

REPRODUCTION IN THE WILD BOAR (*Sus scrofa* LINNAEUS, 1758) POPULATIONS OF PORTUGAL

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ABSTRACT

The wild boar (*Sus scrofa* L., 1758) is a relatively new big game species in Portugal. Portuguese hunting legislation is based on those of other European countries and its application does not take into account regional and ecological variability. This study was conducted in three regions of Portugal: Trás-os-Montes (North), Beiras (Centre), and Alentejo (South). In two hunting seasons (1999/2000 and 2000/2001), we collected 374 females. The national average litter size was 4.17 ± 1.48 foetuses per female. There was a tendency for an increase in litter size from the north to the south of Portugal, and from younger to older females. More than 50% of the females hunted between October and February were in breeding condition (pregnant or lactating), with 69% in the south to 53% in the north. There was a vertical gradient in breeding and farrowing periods. The mating season in the southern (Alentejo) wild boar population appears to occur year-round. The birth periods are different in the north and in the centre of Portugal. The peak months for parturition are February-March (73% of births) in the center (Beiras) and March-April (89% of births) in the north (Trás-os-Montes). Based on our reproductive data for the entire country, we present several considerations and suggestions for wild boar hunting and management in Portugal.

Key words: management, population, Portugal, regions, reproductive phenology, *Sus scrofa*.

INTRODUCTION

By the end of the 1960s in Portugal, the wild boar was considered almost extinct, which was mainly due to African Swine Fever and over hunting (Bugalho et al. 1984). In the decades that followed, however, wild boar populations increased gradually throughout the country. Today, the wild boar is very common and widespread, and is the most important big game species in Portugal.

Official statistics show that the number of animals harvested annually have increased from 423 in 1989/1990 to approximately 8,254 individuals in 2000/2001

(Lopes and Borges 2004), which suggests that the populations of wild boar are growing and probably are expanding their distribution throughout the country (Morais 1979, Seródio 1985, Santos 1994, Fonseca 1999). Nevertheless, to understand the biology of wild boar in Portuguese populations, more specific studies are required.

Reproductive parameters are one of the most important aspects in the management of wildlife populations. The high reproductive capacity of the wild boar is based on the early age of the first pregnancy, the relatively short gestation period, and the high number of piglets per litter (Gerard et al. 1991, Rosell et al. 2001). Previous studies (Kanzaki 1991, Ahmad et al. 1995) showed that ovarian activity occurs between 6 and 10 months of age; however, a minimum body weight, more than age, is required for the onset of puberty (Aumaitre et al. 1982, Mauget and Pepin 1991, Rosell 1998, Fonseca et al. 2001). Several studies in Spain and France (Vericad 1983 and Mauget 1972) reported an average gestation period of 120 d. In addition, the number of foetuses per wild boar varies across a gradient among European countries, which ranges from an average of 4 foetuses/litter in the south (Sáez-Royuela and Telleria 1987, Fernández-Llario and Mateos-Quesada 1998, Rosell 1998, Fonseca et al. 2001) to an average of 5 foetuses/litter in Central and Eastern Europe (Briedermann 1971, Martys 1982, Dzieciolowski 1991).

Other factors, such as photoperiodism (Mauget et al. 1984), female physical condition (Sáez-Royuela 1987), food availability (Aumaitre et al. 1982), density of the population, and the role of the female group (Delcroix et al. 1990) are commonly identified being key in the reproductive biology of the wild boar.

An adequate wildlife sustainable management requires an understanding of the species' reproductive performance so that human activities, such as forestry, agriculture, hunting, are conveniently exploited and carried on. In fact, the evaluation of conception and birth date, litter size and the age of reproductive female wild boars, contributes to the planning of a wise and suitable hunting season. In Portugal, the wild boar main hunting activities are “Esperas ao luar” - a moonlight «waiting hunt» from a high seat or «hide» at ground level – and “Montarias” - a driven hunt with dogs -, which occurs in many other European countries. The former is a more selective process and is permitted during the full moon night period throughout the year, while the latter is more popular and occurs from October until the end of February, although most intensively in January and February. Nevertheless, the reproductive period of the wild boar overlaps the main hunting period, which causes some management problems and ethical questions.

