SITUATION OF WILD BOAR POPULATIONS IN WESTERN POLAND

Fruzinski B.

Katedra Gospodarstwa Lowieckiego Akademii Rolniczejul. Wojska Polskiego 71d, 61-679 Poznan, Poland.

Abstract: On the base of the investigations carried out during ten years, the population of Wild boar inhabiting 8,000 ha forest area in western Poland has been characterised. Such parameters as reproductive ratio, mortality and longevity are described. The reproductivity ratio of population depends on the high degree on the age structure of females. This population consisted of 49% of piglets, 35% 1-2 years old animals and only 16% older than 2 years. Total productivity of population reached about 190% of number of sows. The mortality ratio of piglets during the first 3-5 months of life was about 27% of number of young born. The average length of life was estimated to 1.5 year.

Keywords: Wild boar, *Sus scrofa,* Suidae, Population dynamics, Reproduction, Hunting.

IBEX J.M.E. 3:186-187

The main reason of the Wild boar populations increase in last decades is the change within the populations themselves resulting from the adaptation of the species to the landscape changes caused by the intensification of agriculture and especially by the development of big-area cultivation structure and the spreading of maize cultivation. This has given wild boars perfect feeding and shelter conditions. In effect the reproductiveness of the population increases. The fact that nowadays wild boars are the typical element of landscape in which even small woods adjoin fields, is confirmed by, among other things, high hunting results in regions poor in woodlands but where the land cultivation is at high level. For example in the Poznan region, wooded only in 21%, about 25 boars per 1,000 ha of woodland are hunted every year, whereas in the Krosno region, wooded in 47.3%, and in the Przemysl region, wooded in 41.7%, only 1.5 boars per 1,000 ha of woodland are hunted annually (Fruzinski, 1992).

In the last few decades the number of hunted wild boars systematically increased. In 1992 it reached 122 thousand boars. Since 1975 the yearly boars' harvest has exceeded the population size before the reproduction time, in some years even by 50% (Fig. 1). This has not decreased the population size, as nowadays the realized population increase far exceeds 100% of the population spring state (before the reproduction time).

The reason of this state of affairs is a distinct increase in fecundity of wild boars and the participation of the youngest age classes in mating. About 30% of female piglets (8-10 months old) takes part in reproduction, though they give birth to a relatively small number of young animals. To one female of that age fall 3.9 embryos. With the 1-2 years old females on average 4.3 embryos are found and the participation of those females in mating is 70%. With the 3 years old and older females on average 6.3 embryos are found and almost all the females (97%) take part in mating (Fruzinski & Konig, in press; Fruzinski, *op.cit.*).

Taking into account the number of females of different age classes in a pre-reproductive population, this gives an increase of about 190% of the population state. Because of the substantial majority of females in population, high reproductiveness is well-founded (Fruzinski & Konig, *op. cit.*). The big participation of the youngest sows in mating, as well as other factors, causes the period of giving birth to the young to last the whole year. Although the majority of litters still falls to April (26.6%), March (20.8%) and February (16.6%), it should be stressed that piglets are born from January (9.5%) to December (0.8%) (Fruzinski & Naparty, 1992).

The natural mortality refers almost exclusively to piglets in the first 4-5 months of life and reaches 27% of born animals. The additional mortality, resulting from shooting-off makes the general mortality in the first year of life as high as in non-hunted populations (Jezierski, 1977;

Meynhardt, 1980). The mortality rate of piglets amounts to 31% for males and 26% for females, the mortality rate of yearlings reaches 77% for males and 62% for females. For older age classes the rate is similar and amounts to 73% for males and 63% for females. As a result of high mortality the average life length is 1.5 years (Fruzinski, *op.cit.*) and is lower than in a non-hunted population (24 months for females and 21 months for males; Jezierski, *op.cit.*).
The above presented demographical data of the Wild boar population in western Poland have recently been strongly disturbed in result of swine pest in 1992.

REFERENCES

FRUZINSKI B., (1992) - *Dzik*. Cedrus, Warszawa: 248 pp.
FRUZINSKI B. & KONIG R. in press - Processes and management of wild boar's population.
FRUZINSKI B. & NAPARTY K., (1992) - Chronologie des Frischens bei Wildschweinen. *Z. Jagdwiss.*, 38: 262-264.
JEZIERSKI W., (1977) - Longevity and mortality rate in a population of Wild boar. *Acta Theriol.* 22 (24): 337-348.
MEYNHARDT H., (1980) - *Schwarzwild*. Report. Neumann Verlag, Leipzig.

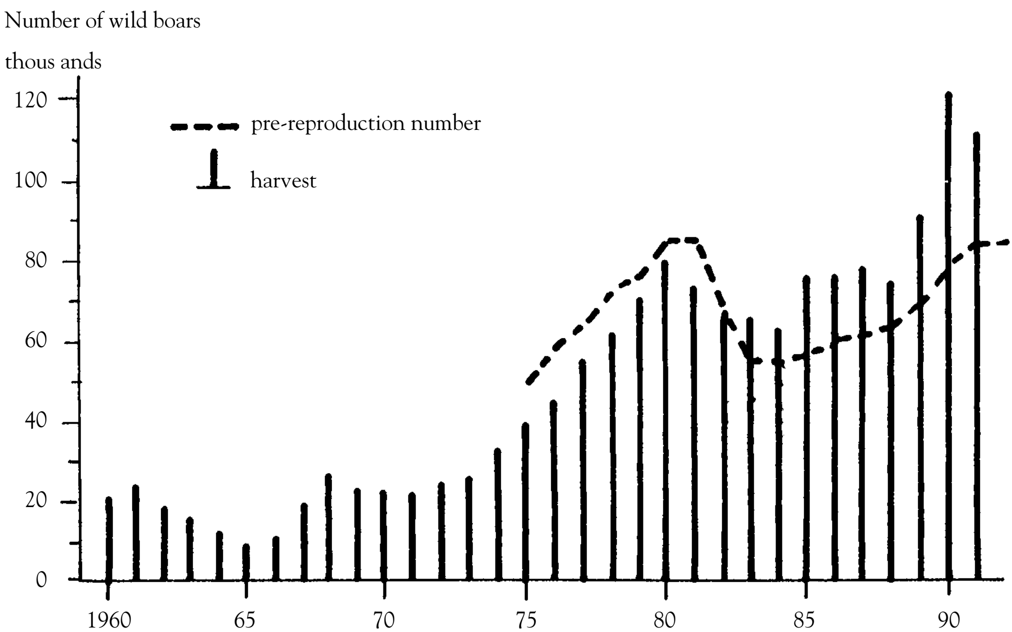


Figure 1 - Long term annual estimation survey of pre-reproduction and harverst numbers in a Wild boar population.

