB breeding population not only in Morocco but also in the African continent.

Distribution data of Little Bustard in Morocco

The LB is considered as very scarce local resident and winter visitor in Morocco (Thévenot *et al.* 2003). It was once widespread, and common, but now breeds in very small numbers between Larach and Tangier (Palacio & Alonso 2009). However, the limits of its breeding range are not fully known. Breeding population is believed to be resident in the country assembling in small groups during the non-breeding season in favorable areas (Thévenot *et al.* 2003). Historically, big wintering flocks up to 1000 birds have been recorded in the lower Loukkos near Larach until mid-sixties (Naurois 1962).

Formerly LB was abundant in the northern part of Morocco from the Atlantic coastline of Mazagan-Tangier though Ma'mora forest and Middle-Atlas foothills to Eastern plateau up to Berkane in Mediteranean coasts (Heim de Balsac & Mayaud 1962, Thévenot *et al.* 2003, Cherkaoui *et al.* 2007, Palacin & Alonso 2009) (Fig.1). However, the last third of the twentieth century saw a drastic reduction in the range occupancy and population size of the LB in Morocco (Palacin & Alonso 2009) with only few sightings of the species. For instance, only two observations were reported to the Moroccan Rare bird Commission since its creation in 1995, but currently a small population survives between Larach and Tangier where its status is poorly known (Qninba *et al.* 2007, Palacin & Alonso 2009). Few birds (2–4) have recently been reported in Tangier peninsula (Cherkaoui, *Pers. Obs.*) during a Great Bustard (*Otis tarda*) survey where approximately 98% of the distribution range of LB occurs (Palacin & Alonso 2009). Nowadays, most known and occupied patches are small, isolated and not protected so that populations of this species are highly susceptible to local extinction (Palacin & Alonso 2009). Currently, the LB highly threatened population in Morocco is the sole African continent breeding population. In Algeria and Tunisia, LB was already extinct (Isenmann & Moali 2000, Isenmann *et al.* 2005). In Morocco, the pressure on the remaining breeding areas will only increase in the future, and thus the species will struggle for its survival (El Agbani *et al.* 2011)..

Study area

The Adarouch Ranch was created by the president of the American company King Ranch and the Moroccan state during the 1960s. It has since been privatized even though the land remains the property of the state. The Ranch has two activities: extensive cow-calf breeding of Santa gertrudis race and feedlot fattening. The Adarouch property is a fenced private pastureland that comprises ca.10,000 ha of open habitats identified as potentially suitable for grassland and extensive farmland birds such as Barbary Partridge *Alectoris barbara*, Eurasian Thick-knee *Burhinus oedicnemus*, Thekla Lark *Galerida theklae*, Greater Short-toed Lark *Calandrella brachydactyla* (*Obs. Pers.*).

The altitude ranges from 450m to 800m above sea level. Adarouch belong to the Central plateau hills which has a Medio-Mediterranean climate with four different seasons: winter, spring, summer and autumn. The months of December and January are cold and misty with recurrent frost while July and August are dry and very hot. The mean monthly minimum temperature varies from 0° to 10°C in winter, gradually rising to 17°C in the spring and 26°C in the summer. Over 90% (500-700mm) of the annual precipitation fall between November and March (El Ghachi & Morchid 2015). Mean maximum temperatures are 40-42°C in July August (El Ghachi & Morchid 2015).

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Adarouch plateau ecosystem supports a wide range of biodiversity which is nationally important. The climax vegetation type has Jujube shrubs *Ziziphus sp* as the dominant species in association with *Asphodelus sp*, *Crucifera sp*, *Chamaerops humilis*, *Genista quadriflora*, *Vitex agnus-castus*, *Myosotis debilis*, *Origanum compactum*, *Retama retam*, *Drimia maritima*. Other patchy habitat type occurs such as Mt. Atlas Mastic Tree *Pistacia atlantica* formations. The plateau contains also permanent agricultural plots, generally harvested and ploughed depending on the crop cycle, destined to cattle fodder production.