Portuguese hunting legislation is based on those of other European countries and its application does not take into account regional and ecological variability. As a contribution to the development of suitable hunting plans that take into account

regional game management objectives, wild boar populations were monitored during two hunting seasons (1999/2000 and 2000/2001) in the north, central and south regions of Portugal.

The aims of this study were to obtain data on some wild boar reproductive parameters throughout Portugal, identify regional differences, and to show how this information can be applied in the sustainable management of wild boar populations.

STUDY AREA

This study was conducted during the 1999/2000 and 2000/2001 hunting seasons in three regions of Portugal: north, central and south, covering all of the Portuguese Continental Territory (Figure 1). We surveyed 37 councils that comprise 20,565 km², all of which are included in the Mediterranean Ibero Atlantic Province (Rivas-Martínez and Loidi 1999).

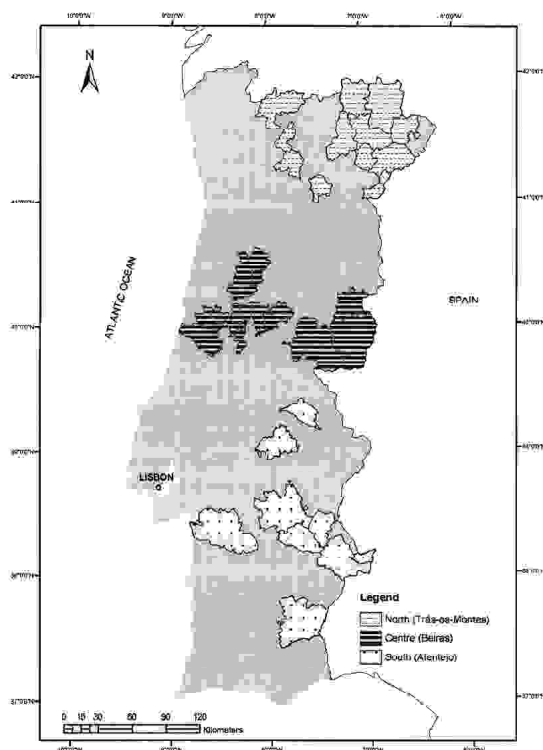


Figure 1. Map of Portuguese councils sampled in this study.

Trás-os-Montes, the north region (40°55' - 42°00'N and 6°12' - 7°55'W, Portugal) has a total area of 12,864 km². The mean annual temperature is 13.1° C. The average annual temperature is 3.8° C minimum and 21.4° C maximum. The area has an average annual rainfall that ranges from 361 to 2,012 mm. The landscape is very heterogeneous with sharp contrasts in geomorphology, climate, and vegetation. The traditional land use is diversified, including forestry and agriculture in a familiar exploitation regime, and rangeland. The forests are characterised by species such as oak *Quercus pyrenaica*, maritime pine *Pinus pinaster*, chestnut *Castanea sativa* and, to a lesser extent, holm oak *Quercus rotundifolia* and cork oak *Quercus suber*. Riparian galleries are dominated by alder *Alnus glutinosa* and other species such as *Fraxinus* sp. and *Salix* sp. The more common shrubs associations are *Genistello tridentatae-Ericetum aragonesis*, *Genisto falcatae-Ericetum arborea*, *Cytiso scoparii-Genistetum polygaliphyllae*, *Cytiso striati-Genistetum polygaliphylla*, *Lavandulo sampaionae-Cytisetum multiflori* and *Erico scopariae-Arbutetum unedonis*.

Beiras, located in the center of Portugal, lies between the Douro and Tejo rivers. It covers an area of 28,202 km², which is divided into two administrative sub-regions: Beira Interior and Beira Litoral. Beira Interior is situated inland, on the east side of the country near the Portuguese-Spanish border, and it is characterised as a mountainous region (maximum Portuguese elevation 1,993 m) with typical vast rangelands in the foothills. Mean annual temperatures (7.8° C minimum and 16.7° C maximum) are lower than in Beira Litoral, and the average annual rainfall is about 1138 mm. Forests are composed mostly of cork oak *Quercus suber* and holm oak *Quercus rotundifolia*. Dominant shrubs associations are *Genisto hirsutae-Cistetum ladaniferi* and *Scillo-Lavanduletum sampaioanae*. Beira Litoral is adjacent to the Atlantic coast. Human densities are higher than in Beira Interior, and agricultural land constitutes only 19.4% of the total sub-regional area. Production on small-sized farms includes mainly maize *Zea mays*, rye *Secale cereale*, potato *Solanum tuberosum* and horticultures. Grazing livestock are much less important to the local economy than in Beira Interior. Forest covers more than 40.6% of the sub-region and the main trees are *Pinus pinaster*, *Pinus pinea*, *Quercus robur*, *Q. faginea*, *Acacia* sp. and *Eucalyptus* sp.