POPULATION DYNAMICS AND MANAGEMENT OF Sus scrofa IN WESTERN SWITZERLAND: A STATISTICAL MODELLING APPROACH

Neet C.R.

Centre de conservation de la faune, d'écologie et d'hydrobiologie appliquées (Etat de Vaud) - 1, chemin du Marquisat, CH - 1025 Saint-Sulpice, Switzerland.

Abstract: In Western Switzerland as in other parts of Europe, the high densities of *Sus scrofa* have serious economic consequences for agriculture. In order to improve management actions and reduce impacts, we have undertaken a time series analysis on factors that may explain the increasing abundance of wild boars and have made stochastic simulations of population dynamics to assess the impact of management by hunting. Over a 32 years period, we show that the expansion of maize cultures explains 49.7% of the variance in the numbers of wild boars annually shot and is thus one of the main factors controlling population growth. Since the amounts of boars taken by hunting can be shown to be proportional to boar populations, we use the data furnished by hunters to calculate survival rates and fecundities for three age classes (0-1 year, 1-2 years, > 2 years) and simulate population dynamics using the RAMAS/age stochastic model for age structured populations. Density dependence parameters are also estimated from hunting data. The stochastic model produces fairly realistic predictions and simulations can be used to compare harvesting strategies. The statistical modelling approach presented in this paper is limited by the quality of parameter estimation, and, in the case of the stochastic population model, by its strong sensitivity to variations in density dependence parameters. However, qualitative predictions and risk assessments can be made, providing a very useful tool for the improvement of Wild boar management.

Keywords: Wild boar, *Sus scrofa,* Suidae, Stochastic population model, Management strategies.

IBEX J.M.E. 3:188-191

1. Introduction

In Switzerland, as in other parts of Europe, the Wild boar *Sus scrofa* may nowadays be considered as a problematic species because of the serious economic impact it has on agriculture. This impact is a consequence of the population increase that has been observed throughout Europe (Saez-Royuela & Telleria, 1986) and the simultaneous difficulty to control populations efficiently by hunting, at least in Western Switzerland. In order to contribute to the improvement of Wild boar management, this paper first examines the effects of a few general environmental and landscape variables on population size over a 32 years period (1960-1991). Then, using data collected from hunting statistics, stochastic simulations of population dynamics are made to explore and assess the impact of different management strategies.

2. Material and methods

A basic assumption in this work is that the amount of boars killed each year by hunting is proportional to population size. To test this hypothesis, the number of boars killed per year by hunting has been compared with Wild boar damage records, standardised per area unit of maize fields actually planted. Since standardised damages should be proportional to population size (see Baettig, 1988) and since the regression analysis shows a reasonable degree of explained variance ($R^2 = 0.61$, $p < 0.001$), it can be concluded that this hypothesis is fairly met by the data.

2.1. Time series analysis of factors influencing population dynamics

A cross-correlation time series analysis (Box & Jenkins, 1976) has been undertaken in order to find whether variables such as the area of maize recorded each year, the mean annual temperature or the mean annual rainfall have an influence on Wild boar numbers (N = number of boars shot per year). Meteorological data have been furnished by the Swiss Meteorological Institute (Zurich), all other data are taken from the annual reports of the Department of Agriculture, Industry and Commerce of the canton de Vaud (Lausanne).

2.2. Stochastic modelling of population dynamics

Using the detailed indications furnished by hunters and a body weight criterion derived from Baettig (*op. cit.*) to separate age classes, life tables including three age classes (0-1 year, 1-2 years, > 2 years) could be constructed for boars in the years 1986-1992 (in the first age class, the number of individuals has been increased by 20% to compensate for the piglets that are not included in hunting statistics). Age specific survival rates, fecundities and their coefficients of variation have also been estimated from these data. Following the method given by Burgman *et al.* (1993) it has also been possible, by regression of the realised growth rate against N, to obtain a rough estimate of density dependence parameters for the Ricker equation, using the formula:

$$\ln \frac{(N_{t+1})}{N_t} = r - ßN_t$$

were r is the rate of increase and ß a measure of the strength of density dependence. Using all these demographic parameters, population dynamics could be modelled using the RAMAS/age stochastic model for age structured populations (Ferson & Akçakaya, 1990).

3. Results

3.1. Time series analysis

A simple look at the graphical data (Fig.1) suggests a relationship between the area of maize planted and N, the number of boars. The cross-correlation time series analysis actually shows that N is best explained by the square root of maize area planted two years before (time lag - 2: $R^2 = 0.497$) and by the mean annual temperature recorded two years before (time lag - 2: $R^2 = 0.288$). When these two variables are combined into a multiple regression analysis, the level of explained variance attains $R^2 = 0.599$ ($p < 0.001$), *i.e.* 59.9 %.

3.2. Stochastic modelling of population dynamics

The demographic parameters used for the simulation of populations dynamics with RAMAS/age are given in Table 1. The Ricker function parameters using the regression method are r = 0.709 and ß = -0.005 ($R^2 = 0.329$, p = 0.01). Using these parameters and an initial population size of 500 (0-1 year: 225, 1-2 years: 140, > 2 years : 135), the simulations produce a stable population after a few years of runtime (as in figure 2 A). In practice, taking ß = - 0.001 gives more realistic results, the population of 500 remaining at a stable level. To compare different management strategies, this modelled population has been submitted to different hunting strategies, all based on an additional harvest of 10% of the initial population size each year. These 50 harvested individuals have been distributed in various harvesting combinations over the three age classes. The results obtained for the different management strategies are not given in detail here but are illustrated by selected results of a second set of simulations (Fig. 2) that was made with exactly the same data except for the survival rate of age class 1 for which a value of 0.5, closer to values observed in other studies (Gaillard *et al.*, 1987), was taken. Qualitatively, the population dynamics did not differ between the first and second set of simulations.

