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SHORT COMMUNICATION

Wild boar (*Sus scrofa*) harvesting using the *espera* hunting method: side effects and management implications

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Abstract Harvesting of wildlife by man has been linked to demographic and evolutionary impacts in many populations. We investigated the sex ratio and age class structure in hunting bags of wild boar harvested by *espera*—nocturnal single hunt at bait—during four hunting seasons in Alentejo (Portugal). In addition, we assessed whether the hunting method is a significant predictor of the probability of harvesting an animal of a particular gender, of particular age class or of a particular combination of these two attributes. We found that the *espera* hunting method allows very selective harvesting regimes, and thus, it seems a highly effective population management tool. Removing a large proportion of adult males, however, may bias the population sex ratio towards females, reduce male life expectancy and raise the degree of polygyny. Our results suggest that recruitment rates are resilient to this skewed sex ratio, and possibly the higher proportion of females in the adult population may even increase productivity.

Keywords Selective harvesting · Population structure · Conservation · Alentejo (Portugal)

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Introduction

Modern sport hunting is often selective of sex or age, or of morphological characteristics, either for hunting regulation purposes or because of a hunter's preferences (Festa-Bianchet 2007). The common preference of hunters to shoot males with large horns, antlers or teeth ('trophy' males) is likely to lead to artificial selection in natural populations, also producing a bias in the sex ratio in favour of females and reducing the survival of elderly animals (Milner-Gulland et al. 2003; Torres-Porras et al. 2009).

In the Iberian Peninsula, population sex ratio and age composition were determined mainly through *montaria* game bag analysis. *Montaria* is a hunting method in which dog teams chase wild boar towards hunters waiting at fixed points; there is no limit to the number each hunter may shoot and they are allowed to shoot piglets, yearlings and adults of both sexes (Fernández-Llario et al. 2003), as in similar drive hunts conducted elsewhere in Europe

(Maillard and Fournier 1995; Monaco et al. 2003; Keuling et al. 2008a; Scillitani et al. 2009). *Montaria* hunting bag analysis has been considered a correct method to estimate sex ratio and age class distribution in wild boar populations (Fernández-Llario and Mateus-Quesada 1998; Massolo and Mazzoni della Stella 2006). In Alentejo County (Portugal), *montaria* hunting bag analysis showed that the majority of the harvested animals were aged <1 year and sex ratio favourable towards females (Santos 2002).

Espera hunting method involves the use of bait to attract wild boar to the shooting range of elevated hunting stands, and it is supposed to promote the selective targeting of specific animals according to a given management criterion. However, there is a need for studies in order to assess if targeting criteria have been taken into consideration or if, on the contrary, the hunting bag departs from selective criteria.

In this study, we analyse sex ratio and age class structure in wild boar *espera* hunting bags during four hunting seasons. Furthermore, we assess whether the hunting method (*montaria* versus *espera*) is a significant predictor of the probability of harvesting an animal of specific gender and age.

Materials and methods

Data collection

Data were collected in Alentejo (38°22′–38°35′ N, 7°35′–7° 43′ W), a Portuguese county belonging to the Mediterranean Ibero-Atlantic Province which comprises an area of 26,766 km^2 (see Fernández-Llario et al. 2003).

We gathered data all year round during four hunting seasons—2005/2006, 2006/2007, 2007/2008 and 2008/2009—on a 920-ha private hunting estate (not fenced) where *montaria* is only occasionally practised and *espera* is the main hunting method, representing more than 80% of the total hunting bag. Wild boar is the only big game species present in the area. The harvested wild boars were aged in the field according to coat colour patterns and to chronology of teeth eruption (Fonseca et al. 2004; Santos et al. 2006); three age classes were considered: piglets—under 12 months old; yearlings—between 12 and 24 months old; adults—older than 24 months.

Hunting by *espera* took place mainly from February to October, avoiding the hunting season of small game species, and promoted the targeting of trophy animals. In each hunting season, about 20 tonnes of wheat grain and 3 tonnes of almond nuts were used to attract wild boar to the shooting range of 15 elevated hunting stands, approximately two times more than the amount of bait provided in central Europe (Keuling et al. 2008b). Besides baiting, no supplementary food was supplied in order to improve carrying capacity. Baiting was done every day from the first quarter moon until full moon and on alternate days during the rest of the lunar cycle. Every month, about six of the stands were used by hunters over three nights, from sunset until approximately 4 h later. The hunting nights were distributed over a period of 10 days, starting on the eighth day before full moon and ending on the first day after the full moon. For each hunting night, the total number of wild boar observed by the hunters was recorded.