Material & Methods

Since that a displaying male was accidentally sighted on March 12, 2017, a survey was urgently launched which lasts four years with a focus on the breeding season (March-May) with two visits per month (Tab. 1).

The site of Adarouch area was visited since January 2016 to monitor farmland birds in general. After the extraordinary LB sighting in March 2017, fieldwork was conducted at least twice per week for 3 months (March, April and May); each year before the harvesting season, a period that encompasses all of the Little Bustard male sexual activity in the nearby Iberian Peninsula for instance (Morales *et al.* 2008). The survey was conducted from March 2017 to March 2020, covering a total area of approximatively ha 6000 within the Adarouch Ranch property. Searching for the birds was systematically pursued

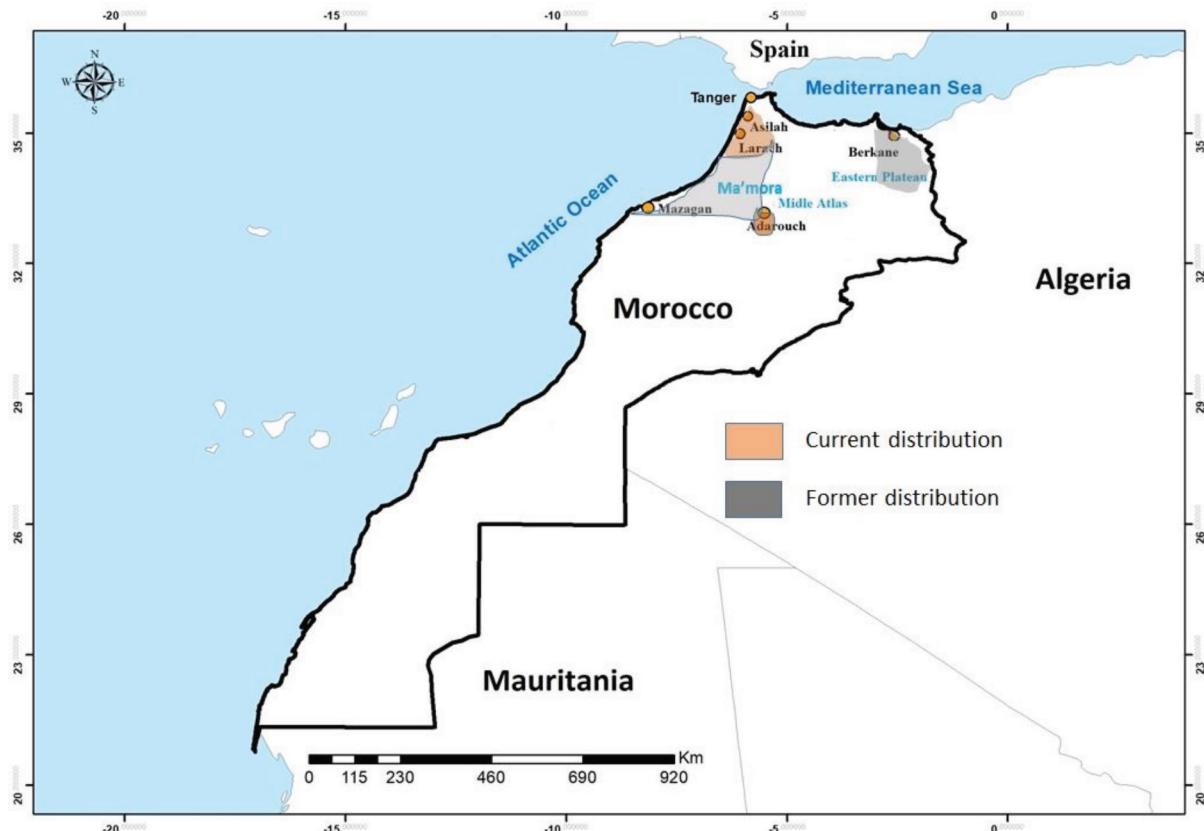
Figure 1. Little Bustard *Tetrax tetrax* distribution map in Morocco.

Table 1. Total sightings at the breeding seasons during the survey period.