The south region of Portugal, Alentejo (38° 22' - 38° 35' N; 7° 35' - 7° 43' W), comprises an area of 26,766 km² and the elevation ranges from sea level to 600-1000 m. The annual rainfall ranges from 600-700 mm at the coast to 400-500 mm inland, increasing to about 200-300 mm in hilly areas. The range of annual mean temperatures is from 15 °C to 17 °C, with higher thermal variations inland. Generally, near the surveyed zones fairly intensive agricultural systems dominate the landscape. The main crops are oats *Avena sativa* and wheat *Triticum* sp. in autumn and winter, and

sunflower *Helianthus annuus* and maize *Zea mays* in spring and summer. The remains of the former natural forest cover the hilly areas. Under scattered trees, mainly holm-oak *Quercus rotundifolia* and cork oak *Quercus suber*, some cereals and pasture are grown. In the more rugged hilly grounds, a dense bush emerges, providing quality cover for the wild boar. In some mountain areas, a few relics of mature stages of climatophilus vegetation are present.

Generally, a climatic, agricultural, and forestry vertical gradient characterizes the Portuguese territory, with a wet and green north region with abundant, small agriculture fields and mainly pine forest, a mountainous central region with larger crop fields in the west and east, common pine tree, *Quercus* forests and a temperate climate, and the south, a typical Mediterranean region, covered by large *Quercus* forests and agriculture fields with a warmer climate, particularly in summer.

MATERIALS AND METHODS

Wild boars were collected during the wild boar hunting process called “Montarias,” reflecting the situation of the species’ reproductive biology between the months of October to February, both inclusive.

All of harvested females (Table 1) were aged in the field based on coat colour and tooth eruption patterns and wear (ONC 1995, Fernández-Llario et al. 1996). Three age classes were considered: piglets - females under 12 months old; yearlings-females between 12 and 24 months old; adults - females over 24 months old. The following data were recorded from the females: date of death, reproductive status (breeding – pregnant or lactating - or not breeding). The reproductive tracts (uterus and ovaries) were removed during field necropsy and preserved by freezing (- 20° C). The embryos or foetuses in the uteri of pregnant females were counted, sexed, and weighed.

TABLE 1
Number of analysed females and foetuses.

	Trás-os-Montes		Beiras		Alentejo	
	Females	Foetuses	Females	Foetuses	Females	Foetuses
1999/2000	51	135	39	95	117	362
2000/2001	53	79	40	104	74	171
Total	104	214	79	199	191	533

Using a gestation period of 120 days (Mauget 1972 and Vericad 1983), the age of the foetuses (T) in days was determined using the Vericad (1983) formula:

$$T = \frac{Ps^{1/3} + 2.3377}{0.097}$$

established in the wild boar according to Hugget and Widdas (1951), where Ps is the foetus' average fresh weight (g) of the litter.

Using the date of death and the estimated age of the foetuses, the conception and birth dates of each litter were determined and presented in fortnight periods.

RESULTS

Breeding status

Of the 374 females examined, 135 (36.1%) were not reproductive and 239 (63.9%) were in reproductive condition. Of the latter, 228 were pregnant and 11 were lactating. In the north of Portugal, 53% of the females were in reproductive condition, while about 67% and 69% of the females in the centre and south, respectively, were either pregnant or lactating.

