

ACTIVITY PATTERNS AND SOCIAL ORGANIZATION OF WILD BOAR (*Sus scrofa*, L.) IN A WETLAND ENVIRONMENT: PRELIMINARY DATA ON THE EFFECTS OF SHOOTING INDIVIDUALS

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ABSTRACT

The expansion of European wild boar populations has produced an increase in the pressure of this species on Mediterranean marshlands. Aiguamolls de l'Empordà Natural Park in Spain is a protected area with close to 850 ha of Integral Reserves where all human activities, including hunting, are forbidden. Since the beginning of the 1990's, the wild boar was only an occasional visitor to the reserves, but in the last few years, this ungulate has become a permanent resident, and a high concentration of individuals in the area has led to the application of population control. Direct observations in the afternoon and at night (with the aid of photon intensifiers) from the periphery of the reserves have allowed the characterisation of 77 wild boar groups and their activity patterns. Most of the animals (70% in spring and 74% in summer) leave the reserves at the beginning of their daily active period, but in autumn and winter, the proportion of the animals that remain inside the reserves increases. The maximum numbers of wild boar inside the reserves occur in autumn, which coincides with the rut, the beginning of the hunting season, and the period when crops are not available in the areas surrounding the reserves. Mean group size was 4.4. The composition of the groups varies seasonally, which is influenced partly by biological events, but also by other factors, such as the removal of some individuals from the population.

Key words: Habitat use, management, population control, social organisation, *Sus scrofa*, wetland.

INTRODUCTION

Wetlands provide high quality habitats for wild boar populations because they provide shelter and a wide variety of food resources (Garzón 1984, Dardaillon 1984a, 1987, Massei et al. 1996). Currently, most of the coastal marshes around the Mediterranean are protected areas in which human activities are restricted and a high diversity of endangered species is concentrated. The increase in wild boar densities

in those areas generates management problems because of the damage caused to crops located around the wetlands, and the possibility of direct negative effects on the biodiversity of the areas caused by the consumption of amphibians, birds, rare plants, etc. by wild boar. Hunting is often forbidden in those very ecologically sensitive areas and, for this reason, management teams must reduce population densities using traps to capture individuals or by shooting some individuals (Hone 1983, Saunders 1993, Debernardi et al. 1995, Dexter 1996). Presently, those types of control programs are used in several Mediterranean coastal areas, and the effects of those measures on wild boar populations are not well known. Although the social organisation and habitat use of wild boar populations in the marshes of Doñana National Park in Spain (Venero 1983, Cuartas 1988, Braza and Álvarez 1989, Fernández-Llario et al. 1996) and the Camargue in France (Dardaillon 1984b) has been studied, only one study showed that the mortality of adult females influences the social organisation of a wild boar population (Janeau et al. 1988).

In Aiguamolls de l'Empordà Natural Park, Spain, before 1990, the wild boar was an occasional visitor, but in the last few years, this ungulate has become a permanent resident. Since 1998, a high concentration of wild boars in the reserves during some periods has made it necessary to apply a population control program by shooting animals and, occasionally, by trapping. The cull is selective and the priority is female group leaders, although other animals in the groups and solitary males are captured.

The ultimate goal of our study is to provide basic information for population management assessments. Some of the questions to be addressed include: Is the primary value of the wetlands to wild boars as a source of safe haven rest sites or food?, Is there seasonal variation in wild boar activity patterns in the wetland?, Is there any seasonal variation in population densities inside the natural reserves?, and What are the effects of shooting individuals?

Within that framework, this paper presents preliminary data on seasonal variation in the use of natural reserves and the social organisation of wild boar populations in wetlands and the potential effects of the removal of adult females on the social organisation of the groups. Note that the population in the park has been monitored since 1999, and the analysis of the 5-year data set to determine the effects of various factors, such as density and reproductive parameters, is in preparation.

STUDY AREA

The study site is located in the Aiguamolls de l'Empordà Natural Park, Spain, a 4.824 ha coastal Mediterranean marshland that is part of the Natura 2000 network and is a UN Ramsar Site. The area is divided into two polygons caused by extended

urbanisation (see Figure 1) and surrounded by a densely populated tourist area, the Gulf of Roses. The area is located between two rivers, the Fluvià and the Muga, and it includes three Integral Reserves. The two largest reserves, where the study was focused, are 321 and 523 ha in size.