Years\weeks	March (Week1 (Week2)	April (Week1 (Week2)	May (Week1 (Week2)
2017	(♀+1♂1) ♂+1♂1	(♀1) ♀+1♂1	(0) ♂ 1
2018	(♀+3♂2) ♀+2♂2	(♂1) (♀ 1	(♂1) ♂ 1
2019	(0) 0	(0) 0	(0) 0
2020	(0) 0		

from outside the fence before we got the permit to enter the property. Once the permit was issued on February 2019, LB search continued on foot and was carried out randomly inside the property afterwards. “Swarovski” scoping scope and “Opticron” binocular 10x30 were used during the survey.

Sightings and bird sexes per habitat type were noted as well as the distances from the nearest road and human settlements (Tab. 2); the habitat types of sighting points have been determined *in-situ* while their respective surfaces were estimated by using QGIS (QGIS version 2.10.1 (Tab. 2)). Males were mapped on an updated cartography of the location that shows the field composition. Also to maximize the chance of observation, two camera traps were set up at suitable places, emitting an infrared beam with a receiver at the other; the camera being triggered when the beam was broken.

As for the livestock (Ovin + Caprin) density data, they were obtained from an unpublished logbook which is not referenced and not publicly available. Moreover, a survey was conducted amongst the local population (laborers and villagers) to enquire about the occurrence of the LB in Adarouch both in

the past and in the present. In addition, a picture of LB in its real size and a video of the species were shown.

The so-called suitable habitats, assumed to be suitable for LB, encompasses 3 major types: Steppe of *Ziziphus* sp (SZ), *Crucifera* grassland (CG) and Fallow-land (FL). By using QGIS the surface of the three habitat assemblages was estimated during the four-year survey as well as the ploughed plots considered as unsuitable for LB (Traba & Moreles 2013). Trends in surface of the three habitats over the four-year survey were estimated using QGIS. One-way ANOVA was also performed to understand whether the surface of suitable habitats of LB had changed over the four successive years of the survey.

A total of 5 sampling points per plot (=habitat) (15 total) were marked at the intersections of a grid composed of squares of 40 m-length sides superimposed upon a map of the plot. For each plot, we calculated the average vegetation height for each year. Summary outputs comparing grazing effects were calculated for vegetation height using the function ‘relevel’ in package ‘nlme’.

Table 2. All the LB sightings per habitat type and distance to the main human infrastructures in Adarouch.

Sex of little bustard	Date	Type of Habitat	Distance to nearest road (km)	Distance to nearest human settlement (Km)
♂	12/03/2017	<i>Curcifera</i> Grassland	0,6	3,1
♂	12/03/2017	<i>Curcifera</i> Grassland	0,5	2,6
♂	20/03/2017	<i>Curcifera</i> Grassland	0,7	4,4
♀	20/03/2017	Steppe of <i>Ziziphussp</i>	0,8	2,8
♂	04/04/2017	<i>Curcifera</i> Grassland	0,7	5,0
♀	04/04/2017	Steppe of <i>Ziziphussp</i>	0,6	4,3
♀	14/04/2017	Fallow	0,5	1,7
♂	06/05/2017	Fallow	0,5	1,4
♂	02/03/2018	<i>Curcifera</i> Grassland	0,7	2,2
♂	02/03/2018	<i>Curcifera</i> Grassland	0,3	2,8
♀	02/03/2018	Steppe of <i>Ziziphussp</i>	0,4	3,2
♀	02/03/2018	Steppe of <i>Ziziphussp</i>	0,6	2,4
♂	13/03/2018	<i>Curcifera</i> Grassland	0,7	2,5
♂	13/03/2018	<i>Curcifera</i> Grassland	0,7	3,8
♀	13/03/2018	<i>Curcifera</i> Grassland	0,5	4,2
♀	13/03/2018	Steppe of <i>Ziziphussp</i>	0,7	2,9
♀	13/03/2018	Steppe of <i>Ziziphussp</i>	0,5	3,3
♀	02/04/2018	Fallow	0,4	1,9
♂	17/04/2018	Steppe of <i>Ziziphussp</i>	0,6	2,3
♂	05/05/2018	Steppe of <i>Ziziphussp</i>	0,5	4,7
♂	05/05/2018	Fallow	0,6	2,7