Data analysis

Data were analysed using the SPSS software (SPSS software version 16, SPSS, Chicago, IL, USA). We performed one-way between-groups ANOVAs, with post hoc tests, to find out whether the mean number of harvested wild boar per hunting night and the mean number of wild boar observed per hunting night differed among the four studied hunting seasons. To analyse the sex ratio in *espera* hunting bags, we made a binomial test determining whether the proportion of males was different from 0.5. Finally, to see if the sex ratio and age class proportion were related to the hunting season, we used the chi-square test and the Fisher's exact test (for independence of two categorical variables).

To assess whether the hunting method (*montaria* versus *espera*) is a significant predictor of the probability of harvesting a male, of harvesting an animal older than 1 year, of harvesting a male older than 1 year and of harvesting a male older than 2 years, we also used *montaria* unpublished data presented elsewhere (Santos 2002). These data concern 248 wild boars harvested during two hunting seasons in 20 different private estates ecologically similar to our study area. We used the SPSS software procedure called binary logistic to perform logistic regressions by the forward:LR method with the aforementioned dependent variables, separately. To evaluate the relative amount by which the odds of the outcome increase or decrease when the value of the predictor variable increases by 1 unit, i.e. the hunting method changes from *montaria* to *espera,* we used the odds ratio (exponential of the logistic coefficient *B*).

Results

During the four hunting seasons, 192 wild boars were harvested on 127 hunting nights (Table 1). Since about six stands were used on each hunting night, a total of approximately 762 *esperas* took place and near 0.25 wild boars were shoot per *espera*. The mean number of harvested wild boar per hunting night, as well as the mean number of observed wild boar per hunting night, varied

Table 1 Wild boar *espera* game bags during four hunting seasons in Alentejo (Portugal)

	Hunting seasons				
	2005/2006	2006/2007	2007/2008	2008/2009	Total
Number of hunting nights	35	31	24	37	127
Mean number of harvested wild boar per hunting night (standard variation)	2.00 (1.372)	0.81 (0.946)	1.46 (1.103)	1.73 (1.170)	1.53 (1.240)
Mean number of observed wild boar per hunting night (standard variation)	14.63 (11.847)	6.90 (7.884)	17.67 (14.547)	17.24 (13.162)	14.08 (12.607)
Number of wild boar harvested per 100 ha	7.60	2.83	3.70	6.74	20.87
Gender of harvested wild boar					
Male	40	19	19	34	112
Female	30	7	15	28	80
Total	70	26	34	62	192
Age of harvested wild boar					
Piglets		4		0	4
Yearlings		5		14	19
Adults		13		46	59
Total		22		60	82

significantly among the hunting seasons (ANOVA: F=6.234, p=001; ANOVA: F=5.283, p=0.002), reflecting hunting quota adaptation to population fluctuations.

In the hunting seasons of 2005/2006 and 2007/2008, lack of logistical support did not allow to correctly identify the age class of a significant number of harvested wild boar; thus, for age structure analysis, only the hunting seasons of 2006/2007 and 2008/2009 were taken into consideration. The harvested population is male-biased (binomial test, $p<0.001$) and largely composed of yearlings and adults (Table 1). The mean number of harvested and observed wild boar per night, as well as the proportion of animals older than 1 year (Fisher's exact test, p=0.004), increased from 2006/2007 to 2008/2009, without significant differences in sex ratio between these two hunting seasons (Pearson χ^2=2.762, p=0.430).

There were highly significant differences between *espera* (data from this study) and *montaria* (unpublished data collected by Santos 2002 in the same region) concerning sex ratio (Pearson χ^2=7.596, p=0.006) and age class distribution (Pearson χ^2=82.386, $p<0.001$). Furthermore, the graphical comparison of sex ratio and age structure between *espera* and *montaria* shows opposed harvesting selectivity (Fig. 1). In fact, contrary to what happens in *espera* hunting bags, in *montaria* hunting bags, the sex ratio is female-biased and the majority of the harvested animals are <1 year old.

The logistic regressions showed that the hunting method (*montaria* versus *espera*) significantly affects the probability of harvesting a male (χ^2_{Wald} (1) = 7.427, p=0.006), of harvesting an animal older than 1 year (χ^2_{Wald} (1) = 41.387, $p<0.001$), of harvesting a male older than 1 year (χ^2_{Wald} (1) = 68.030, $p<0.001$) and of harvesting a male older than 2 years (χ^2_{Wald} (1) = 72.413, $p<0.001$). When *espera* instead of *montaria* is the hunting method used, the odds of harvesting a male are 1.957 times higher, the odds of harvesting an animal older than 1 year are 28.743 times higher, the odds of harvesting a male older than 1 year