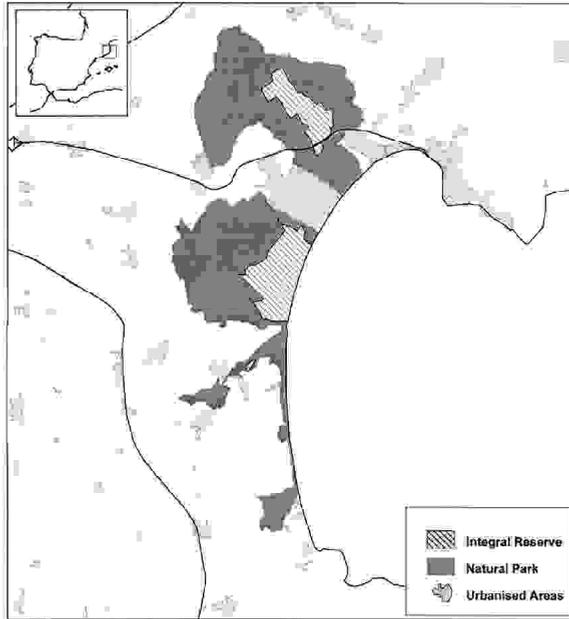


Figure 1. Location of the study area in the Mediterranean coastal area of the Gulf of Roses (Girona, northeastern Iberian Peninsula).

The area of the park is only slightly elevated above sea level, and the plain is formed by Quaternary sediments that are the result of the interaction of the sediments brought by the two rivers and the dynamics of the sea. The development of this deltaic system is responsible for the marsh's existence. The area has a typically Mediterranean climate, with an average annual precipitation of 600 mm, and a mean annual temperature of 15 °C. The area experiences periods of strong winds from the north, which occasionally exceed 100 km/h.

The wetland ecosystem contains a wide diversity of habitats including beaches with sand dunes, salt marshes, brackish and salt water coastal lagoons, permanent and temporal rivers and streams, temporal freshwater lagoons, salt and brackish marshes with permanent and seasonal water, and flooded meadows. The majority of those habitats are within Integral Reserves, although flooded meadows are also found elsewhere in the park.

The cultivated fields surrounding the reserves account for the majority of the land in the area, which is characterised by elevated soil fertility. In that aspect, it is noteworthy that rice fields, that occupies small surface in this wetland, are important habitat for waterfowl. In addition, apple trees, sunflower, maize, and other cereals are the dominant crops grown in the area.

The area has a high diversity of vertebrates, especially protected bird species, amphibians, and mammals, such as polecat *Mustela putorius* and otter *Lutra lutra*. A population of fallow deer *Dama dama* was introduced in 1991 and now is estimated to have close to 140 individuals.

MATERIAL AND METHODS

The characterisation of wild boar groups and their activities were determined in two natural reserves using direct observations in the afternoon and at night (with the aid of photon intensifiers). The observation sites were on the periphery of the reserves and, together with the location of wild boar groups, was recorded using GIS.

This paper is based on observations that occurred on 77 days from October 1998 to August 2002, and were made in the period that animals were shot for the purpose of reducing their density in the reserves. The rangers received training and collaborated in the gathering of data. Most (75%) of the observations were made between 1800 h and 2300 h (range = 1600 h - to 0200 h. Although the number of observation days in spring was less than at other times, the duration of the observations did not differ significantly between seasons (Scheffe Test).

Data of group size and composition were obtained from wild boar groups in which one or more individuals were shot and, in each case, the observation time, group size, characteristics of the animals (sex and age class), typology of the group, and the main activity pattern were recorded. In addition, we recorded the total number of individuals (not only the group shoot) observed in each observation period. We identified five types of groups: solitary males, mixed groups composed of adult males, females, and subadults, family groups composed of females and subadults (piglets or yearlings), groups composed of subadults, and a fifth category of others. Also, four types of main activities were identified: entering a reserve, leaving a reserve, moving within a reserve, and feeding within a reserve.

A total of 395 individuals were observed. We documented the activity patterns of 79 groups and the size and composition of 77 groups containing 336 individuals. Of the 395 individuals observed, 100 were captured, and most of them were examined, identified by sex and age, and measured for biometrical data. Stomach contents (to assess the annual variation in diet) and reproductive tracts (to determine fertility, litter size, and rut and birth periods) were collected, and will be analysed as part of

the broader study of this population.

The ANOVA test was used to compare the number and duration of observations between seasons. Non-parametric tests were used when the distribution of values of the variables deviated from normality; specifically, group size (Kruskal-Wallis test), and the number of individuals captured (Shapiro-Wilk's W test).

RESULTS

In 77 days of observations we observed 395 individuals (Table 1). The number of individuals observed in the reserves was highest in autumn (mean = 6.33), and up to 21 individuals were observed in a single day. The number of individuals observed did not differ significantly among the four periods (Kruskal-Wallis test: $H_{3,77} = 2.02$; $p = 0.568$).

TABLE 1
Seasonal variation in the range and mean number of individuals per day recorded in the Integral Reserves of the Aiguamolls de l'Empordà Natural Park, Spain (N=Days of observation; Mean: mean number of individual observed; SE, standard error).