4. Discussion

The results presented here suggest that hunting data may be used to analyse population dynamics and improve management. This supports previous results obtained by Badia *et al.* (1991), who have clearly shown how detailed hunting data can be used to estimate population size.

The indication that maize cultures strongly influences Wild boar populations is not a surprise and quantitatively confirms the intuition of many wildlife managers in Switzerland. The two years time lag suggests that maize has a positive influence on female fitness and reproductive success, that translates into an increase of young boars shot in their second year of life.

The use of demographic parameters estimated from hunting statistics to perform stochastic

Table 1. Mean demographic parameters used for *Sus scrofa* (Years : 1986-1992, n = 7; mean sex ratio: 42 % of females). The parameters have been estimated from hunting data (see text).
CV = coefficient of variation.

Age class	% of N	Fecundity	CV	Survival	CV
0	45	2.17	0.113	0.547	0.225
1	28	5.12	0.113	0.906	0.061
2	27	6.23	0.113	0.20	0.061

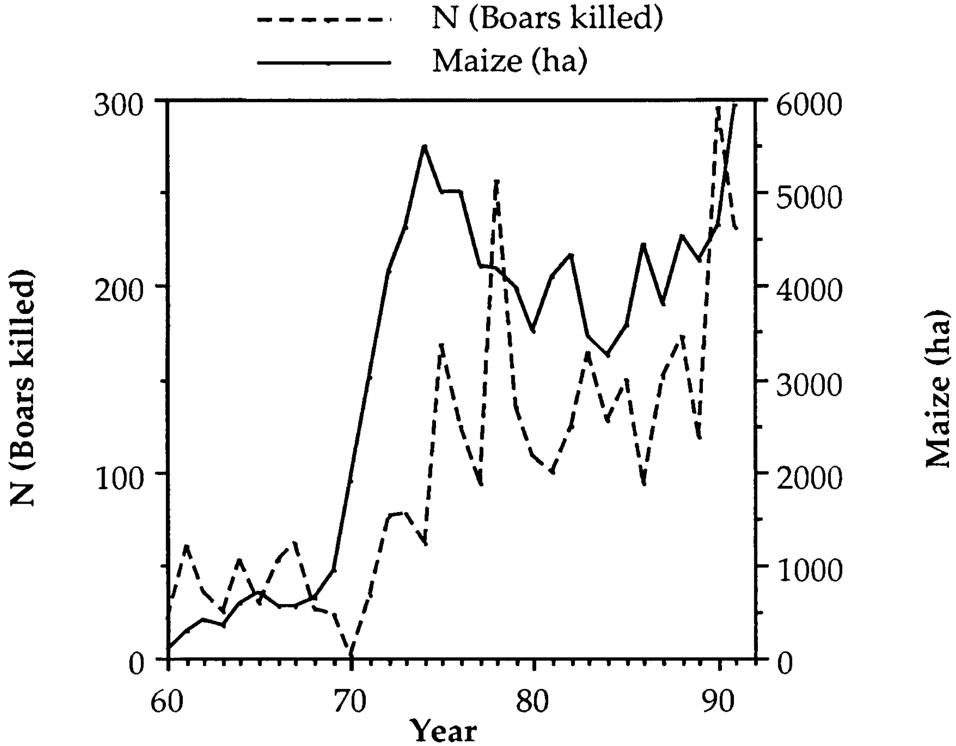


Figure 1. Variation of the number of boars killed by hunting (N) and of the area of maize planted in the Canton de Vaud (Switzerland) between 1960 and 1991.

population simulations shows that although such an approach may be expected to be biased in several ways, the values obtained for survival and fertility do not strongly differ from values obtained by other authors, *e.g.* Gaillard *et al.* (*op. cit.*), Spitz (1989) and Gerard *et al.* (1991). The two statistical modelling approaches presented in this paper are certainly limited by the quality of parameter estimation. In the case of the time series analysis, although very rough and general data were used, fairly predictive results could be obtained on the factors controlling population dynamics. Thus, with better data, one might be able to obtain a precise estimation of the influence of environmental and landscape factors on the Wild boar population dynamics. In the case of the stochastic population model, the results are even more dependent on parameter estimation. The strong sensitivity of the model to variations in density dependence parameters is a classical problem (Burgman *et al.*, 1993). However, the fact that qualitative predictions and risk assessments can be made is encouraging because even if quantitative predictions are unlikely to be made, the RAMAS/age model provides a very useful tool for comparing Wild boar management strategies. This model could be improved for wildlife managers by adding a possibility to make more investigations on harvesting effects, *e.g.* by including a function to produce the emigration of relative proportions of each age class rather than constant and absolute numbers of migrating individuals each year.

5. Acknowledgements
The author is very grateful to A. Mabille, C. Neet-Sarqueda and the wildlife rangers of the canton de Vaud, who have all made very useful contributions to our Wild boar management programme.

REFERENCES

BADIA J., SPITZ F. & VALET G., (1991) - Estimate of the size of a hunted population. *Ecol. Model,* 55: 113-122.

BAETTIG M., (1988) - *Recherche et étude du Sanglier dans la République et Canton du Jura.* Office des eaux et