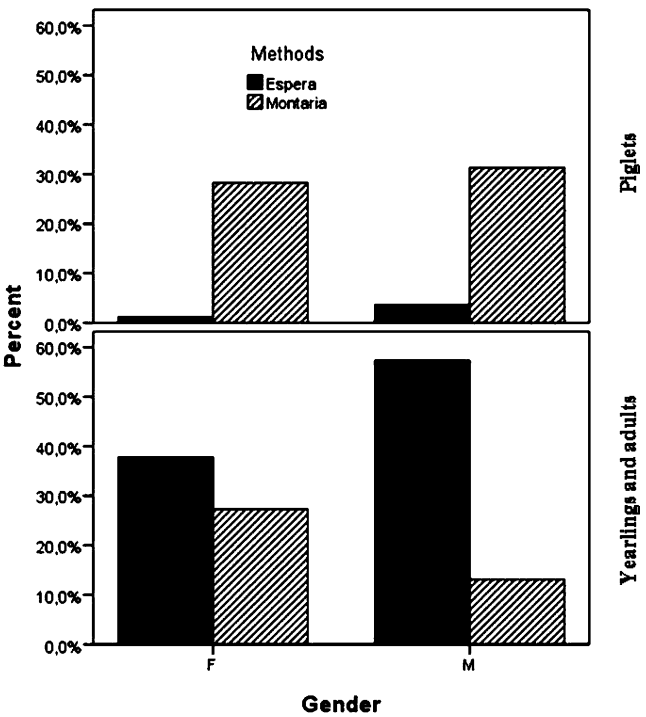

Fig. 1 Gender distribution (F female, M male) by age classes in *espera* (n=82) and in *montaria* (n=428) wild boar hunting bags in Alentejo (Portugal)

are 8.920 times higher, and the odds of harvesting a male older than 2 years are 8.336 times higher.

Discussion

Our results show that *espera* hunting bags, conversely to *montaria* hunting bags (Fernández-Llario and Mateus-Quesada 1998; Santos 2002), are male-biased and adult-biased and that the odds of harvesting an adult male are much higher. Our *espera* hunting bags also diverge from those obtained outside the Iberian Peninsula using hunting methods similar to *montaria* (Dzieciolowski and Clarke 1989; Ahmad et al. 1995; Boitani et al. 1995; Durio et al. 1995; Moretti 1995; Berger et al. 1998; Massolo and Mazzoni della Stella 2006).

Espera selectivity is clearly pointed out by the sharp difference between the mean number of wild boar observed per hunting night and the mean number of wild boar actually harvested per hunting night (Table 1). In addition, yearling and adult males represent almost 60% of the *espera* hunting bag (Fig. 1), a proportion that clearly departs from those observed in both natural and hunted wild boar populations in the Iberian Peninsula (Fernández-Llario 1996; Fernández-Llario and Mateus-Quesada 1998) and elsewhere in Europe (Moretti 1995; Berger et al. 1998; Massolo and Mazzoni della Stella 2006).

The studied hunting estates are not fenced, and thus, a comparison between *espera* and *montaria* harvesting per hectare may be misleading. However, *espera* seems to be a rather effective hunting method considering that only about four attempts were needed to shot a wild boar, considerably less than that in central Europe (Liebl et al. 2005; Keuling et al. 2008a). Despite this high efficacy, *espera* yields conservative results that allow wild boar renewal and its sustained use.

Espera hunting bags reveal that harvest criteria are usually observed, presumably because the hunters are able to carefully watch the target and have plenty of time to make the right decision before shooting. Conversely, in *montaria*, the harvest criteria may be difficult to observe, particularly when the targets are running through thick vegetation in hilly ground (Martínez et al. 2005). Allowing higher selectivity than *montaria*, *espera* seems to be more effective in terms of the population structure management, regardless of management goals.

The *espera* hunting method does not mimic the patterns of wild boar natural mortality since the large majority of animals (75–95%) eaten by wolves (*Canis lupus*) are non-adults (Jędrzejewski et al. 1992; Mattioli et al. 1995; Nores et al. 2008). Thus, according to Bischof et al. (2008), if the management goal is to minimise the demographic disturbance induced by artificial harvest, a neutral hunting method, such as *montaria*, should be recommended. On the other hand, if assuring prey availability to large carnivores, like wolf or Iberian lynx (*Lynx pardinus*), is a management goal, then *espera* seems a rather suitable hunting method.

In light of this study, *espera* is a hunting method that allows highly selective harvesting regimes, and thus, it seems a very effective tool for population structure regulation whatever the management goals may be. *Espera* may be suitable for both cropping large trophy males and removing numerous piglets and yearlings, as well as the best reproductive females, if the goal is agricultural damage prevention as it happens in many parts of Europe (see Schley et al. 2008).

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