	N	Mean \pm SE	Range
Winter (Jan-Mar)	24	4.67 \pm 0.67	1 – 12
Spring (Apr-Jun)	10	4.70 \pm 1.31	1 – 14
Summer (Jul-Sep)	19	4.42 \pm 0.86	1 – 13
Autumn (Oct-Dec)	24	6.33 \pm 1.04	1 – 21
	77	5.13 \pm 0.47	1 – 21

The activity patterns of the 79 groups show that the majority of the groups leave reserves in the first hours of their active period (Table 2). In spring and summer, about 70% of the individuals leave the reserves, but the numbers decrease in autumn and winter, when 66.7% and 54.2% of the wild boars, respectively, remain inside the reserves. In autumn, about 29% of the individuals were observed feeding inside the reserves, but at other times of the year, it is a minor activity and does not occur at all in summer.

Mean group size did not differ significantly among the four seasons (Kruskal-Wallis test: $H_{3,77} = 1.75$; $p = 0.627$), but reached a maximum mean of 5.5 individuals per group in autumn (Figure 2), when the largest group contained 21 individuals. By comparison, in spring, winter, and summer, the largest group sizes were 8, 12, and 13, respectively.

TABLE 2

Main activity patterns of wild boar groups (N=79) observed in the afternoon and at the beginning of the night from observation sites on the periphery of the Integral Reserves of the Aiguamolls de l'Empordà Natural Park, Spain.

	N	Entering the reserves (%)	Leaving the reserves (%)	Movin inside the reserves (%)	Feeding inside the reserves (%)
Winter (Jan-Mar)	24	4.1	41.7	41.7	12.5
Spring (Apr-Jun)	10	-	70.0	20.0	10.0
Summer (Jul-Sep)	19	-	73.7	26.3	-
Autumn (Oct-Dec)	24	-	33.3	37.5	29.2

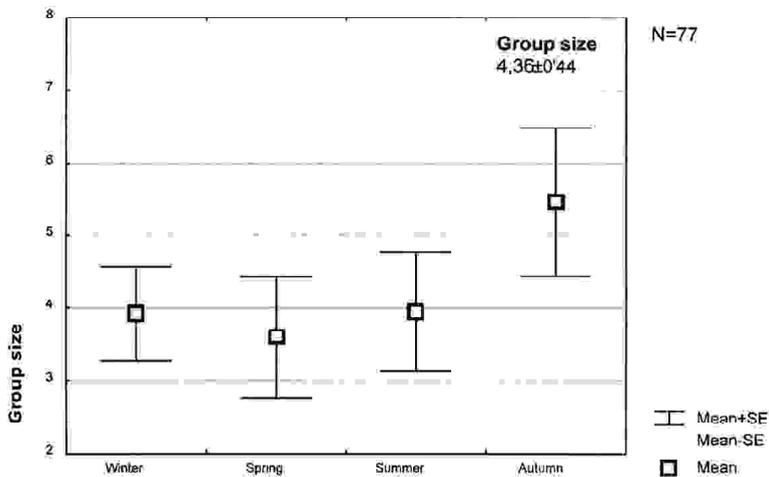


Figure 2. Seasonal variation in the mean and range of the size of wild boar groups observed in the Integral Reserves of the Aiguamolls de l'Empordà Natural Park, Spain.

The composition of groups varied seasonally. Matriarchal groups composed of adult females with yearlings or piglets represented between 40 and 53% of all of the groups observed in each season (Figure 3). Mixed groups, including adult males, adult females and young, occurred only in autumn (20.83%) and winter (12.5%). Solitary males were seen year-round, but were most frequently observed in summer. Groups of subadults (of both sexes) were observed in all seasons and were most frequent from April to June, when they constituted 30% of all of the groups observed. The category "other groups" included solitary young (4 cases distributed throughout the year, solitary adult females (2 cases in winter and 1 in autumn), and adults of unknown sex (2 cases). On different occasions, the groups composed of only young animals were seen on days following the capture of females.

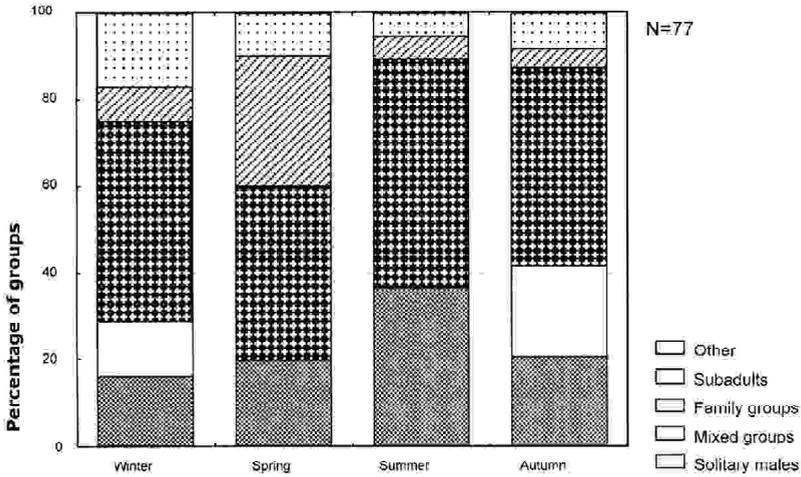


Figure 3. Seasonal variation in the types of groups of wild boar observed in the Integral Reserves of the Aiguamolls de l'Empordà Natural Park, Spain.