Results

Our survey confirmed the presence of LP in Adarouch ranch for the first time ever in this location with regular sightings between the first observation on March 2017 until May 2018 where up to 5 birds in total were sighted. However, not a single bird was found during spring surveys in 2019 and 2020, although the authorization from the Ranch Adarouch administration was released which allow to explore the habitat even better inside the fenced area but only 3 months a year.

These birds were using an area of suitable habitats of about ha 5.700 between Amghass village (33.392100, -5.552487) and “Domaine Adarouch” (33.502689, -5.484243). In a pastureland area dominated by a mosaic-like landscape composed of ZS, CG, FL and cultivated plots north of Amghas village, 60 km from Meknes, one male was displaying from 0.4 m tall grass at 10:35hrs was sighted. After 45 minutes another male bird was sighted from the grass cover. During breeding season, the male becomes territorial and performs a jumping aerial display in grassland habitats (Faria & Silva 2010). Because of far distance and in respect of the privacy of the property, proper photograph of the bird could not be obtained, but based on its size, flight pattern, and wing clapping noise we assumed it was a LB. It has been estimated that the two displaying males were 800 m far from each other. Nevertheless, no more observations were made, during the same week, as we were not allowed by the wardens

of Adarouch Ranch property to use optical materials. After returning to the same place a week later on March 20, 2017, another displaying male was sighted at 1,4 km southeast from the first male sighting. A female bird was spotted 100m away. The search has been resumed on April and May 2017 producing observation of one male and one female on April, 4; One female on April, 14 and only one male on May, 6. A year later, up to 5 birds were sighted in march 2018, 3 more than in March 2017, and 1 and 2 birds maximum respectively sighted on April 2018 and May 2018 (Tab. 1).

With regards to the baseline survey of the local population, the answers were frequently inconsistent with the survey, unreliable, or even misleading in other species. Out of the 65 people questioned, only seven knew LB in the local names “Hbara” or “Ra’ada”; six of them identified LB as Hbara while only one person recognized LB as “Ra’ada”. In Moroccan dialect “Ra’ada” means “vibrator – vibrating” which is the right local name for LB whereas “Hbara” is the name for Bustards in general. Therefore, such statements were cautiously accepted and only as an auxiliary source of information. Both results of sightings and interviews confirmed that the population of LB at Adarouch Ranch was extremely small, unknown and scarce.

Trends in each habitat type were assessed (Fig. 2) and total suitable habitat (SZ+CG+FL) trend was compared to the ploughed area over the 4 year-survey (Fig. 3). The Anova test (df 3, p < 0.05) shows the slight significant variation in

surface over the years (Tab. 3); total surface of suitable habitat showed marginally significant differences between years and was declining over four-year survey ($y = 1776x - 4E+06$; $R^2 = 0.8956$). Yet, the ploughed plots have been extended after the summer of 2018 ($y = -1570x + 3E+06$ $R^2 = 0.8462$). Moreover, the livestock densities have dramatically increased since autumn 2018 from approximately annual average of 0.2

Cattle/ha-1 to 26.4 cattle/ha-1 in late 2019. Significant effect of grazing ($F_{3,19}=33.573$, $P < 0.001$) and year ($F_{7, 152}=58.261$, $P < 0.001$) was found on mean vegetation height, with grass vegetation being heavily grazed. Similarly, significant effect of grazing ($F_{3,21}=11.896$, $P < 0.001$) and year ($F_{7, 157}=21.197$, $P < 0.001$) was found on vegetation height.