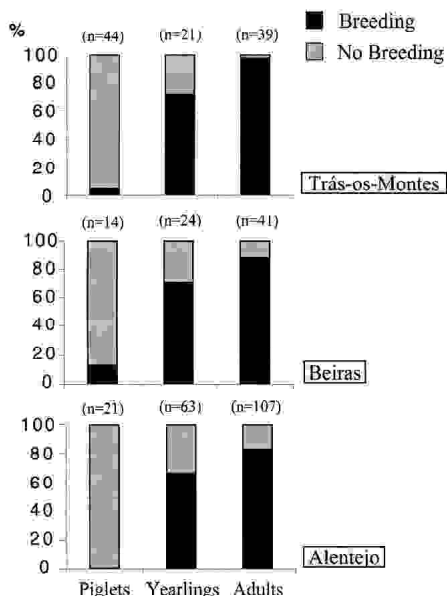


Figure 2. Relationship between female age classes and breeding condition in the three Portuguese studied regions.

The proportion of breeding females was smaller among piglet females and higher among older females (yearlings and adults) in all of the Portuguese regions (Figure 2). In Trás-os Montes, 5% of the females less than 12 months were pregnant, but 71% and 97% of yearlings and adults, respectively, were pregnant. In Beiras, 14% of piglets, 63% of yearlings, and 88% of adult females were in reproductive condition. In the south of Portugal – Alentejo – no pregnant piglets were found, while 67% of yearlings and 83% of females above 24 months were pregnant. Our

sample included four piglets in reproductive condition. From those, the minimum body weigh of 33 Kg was observed in the central part of Portugal.

Litter size

The average number of foetuses per litter was $4.17 (\pm 1.48 \text{ SD})$. There was a trend for litter size to increase from the north ($\bar{x} = 3.96$) to the south of Portugal ($\bar{x} = 4.37$). There were differences in the average litter size between the two hunting seasons (Two-Way ANOVA, $F_{1, 229} = 3.24, p > 0.05$) and among the three regions (Two-Way ANOVA, $F_{2, 229} = 2.32, p > 0.05$). The size of the litter comprised 1-6 foetuses in the north, 1-8 foetuses in the centre, and 1-9 foetuses in the south (Figure 3) of the country.

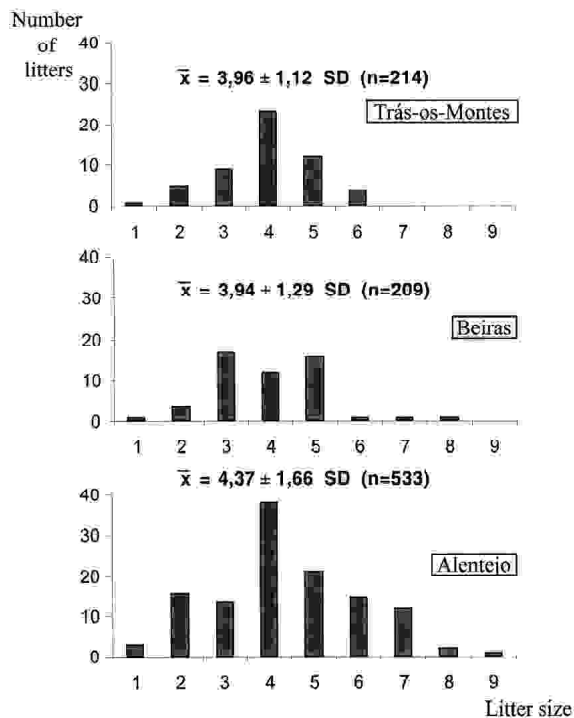


Figure 3. Litter sizes of Portuguese wild boar populations.

Significant differences were found among the three age classes (Two-Way ANOVA, $F_{2, 229} = 11.17, p < 0.05$). Younger females had a lower average litter size ($\bar{x} = 3.17 \pm 0.75 \text{ SD}$) compared to yearling ($\bar{x} = 3.57 \pm 1.25 \text{ SD}$) and adult ($\bar{x} = 4.47 \pm 1.50 \text{ SD}$) females.

Conception and Birth dates

Regarding the phenology of reproduction during the two hunting seasons, there was a tendency for the conception and birth distribution patterns to be same in both hunting seasons, and that pattern was apparent in the three study areas (Figure 4).