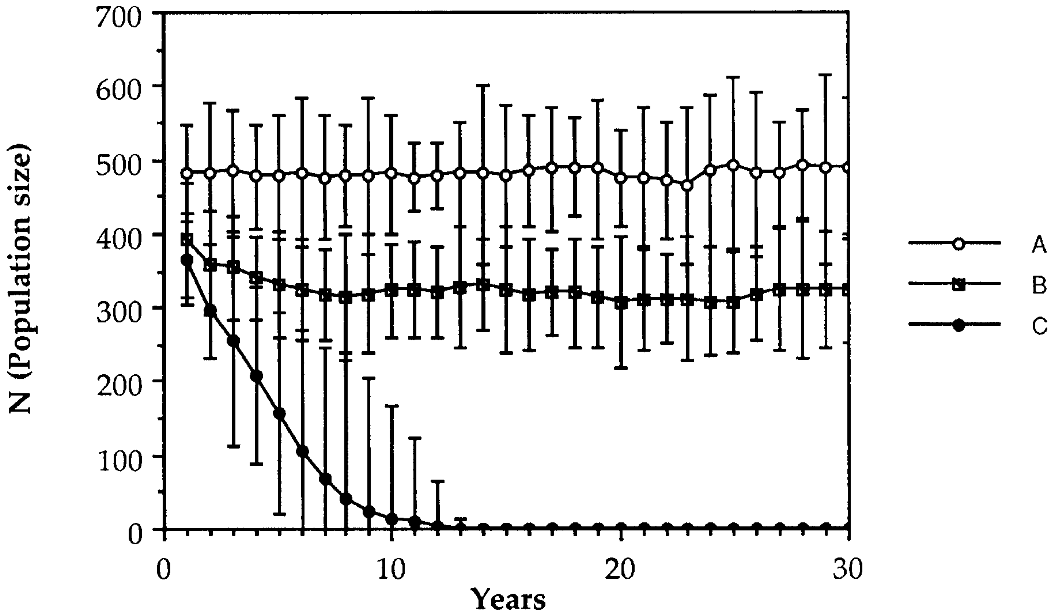


Figure 2. Three population trajectories simulated using RAMAS/age. A. Without additional hunting. B. With selective additional hunting of 50 individuals per year in the age class 2. C. With selective additional hunting of 25 individuals in age class 0 and 25 individuals in age class 1. Error bars are 95 % confidence intervals for population size estimates.

de la protection de la nature. Les Champs Fallat, 2882 Saint-Ursanne, Suisse.

BOX G.E.P.& JENKINS G.M., (1976) - *Time series analysis. Forecasting and control.* Holden-Day, Oakland CA, 575 pp.

BURGMAN M.A., FERSON S. & AKÇAKAYA H.R., (1993) - *Risk assessment in conservation biology*. Chapman and Hall, London, 314 pp.

FERSON S. & AKÇAKAYA H.R., (1990) - *RAMAS/age User Manual.* Exeter Software, Setauket, New-York, 143 pp.

GAILLARD J.M., VASSANT J. & KLEIN F., (1987) - Quelques caractéristiques de la dynamique des populations de sangliers *(Sus scrofa scrofa)* en milieu chassé. *Gibier Faune Sauvage*, 4: 31-47.

GERARD J.F., TEILLAUD P., SPITZ F., MAUGET R. & CAMPAN R. (1991) - Le Sanglier. *Rev. Ecol.*, Suppl., 6: 11-66.

SAEZ-ROYUELA C. & TELLERIA J.L., (1986) - The increased population of the Wild boar *(Sus scrofa* L.) in Europe. *Mammal Rev.*, 16: 97-101.

SPITZ F. (1989) - Mortalité et dispersion chez le Sanglier *(Sus scrofa)* de Camargue. *Gibier Faune Sauvage*, 6: 27-42.

BIRTH DISTRIBUTION, STRUCTURE AND DYNAMICS OF A HUNTED MOUNTAIN POPULATION OF WILD BOARS (Sus scrofa L.), TICINO, SWITZERLAND

Moretti M.

CH - 6717 Dangio-Torre, Switzerland

Abstract: Wild boars killed during the hunting seasons 1988-1992 were aged from tooth-eruption and tooth-wear. A monthly birth distribution and an age and sex pyramid were built. Births take place throughout the year, though about 83% are concentrated between February and August. The remaining 17% occurs between September and January. The pyramid of the age classes of the population typically agrees with that of a hunted population, so that the first two age classes (0-1 and 1-2 years) depict 82% of the population. On the grounds of these results and according to other studies, a few conclusions are inferred regarding the demographic increase of hunted populations.

Keywords: Wild boar, *Sus scrofa,* Suidae, Population dynamics.

IBEX J.M.E. 3:192-196

1. Introduction

The population of wild boars in Ticino (Swiss Canton, south of the Alps) is very recent. The first animal was recorded at the beginning of the 80's in a region called Malcantone, on the border with the Lombardic Alps region (Italy). In subsequent years the population quickly spread northwardly and increased significantly (Baettig, 1985; Moretti, 1991; Moretti, 1992). After the appearance of this species in the study area eight years ago and from the first huntig season in 1988, a study was accomplished based on hunted animals in order to analyse some important aspects of the population's structure and dynamics.

2. Study area

The Malcantone region (Southern Switzerland) covers an area af 7,000 ha with a southern orientation; altitudes range from 200 to 1,800 m u.s.l. (Fig. 1). The annual rainfall is 1,700 mm (mean for the last 30 years). The environment is as follows: wood 60%; urbanized area 15.5%; agricultural area 10.5%, alpine meadows 10%; uncultivated land 4%. The chestnut *(Castanea sativa)* predominates between 200 and 1,000 m u.s.l., pure or mixed with beech *(Fagus sylvatica)* or with oaks (*Quercus sp.)*. In the study area, the species has found optimal environmental conditions (Moretti, 1991).

3. Methods

3.1. Sex and age ratio

During the hunting season of 1990-91, 521 wild boars were killed and examined. All animals were shot in the Malcantone region (Ticino, Switzerland) between 200 and 1,600 m above sea level. The hunting code did not provide any special restriction and all age classes were therefore present in the analysed samples. Some animals were aged from tooth-eruption and tooth-wear according to Iff (1978), whose age classes were adapted from the recent works of Boitani & Mattei (1992) and Genov *et al.* (1992) in accordance with Matschke (1965). The sex ratios were compared with the theoretical distribution 1:1 (Chi-square test).

3.2. Natality, birth distribution and static life table

The uteri of 17 females were analysed and the number of foetuses were counted. The monthly birth distribution of 320 wild boars between 6 and 18 months of age was calculated.

The life table distributed into age classes was etablished in accordance with Blant (1987) and Henry and Conley (1978). Even if hunting is considered the main cause of mortality of hunted populations (Baettig, 1988), the limits of the hunting techniques are unknown. Nevertheless it is worth a discussion and a comparison with the results of other studies.

Figure 1. Study area

Different parameters have been considered as follows:

- x : age class
- l : number of animals of 'x' age from the hunted sample
- l_x: number of animals of 'x' age from an initial population of 1,000 individuals
- d_x: number of dead animals between 'x' and 'x + 1' and thus: $d_x = l_x - l_{(x+1)}$
- q_x: mortality rate: $d_x / l_x)$
- p_x: survival rate $(1 - q_x)$
- e_x: mean expectation of life remaining.