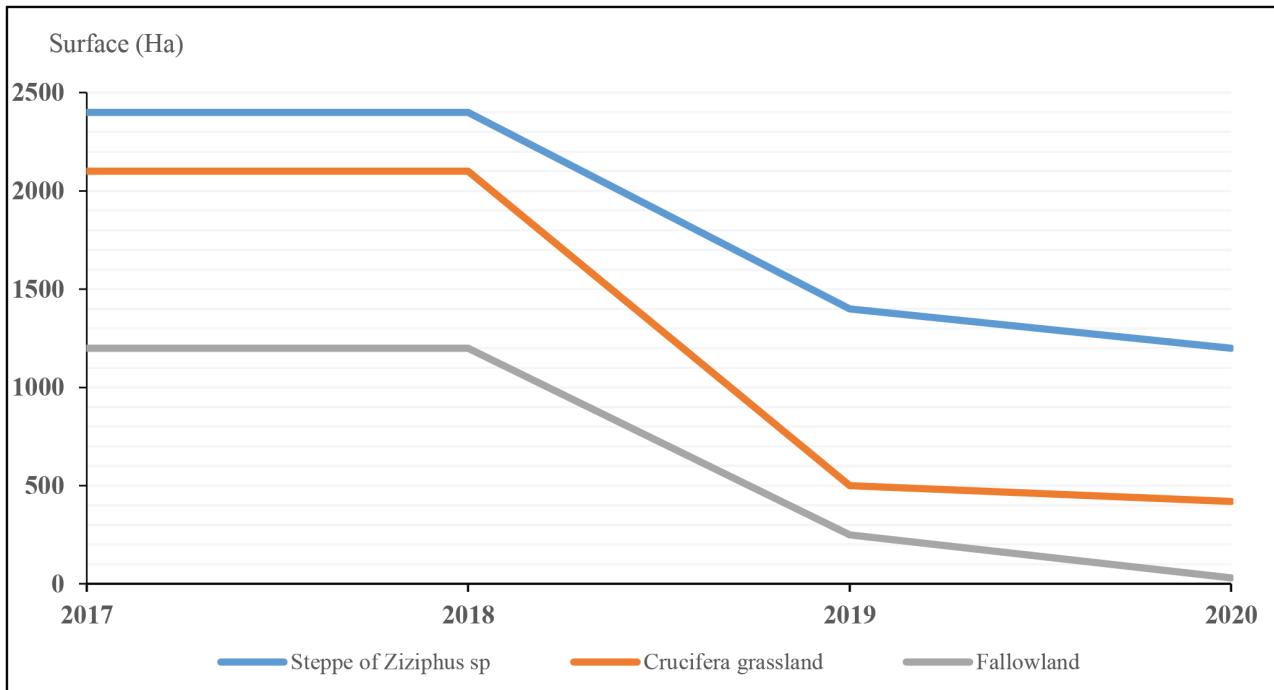


Figure 2 Trend of habitat types (SZ; CG; FL and PA) during the survey (2017-2020)