DISCUSSION

For wild boar populations, the primary value of the wetland Integral Reserves seems to be as a source of secure places for resting periods throughout the year, but also to provide food resources, especially in autumn. In the population of this study, however, part of the animals' home range is outside of the reserves, as was reported in another wetland population in the Camargue (Janeau et al. 1988), where only half of the total ($\sim 15\text{-}20 \text{ km}^2$) home range was located inside reserves.

In our study, the wild boar exhibited two main habitat use patterns. In spring and summer, a high proportion of individuals spent the day in the reserves and left during the active period to feed on crops in the areas surrounding the reserves. Thus, it is not surprising that 70% of the diet of wild boars in this population in July and August is cultivated plants (Herrero et al. 2004). In autumn, the number of individuals that obtained refuge and food resources inside the reserves increased. It is in that period that the maximum number of individuals was observed in the reserves. There are at least three factors that might explain those observations: coincidence with the rut period, the beginning (in mid-October) of the hunting season in the areas surrounding the reserves, and the harvesting of crops around the reserves, which occurs at the end of summer. So, the factors that can influence the concentration of animals inside the reserves in autumn are the availability of alternative food resources once crops are harvested, the secure shelter they can find in the reserves, which are undisturbed by hunting, and can be used during the rut period.

In our study, mean group size was within the range reported for Iberian wild boar populations - generally 3 to 5 individuals - (Rosell et al. 2001) and is close to the most frequent group size (4) in European populations (Bon et al. 1986). Maximum aggregations were observed in autumn, which coincides with the rut period when males join the basic units of adult females and young, and produce groups of up to 20 individuals in some cases. Maximum group sizes in other wetlands and forest areas occur in autumn (Dardaillon 1984b) and (Rosell 1998). Nevertheless, in Doñana Natural Park, an extensive marshland area, the maximum group size occurs in spring (Fernandez Llarío et al. 1996) following the birthing period. The mean group size in Doñana Natural Park is lower (about 3.2 individuals per group) than in Aiguamolls de l'Empordà. The smaller groups sizes in the former are thought to be a consequence of a high level of food competition, rather than habitat type (Fernandez Llarío et al. 1996). According to this explanation, the large group sizes observed in autumn in the Aiguamolls de l'Empordà might indicate the high availability of food resources, including animal matter (Herrero et al. 2004).

Seasonal variations in wild boar social organisation have been directly related to the biological cycle, particularly the rut and birthing periods (Bon et al. 1986, Fernández Llarío et al. 1996) and, in our study area, we noted the influence of the mating period by the appearance of mixed groups (adult males, adult females and young). Nevertheless, in autumn, the increased frequency of subadult groups (mainly composed of males), which are expected to be expelled by adult males during the rut (Bon et al. 1986, Dardaillon 1984b, Fernández Llarío et al. 1996), was not observed. In our study area, groups of subadults are present year-round, probably because of the influence of the shooting of the adult females that give rise to these groups. It is not clear why there was a strong increase in subadult groups in spring and it would be necessary to examine the question using a wider sample. But, a possible explanation is the separation of the remaining adult females that give birth, which would leave groups composed young animals, only. Also, the presence of solitary young animals might be explained by the perturbation caused by the removal of individuals.

So, in wild boar populations, variations in social organisation cannot be due solely to the effects of the biological cycle, but also to the mortality of individuals, especially adult females (see also Janeau et al. 1988). With respect to the application of wild boar control programs in wetland areas that suffer the effects of high densities of boars at certain periods of the year, it is important to note that, in our study area, some groups from which adult females have been captured continue to use the area and the occasional shoot is not sufficient to expel the groups from these areas entirely. Similar results were obtained in New South Wales, Australia (Dexter 1996) on a shrubland and riverine woodland habitat, where the position of home ranges of feral

pigs did not appear to be affected by an intensive shooting exercise conducted from an helicopter. Future analysis of data from the wild boar population in Aiguamolls de l'Empordà Natural Park will probably help to determine whether it is necessary to manage these populations by establishing an annual capture program with the aim of insuring a sustainable number of individuals. It is also important to know the extent to which the situation inside the reserves is influenced by variations in population density in the areas surrounding the park.

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