4. Results

4.1. Sex and age ratio

Figure 2 indicates the percentage distribution of the different age classes for both sexes. The result is a symmetric pyramid whose base consists of 46% of animals aged 0-1 years (class 1) and of 36% of animals aged 1-2 years (class 2). If added, these two classes (from 0 to 2 years) represent 82% of the population. Animals older than 2 years only represent the 18%. In the sample the sex ratio is balanced in all age classes (mean: 0,98).

4.2. Natality, birth distribution and static life table

The results of the analysis of 17 uteri appear in Table 1. The mean number of foetuses is 4.8 per pregnant female. In this sample, five out eight females in the age class 0-1 year (class 1) and all females in other classes take part to the reproduction.

The births occur throughout the year, though about 83% are concentrated between February and August (Fig. 3). During this period it

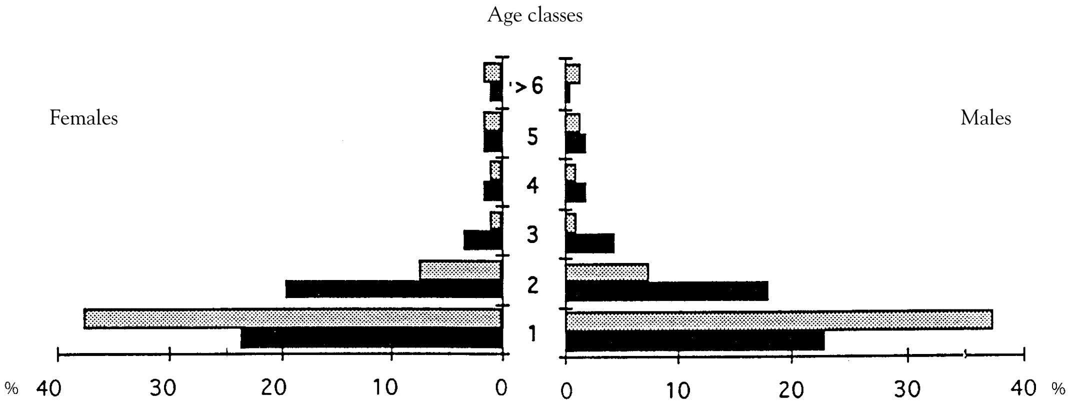


Figure 2. Composition in age classes and sex of shot population of Wild boar (n = 521). Black = real age-rate of the studied population; Grey = theoretical age-rate.

Table 1: Number of foetuses per female (n=17) per age class.

	Number of foetuses per female									Pregnant females	Mean of foetuses per pregnant female		
Age classes (years)	0	1	2	3	4	5	6	7	8	(%)	MORETTI (n = 17)	**BRIEDERMANN (n = 251)**	**BAETTIG (n = 39)**
0-1	3			4				1		63%	3,8	4,0	4,7
1-2				1		1	2	1		100%	5,4	5,5	6,1
> 2					1	1	1		1	100%	5,7	6,6	7,3
TOTAL	3	-	-	5	1	2	3	2	1		4,9	5,3	5,6

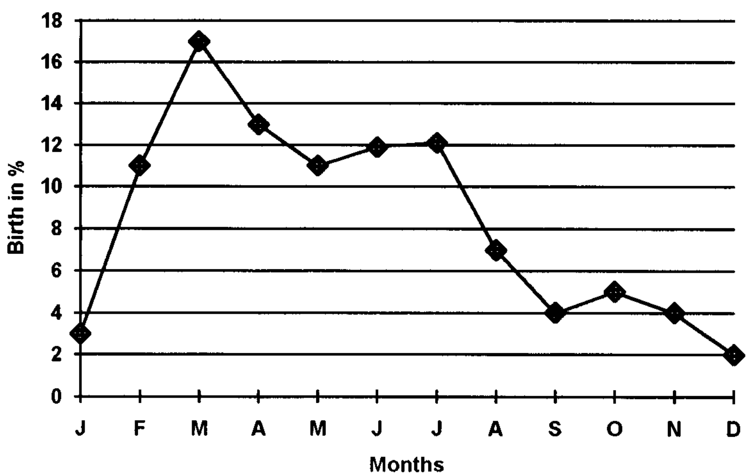


Figure 3 - Monthly birth distribution (in %) according to the age at the killing (n = 320).

Table 2: Static life table based on 521 wild boars shot in study area between 1990 and 1991. x: age classes; l: number of animals in 'x' age class from the hunted sample; l_x: number of animals of 'x' age from an initial population of 1,000 individuals; d_x: number of animals shot beween 'x' and 'x+1' and thus $[l_x - l_{(x+1)}]$; q_x: mortality rate (d_x/l_x); p_x: survival rate $(1-q_x)$; e_x: survival chance (T_x/L_x), where $L_x = \{l_x + l_{(x+1)}\}/2$ and $T_x = \sum L_x$.

Survival table						Static life table				
x	l	l_x	d_x	q_x	p_x	d_x	l_x	L_x	T_x	e_x (in months)
0-1	241	1000	220	0.22	0.78	220	1000	890	1363	1.53 *(18 months)*
1-2	188	780	614	0.79	0.21	614	2791	473	598	1.26 *(15 months)*
2-3	40	166	83	0.50	0.50	83	377	124	203	1.63 *(20 months)*
3-4	20	83	8	0.10	0.90	8	38	79	139	1.76 *(21 months)*
4-5	18	75	29	0.39	0.61	29	132	60	89	1.48 *(18 months)*
5-6	11	46	33	0.73	0.27	33	151	29	35	1.21 *(14 months)*
6-7	3	12	12	1.00	0.00	12	57	6	6	1.00 *(12 months)*
> 7	0	0	0			0				
	521	2162								

seems that the number of births follows a bi-modal distribution with a peak in March and one other between June and July. The remaining 17% are distributed, more or less regularly, between September and January, with minimal values between December and January.

Table 2 shows some important parameters of the population dynamics of a sample of 521 shot wild boars. The *mortality rate* per classe follows an alternate movement with minimum values at 0-1 and 3-4 years (10-22%), and maximal values at 1-2 and 5-6 years (73-79%). The *mean expectation of life remaining* in the single classes of the analysed population is higher in the classes between 2 and 4 years (e_x=20-21 months) compared to the younger and to the older ones (e_x=12-18 months). These values never go over two years, which represents the mean value of the turn-over of the population.