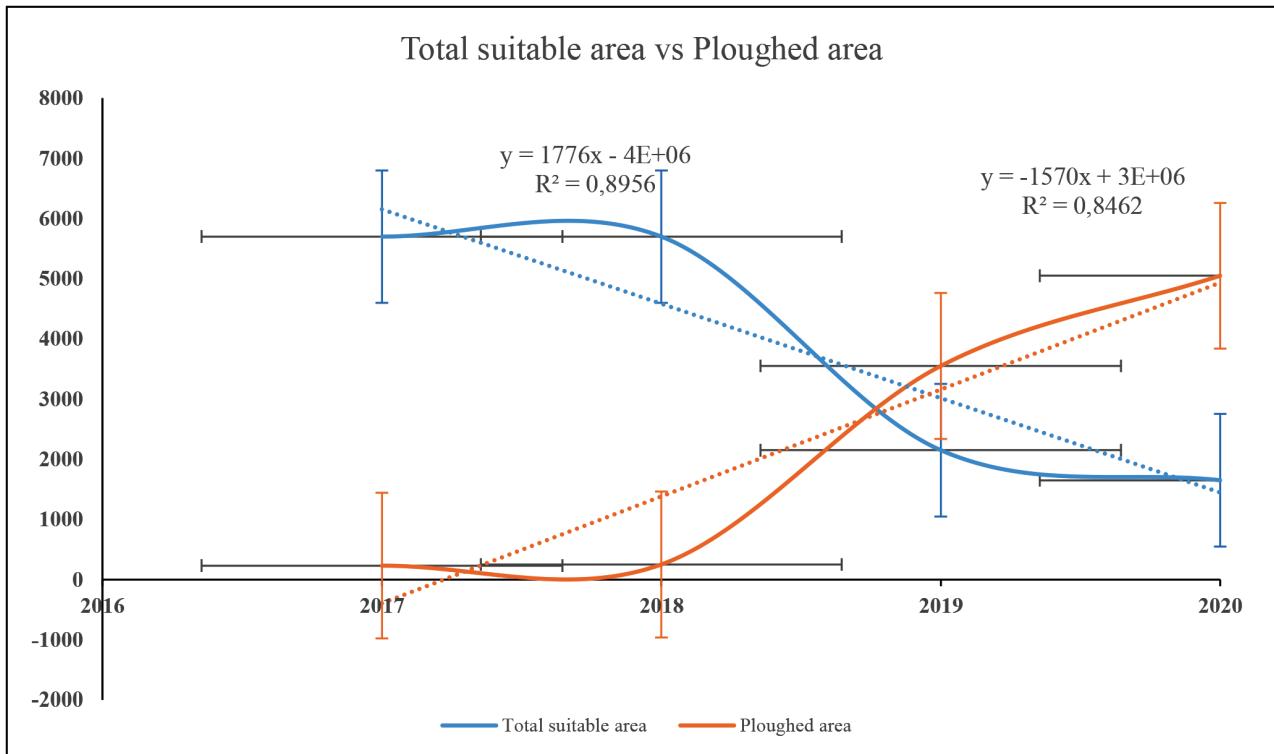


Figure 3. Trends in total suitable plots vs Ploughed plots at Adaouch during the survey (2017-2020).

Table 3. Test One-way Anova.

VARIANCE ANALYSIS

<i>Source des variations</i>	<i>SS</i>	<i>Df</i>	<i>Ms</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	4855000	3	1618333,33	4,31	0,04	4,07
A Within groups	3001466,67	8	375183,33			
Total	7856466,67	11				

Discussion

This work extends the actual known breeding range of LB in Morocco and confirms that LB was well established in Ranch Adarouch. However, this is likely not range expansion, but the result of an increasing birdwatching pressure that leads to discover a relic or an isolated breeding population of the species in Adarouch. This population could have, apparently, persisted in the area due not only to the extensive/traditional pastoral system, but also to the low densities of human settlements/activities because of private land status.

The population size in Adarouch was at least 5 individuals (Two males and 3 females), leading to an estimate that there were probably less than 10 birds in the entire area, although surveyed habitat could support few more birds. Only males were observed in May assuming that females were either incubating or rearing chicks. According to Heim de Balsac & Mayaud (1962) and Thévenot *et al.* (2003), LB breeds from March to June. In sum, males (n=13) were more frequently sighted than females (n=8) due to the male's courtship display rendering them fairly visible. Due to the scarce records in Morocco, it had not been thought that LB breed in a site where it had never been reported breeding before.

As LB is known to use a mosaic of grassland, and cropland in human dominated landscape, its breeding activity gets influenced by the grazing pattern of livestock, and quantity of food, during a given period (de Juana *et al.* 1993, Faria & Sylva 2010). For example, bustards usually avoid overgrazed areas, and are known to avoid human settlements and predators during their breeding seasons (Faria & Sylva 2010, Sylva *et al.* 2014). Adarouch landscape provide conductive habitat (grassland and fallow) and shelter for LB, support few human settlements (less than 1% of the total occupied area) and grazing activities (approximately 0,2 Cattle/ha-1 until late 2017) is extensive. These conditions have been probably responsible of maintaining LB in the ranch until recently.