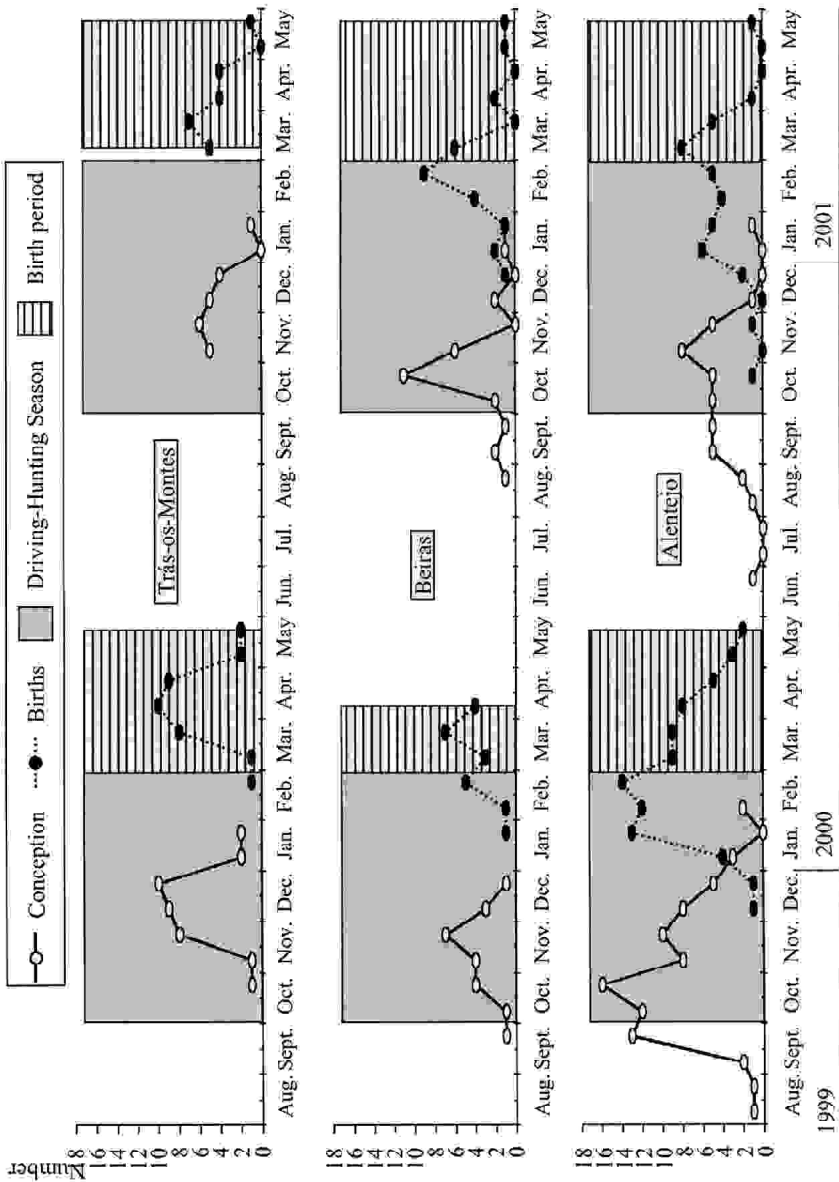


Figure 4. Wild Boar Females' reproductive phenology in Portugal during the hunting seasons 1999/2000 and 2000/2001.

In Alentejo, although there was a limited and relatively small sampling period (October to February), it is difficult to identify a distinct peak in conceptions and births, which suggests a protracted reproductive period throughout the year. The maximum of number of conceptions and births did occur, however, in the September-November and January-March periods, respectively. In Beiras, 73% of the conceptions and births occurred in October/November and in February/March, respectively, while in Trás-os-Montes the peak rut period occurred in November/December and, 120 days later (March/April) 89% of the births occurred. In south and central Portugal, half of the wild boar births overlapped the main -hunting season, which occurs between October and February.

DISCUSSION

As in other European wild boar populations, those in Portugal show older females (above 12 months) have highest breeding percentages when compared with other age classes (Figure 2). Resources available for reproduction increase with the weigh and physical condition increment and consequently with age (Fernández-Llario and Mateos-Quesada 1998). For instance, yearlings and mainly adult females that reach maturity use the available food resources primarily for reproduction, whereas piglets use the same resources for growth. The observed pregnant female minimum body weigh of 33 kg falls within the values reported elsewhere (Mauget and Pepin 1991, Rosell 1998, Fonseca et al. 2001) for female weight at first breeding.