5. Conclusions

5.1. Birth distribution

The birth distribution agrees with that presented by other authors (Briedermann, 1986; Baettig, 1988; Gerard *et al.*, 1991; Durio *et al.*, 1992) and also agrees with the hypothesis on the females' winter estrus, which in this case happens between November and March. The long period of births and the bi-modal movement between February and July suggest, nevertheless, that the female oestrus is barely synchronized (Meriggi *et al.*, 1988; Gerard *et al.*, *op. cit.*; Mauget *et al.*, 1984). The favourable environmental conditions and the abundant availability of suitable food in the study area (Moretti, 1991) could confirm Mauget's hypothesis (1980) according to which wild boars react to increased food availability switching from one farrowing period (April) to two periods (January - February and July - August). This hypothesis is also confirmed by Durio *et al.* (*op. cit.*). On the other hand the lost of the nestling during particularly rainy springs brings the females to a new oestrus, which has a period of 21 days (Mauget *op. cit.*; Gerard *et al.*, *op. cit.*).

5.2. Population structure, survival & mortality rates and hypothesis on the dynamics of hunted populations

The structure of the sampled population is the same as that of several populations hunted in Europe and shows the symptoms of a quite superficial management (Briedermann, *op. cit.*; Meriggi *et al.*, *op. cit.*). The mortality rate in hunted populations during the first year is very low compared to natural ones even when they are characterized by low mortality among young animals (Jezierski, 1977; Andrzejewski & Jezierski, 1978, in Briedermann, *op. cit.*). From the second or third year on the movement and the values become closer to those of a natural population.

One important aspect, which is connected with such a management is the increase of the population size. Actually, in normal environmental conditions, about 40% of younger

females (0-1 years) take part in the reproduction, with an average of 4 offspring (Briedermann, *op. cit.*).
The ecological-environmental conditions in the study area are good, especially the trophic ones (Moretti, 1992). From the climatic point of view, the situation is mostly good, although it is not known how much particularly rainy springs affect the natural mortality of younger animals. If hunting is the most significant reason of mortality among Wild boar (83%, Baettig, 1988) then it is possible to predict that the population will increase in the next few years. In case of massive migration towards the neighbouring Italian regions, local hunting statistics would not be able to show this fact directly. Therefore the coordination of studies and the management of populations between neighbouring confined regions (in the studied case between north-italian regions and southern parts of Switzerland) should be improved.

References

ANDRZEJEWSKI R. & JEZIERSKI W., (1978) - Management of Wild boar Population and its effects on commercial land. *Acta Theriol.* 23, (19): 309-339.

BAETTIG M., (1985) - Rapporto sulla situazione del cinghiale nel Malcantone nell'anno 1984. *Il Cacciatore Ticinese*, 9: 167-170.

BAETTIG M., (1988) - *Recherche et étude du Sanglier dans la République et Canton du Jura.* Office des eaux et de la protection de la nature, St. Ursanne (JU), Suisse, 133 pp.

BLANT M., (1987) - *Dynamique de population, condition et constitution du Chevreuil, dans les cantons de Neuchâtel et Vaud (Ouest de la Suisse).* Thèse, Univ. de Neuchâtel, 160 pp.

BOITANI L. & MATTEI L., (1992) - Aging Wild boar *(Sus scrofa)* by tooth eruption. In: *"Ongulés/Ungulates 91"*. F. Spitz., G. Janeau, G. Gonzalez & S. Aulagnier (eds), S.F.E.P.M.-I.R.G.M., Paris-Toulouse: 419-421.

BRIEDERMANN L., (1986) - *Schwarzwild.* Neumann-Neudamm, Berlin, 540 pp.

DURIO P., GALLO ORSI U., MACCHI E. & PERRONE A., (1992) - Monthly birth distribution and structure of an Alpine population of Wild boar *(Sus scrofa)* in North-West Italy. In: *"Ongulés/Ungulates 91"*. F. Spitz., G. Janeau, G. Gonzalez & S. Aulagnier (eds), S.F.E.P.M.-I.R.G.M., Paris-Toulouse: 395-397.

GENOV P. V., MASSEI G., BARBALOVA Z. & KOSTOVA V., (1992) - Aging Wild boar (*Sus scrofa* L.) by teeth. In: *"Ongulés/Ungulates 91"*. F. Spitz., G. Janeau, G. Gonzalez & S. Aulagnier (eds), S.F.E.P.M.-I.R.G.M., Paris-Toulouse: 399-402.

GERARD J.F., TEILLAUD P., SPITZ F., MAUGET R. & CAMPAN R., (1991) - Le Sanglier. *Rev. Ecol.* (Terre Vie), Suppl. 6: 11-66.

HENRY V.G. & CONLEY R.C., (1978) - Survival and mortality in European wild hogs, *Proc. Annu. Conf. Southeast. Assoc. Game and Fish Wildl. Ages*, 32: 93-99.

IFF U., (1978) - Détermination de l'âge chez le Sanglier. *Diana* (Suisse), 10: 377-381.

JEZIERSKI W., (1977) - Longevity and mortality rate in a population of Wild boar. *Acta Theriol.*, 22, (24): 337-348.

MATSCHKE G. H., (1965) - Aging European wild hogs by dentition. *J. of Wildl. Manage.*, 7: 109-111.

MAUGET R., (1980) - *Régulation écologique, comportementale et physiologique (fonction de reproduction) de l'adaptation du Sanglier, Sus scrofa* L. *au milieu.* Thèse de Doctorat d'Etat, Université de Tours, 1980.

MAUGET R., CAMPAN R., SPITZ F., DARDAILLON M., JANEAU G. & PÉPIN D., (1984) - Synthèse des connaissances actuelles sur la biologie du Sanglier, perspectives de recherche. Symposium International sur le Sanglier. F. Spitz & D. Pépin (eds), Toulouse, *Les Colloques de l'INRA*, n° 22: 15-50.