Although the short-term effects of livestock grazing on individual species has been well studied globally (Evans *et al.* 2015), in Morocco few studies have tackled this issue (Bechchari *et al.* 2014). Recently, Adarouch Ranch habitats have deteriorated with associated declines in local grassland birds (*pers. obs.*). In fact, grazing by increased densities of associated ovine/caprine flocks has been implicated in these changes. Local communities from around the property, and due to the severe drought, were authorized to bring their cattle that came in large herds since summer 2018. Consequently, grasslands become highly disturbed and heavily grazed due to this unusual increase in farming activities and overgrazing. As ground-nesting birds, bustards are particularly sensitive to vegetation structure which is often manipulated by livestock grazing (García *et al.* 2007). Moreover, disturbance from shepherds, dogs, and cattle during the breeding season of 2019 and 2020 was, evidently, a serious threat for LB

leading undoubtedly to their rapid extirpation from Adarouch ecosystem.

These results show a local-wide relationship between the temporal trend in the amount of a suitable habitat type linked to extensive agriculture and the population trends of LB in Adarouch Ranch. LB extirpation happened when the change of suitable habitats decreases below -20% during the four-year survey and the total surface dramatically collapse and the ploughed area exceptionally increased. This is also consistent with other studies conducted in the Iberian Peninsula, where LB declines are especially pronounced when the yearly change of fallows falls below -20% and the values of the LB population, as well as Farmland bird indexes, dramatically collapse (Sanderson *et al.* 2013, Traba *et al.* 2013).

It is important to bear in mind, however, that this assessment considered only trends in the suitable surface over 4 years, but not for a longer period and does not include changes in land management food availability and other environmental parameters. Unfortunately, available official statistics in this regard are fragmentary and do not cover the entire period considered in our analysis, although they clearly indicate a trend to increasing field-level intensification.

The Adarouch LB population confirms that Human disturbance (shepherds, dogs), intensive agriculture and, livestock grazing pressure during the breeding season are by far, the most significant threats to the LB in Morocco. Considering the scale and rate of these changes there is an urgent need for more data on the ecology of the LB, namely on (1) the identification of specific habitat requirements, both in breeding and non-breeding seasons, (2) the assessment of land-use use patterns. Improving our understanding of the Bustard' ecosystem services could help conservation managers in promoting their protection locally.

Wildlife management consists of habitat evaluation, assessment, and periodic monitoring. Participation of the local public is essential for a conservation plan to work, and its outcome becomes sustainable. We need growth and development, but in a sustainable way, as we are dependent on nature in direct, or indirect ways. Below are some suggestions:

1. Development of alternative habitat: almost all the habitats suitable for bustards are generally privately held, and not controlled by the state forest department. According to current and future land-use scenarios, soon there will be no open land available in the entire LB's breeding range in Morocco (Larach - Tangier). Therefore, promoting fallows and extensive farming patches of a few thousand hectares in this area can help protect LB.

2. To encourage traditional agricultural practices under special schemes, if necessary, or explore the possibility of selling the bustard-friendly crop at higher prices, under the banner of bustard conservation.

3. Promotion of organic farming for the long term benefit to the bustard conservation programme. Rampant use of pesticides affects birds, and their food chain, directly, and indirectly. Therefore, it is essential to promote organic farming in bustard areas to reduce chemical contamination in their food chain.

CONCLUSION

In spite of all these measures, owing to the extinction-prone, k-selected nature of the species and threat intensive farming, LB is in urgent need for ex situ conservation and subsequent supplementation of existing small in situ populations. At Adarouch ecosystem, extensive farming of cattle and horses is being dominated by an increasing trend towards grazing and farming intensification, which implies increased use of vegetation cover and habitat heterogeneity loss. This rapid change in farming practices has generated drastic transformation in vegetation structure, permanent disturbance, and probably food shortage that explains, amongst other factors, the fast extirpation of this newly discovered population of little bustard.

Our study has shed light on the impact of unsustainable agriculture and grazing practices on specialist birds such as the Little Bustard and has brought lessons on how the management of the remaining suitable breeding areas should be. Therefore, the major challenge is to urgently implement conservation measures to preserve the very small population surviving in northern Morocco.

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