The average litter size of 4.17 foetuses per female reflects the relatively low reproductive capacity of the Portuguese wild boar populations when compared with other Central and Northern European wild boar populations. Dardaillon (1988) and Aumaitre et al. (1982) obtained mean litter sizes of 4.44 and 4.75, respectively, in French wild boar populations, whereas in Germany, Briedermann (1971) found an average litter size of 5.0, 5.2 for Poland (Dzieciolowski 1991) and 5.8 piglets per litter in Austria (Martys 1982). Those data contrast with the litter size in Spanish wild boar populations, which is similar to the value found in our study, which emphasizes the similarities among wild boar populations in the Iberian Peninsula. In fact, in northern Spain, the wild boar populations showed an average litter size of 4.3 (Sáez-Royuela and Telleria 1987), in Catalonia it was 3.6 and 4.06 (Rosell 1998), in the southeast Spain it was 4.1 (Abaigar 1992), and in central Spanish is was 3.58 (Fernández-Llario and Mateos-Quesada 1998).

Our study illustrates the smaller litter sizes observed in Iberian wild boar populations (ranging from 3.6 to 4.3) in contrast with the Central and Northern European wild boar populations where average litter sizes range from 4.4 to 5.8.

The Portuguese regional litter size average increases from the north to the south (Figure 3). The higher number of foetuses/litter obtained in Alentejo indicates that the southern wild boar population comprises a high number of older females than in the northern population. Furthermore, natural food availability is higher in the south and supplemental feeding is a common management practice.

The sampled wild boar populations' reproductive capacity increases from piglet to adult females age class in all three of the regions we studied. Consequently, the percentage of older females in the population, usually animals in good physical condition and high weight gain, has a great importance in the populations overall production, as described by Sáez-Royuela (1987) in Spain, Gerard et al. (1991) in France and Boitani et al. (1995) in Italy.

Portuguese wild boar exhibited seasonal breeding patterns, more pronounced above Tejo River (Figure 4). Therefore, in north and central Portugal, it is possible to distinguish a fall/winter period of conception and a spring period of birth directly related to the strong climatic and food availability seasonality observed in these regions. Those patterns are similar to those reported by other in central Spain (Sáez-Royuela and Telleria 1987) and in Tuscany, Italy (Boitani et al. 1995). In Alentejo, the length of the main breeding period might be a result of prolonged period of high food abundance and availability length of time comprised between late autumn and late winter. In addition, the presence of lactating females in the November/December hunting bags, coupled with the occurrence of births in early winter, suggests the occurrence of some births in the summer (August/September). South Portugal, similarly to what has been observed for the West region of France (Mauget 1972) and North-western Italy (Durio et al. 1995). The Alentejo's food availability verified all the year round (oats and wheat in the spring and summer, sunflower and maize in the summer and fall and mast in the fall and winter) would be the most probable reason for such conception and birth distribution patterns.

During the two studied hunting seasons, the birth period in Beiras and Alentejo shows a considerable overlap with the "Montarias", the main wild boar National hunting season as regulated by the Portuguese hunting law. Hence, this shows that the Portuguese law is not adequately designed for an adequate sustainable management of the wild boar population. Data on wild boar reproductive phenology suggest the adoption of some measures at a regional level, according to the game management conservation principles, namely the avoidance of hunting when the population comprises a high number of piglets. Thus, in Northern Portugal the obtained data does not support a change in the hunting period. By contrast, in the Centre of the country the overlapping of "Montarias" with the period of birth in February justify the exclusion of the above hunting process during this month. The particular Alentejo

situation in the national level both in terms of wild boar reproductive biology, with an extended reproductive period along the year, and in terms of hunting organization emphasizes the manager role in each hunting management geographical unit.

To conclude, the data presented here shows that the hunting season should not be settled in an administrative model but ought to agree with the different regional reproductive wild boar phenology, which can be different in each year. Game managers should improve the knowledge of wild boar populations, to which this study gives a contribution. Hence, a sustainable hunting management of the Portuguese wild boar populations should take into account annually environmental factors and the differences in the life history strategies of the populations according to their location.

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