MERIGGI A., STOPPANI N., CESARIS C., ZACCHETTI D. & BARBIERI F., (1988) - Analisi degli abbattimenti di cinghiale *(Sus scrofa)* nell'Appennino settentrionale lombardo. In: *Atti del I Convegno Nazionale dei Biologi della Selvaggina*, Bologna 1988, Vol. XIV: 641-642.

MORETTI M., (1991) - *Saisonale Raumverteilung, Habitatnützung und Standortwahl des Wildschweines (Sus scrofa* L.) *in einem Berggebiet auf der Alpensüdseite der Schweitz (Malcantone, Tessin).* Diplomarbeit, Zool. Inst. der Univ. Zürich, Abt. Ökologie.

MORETTI M., (1992) - *Contributo alla conoscenza del Cinghiale* (*Sus scrofa* L.) *nel Ticino*. Rapporto finale relativo ai risultati della caccia 1988-1992. Ufficio caccia e pesca, Dipartimento del territorio, Bellinzona.

DEMOGRAPHIC PATTERNS OF A WILD BOAR (Sus scrofa L.) POPULATION IN TUSCANY, ITALY

Boitani L., Trapanese P., Mattei L.

Dipartimento di Biologia Animale e dell'Uomo, viale Università 32, 00185, Roma, Italy.

Abstract: 1253 wild boars, killed during seven hunting seasons between 1984 and 1991, were aged from tooth eruption and tooth wear. Annual age and sex pyramids were computed. The overall structure of the sample showed that 52% of the killed wild boars was 7-22 months old, while the sex ratio was slightly unbalanced in favour of males (1:0.85). The reproductive tracts of a portion of sows (73%) were analysed and corpora lutea and embryos were counted. The pre-natal sex ratio showed a preponderance of female fetuses (1:1.2). Further data on age-specific corpora lutea, embryos and piglets/female ratio were recorded for each year of the study. Figures from annual life and reproductive tables were used to evaluate age-specific mortality, survival, longevity, mean expectation of further life, reproduction and recruitment.

Keywords: Wild boar, *Sus scrofa*, Population dynamics, Life tables.

IBEX J.M.E. 3:197-201

1. Introduction

In recent years Wild boar populations have increased both their numbers and distribution in Italy. In spite of growing concern for their conflicts with human activities (damages to crops), detailed studies of their distributions, densities and population dynamics are still lacking. Here we present some aspects of a demographic survey of a Wild boar population, as drawn from hunting data. Boar hunting is carried out throughout Italy, though with different methods and efficiencies, and it is the major cause of mortality among (non-piglets) individuals during winter (Boitani *et al.*, in press).

2. Study area

The study was conducted in the 11,000 ha Commune of Monticiano (Siena, Tuscany), a widely wooded (86%) hilly area (300-400 m u.s.l.) including two main rivers: Merse and Farma. The climate is sub-mediterranean and average annual temperatures are 4.6°C in January and 24°C in July. Forest cover (oak, chestnut, maquis) is interrupted by a mosaic of a few fields (average 10%) of sunflower, corn and barley, and many untilled fields.

Ungulates are present with significant densities of Fallow-deer (*Dama dama*) and Roe-deer (*Capreolus capreolus*).

In the study area wild boars are hunted by seven specialised teams (bound hunting with posted shooters): hunting effort is high (average of 3 days a week for 3 months), rather constant year by year and uniformly distributed.

3. Methods

From 1984 to 1991 we collected the harvest data of two hunting teams, whose hunting areas occupy about 44% of Monticiano territory. 1,253 legally killed wild boars were analysed with regards to sex, age and weight (with the exception of piglets < 6 months old). Age was assessed on the basis of teeth eruption and wear, following Matschke (1967) and Boitani and Mattei (1992). 180 animals (14% of the sample), whose age was not determined because the skull was damaged, were classified on the basis of the weight-age relation worked out from 1,073 fully classified animals. Aged animals were initially divided into six classes for a preliminary demographic analysis (0-6, 7-12, 13-17, 18-22, 23-32 and >32 months old) and then reorganised into one year categories (0-1, 1-2, 2-3, 3-4, 4-5 and 5-6 years old) in order to compute life and reproductive tables. The last three age groups (3-6 years) were identified through the degree of wear of the tuberculate teeth and the length of upper and lower canine (Iff, 1978). 73% of all sows were examined for reproductive activity and dissected to count the corpora lutea and embryos (which were sexed). Birth dates were obtained from the age of the animals at death. In order to reduce the age assessment error, only the animals up to 24 months old were considered for birth distribution analyses. Age specific and annual parameters were used to investigate the harvest data: sex-ratios, age structures, weight-age relationships and reproductive parameters were computed. Age and reproductive tables were obtained following Pikula *et al.* (1985).

Table 1: Embryos, piglets, juveniles, adults and total (post-natal) annual sex ratio (M:F).

Year	Embrios	Piglets	Juveniles	Adults	Total
1984 - 85	1:1.6	1:1.67	1:0.54	1:0.88	1:0.96
1985 - 86	??	1:1.12	1:0.80	1:1.24	1:1.05
1986 - 87	1:0.8	1:0.57	1:0.53	1:1.30	1:0.72
1987 - 88	1:1.5	1:1.22	1:0.67	1:1.04	1:0.89
1988 - 89	1:1.2	1:1.31	1:0.52	1:0.73	1:0.83
1989 - 90	1:0.9	1:0.92	1:0.39	1:0.92	1:0.75
1990 - 91	1:1.4	1:1.37	1:0.46	1:0.85	1:0.79
MEAN	1:1.2	1:1.09	1:0.57	1:1.00	1:0.85

4. Results and discussion

During the 7-years period the number of sampled wild boars fluctuated between 109 (1988-89) and 239 (1985-86), showing opposite trends in adult (>2 years) and yearling (1-2 years) percentages: until 1987 the former decreased and the latter increased, whereas trend reversed after the 1988 minimum. Piglets' (7-12 months) harvest showed smooth changes with a peak in 1989-90 (Fig. 1).

The overall sex ratio was slightly unbalanced in favour of males (1:0.85). Similar results were also found by Boisaubert *et al.* (1987), Durio *et al.* (1992) and by Massei and Tonini (1991). Opposite to great fluctuations among piglets, a constant tendency for yearling males to be more numerous than females was maintained (Tab.1). Lack of information about natal and post-natal sex-ratios did not allow a comparison with embryo trends: males and females may suffer different kinds of mortality during this period. Average pre-natal sex-ratio was fairly balanced (1:1.2), ranging from 1:1.6 in 1984-85 to 1:0.8 in 1986-87.

The age distribution indicated a relatively young population: 70% of the killed animals was 6 to 24 months old. However, the living population was probably even younger (x =

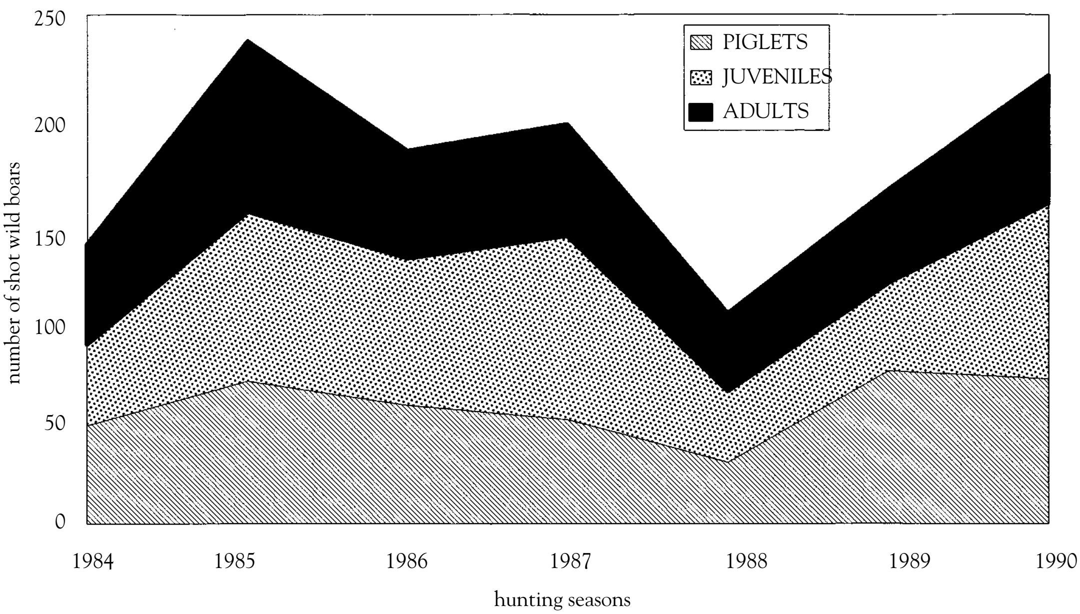


Figure 1 - Harvest trend and age classes of hunted wild boars.

2.25 years), as the piglets were only seldom hunted because of tradition and difficulty of finding them. Durio *et al.* (*op. cit.*) in Italy and Vassant *et al.* (1988) in France described similar situations. High rates of reproduction and of adult mortality are among the causes of the particular age structure. With the exception of 2-3 years old animals, wild boars tended to decrease in number with increasing age. The stronger annual fluctuations were found in 3-4 years old age-class, while younger than 2 years old individuals showed two peaks (1985-86 and 1989-90), probably due to an increased reproductive success. In the 1988-89 season the harvest was very poor. A decrease in number of living wild boars may have been the cause, while the abundance of piglets and yearlings (strong reproductive effort) during the following season was also the consequence.

80% of sampled wild boars weighed 20-80 kg, without significant differences between sexes. As noted also by Klein (1984), weight gain was fast up to about 2 years, when both sexes reached about 45 kg (males = 47.4 kg; females = 43.3 kg), while during the third year only males increased their weights at similar rate up to 60 kg (Tab. 2).

Table 2: Mean weight and standard error (SE) for age and sex classes.

Age Classes (months)	Mean weight of Males (kg) [S.E.]	Mean weight of Females (kg) [S.E.]
1 (5-6)	19 [7.3]	18 [7.1]
2 (7-12)	18.7 [7.5]	20.5 [7.5]
3 (13-17)	30.8 [10.2]	30.5 [12.3]
4 (18-22)	47.4 [10.5]	43.3 [9.4]
5 (23-32)	59.5 [14.5]	47.9 [6.5]
6 (>32)	72 [18]	56.2 [12]

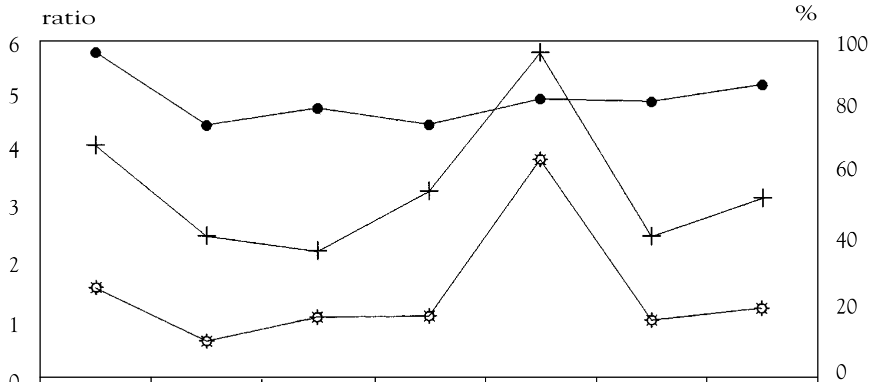
A positive relation between mean weight and mean age was found (r = 0.97977, age classes for males = 6; r = 0.98786, age classes for females = 6). Mean weight of 0.5-1 and 1-2 years old age classes had maximum annual fluctuations of 10 kg for both sexes and groups ($p>0$). Stronger variations during middle seasons were probably due to different trophic conditions.

The intensity of reproduction output was not equal in different study years. Great reproductive effort was evident in 1984 and 1988, when the percentages of pregnant sows, the fertilisation rates and (in 1984 only) the numbers of embryos per female reached a peak (Fig. 2). The mean number of piglets (*i.e.*, embryos) per litter was 4.95 (± 0.42) with no significant differences among years except in 1984-85 (5.8 piglets per litter). A correlation between mean number of foetuses and sow weight classes was found ($y = 2.7487 + 0.6473\,x$; r = 0.5481, n = 5); however the relation did not hold true for piglet and female age classes (sizes only depended upon mothers' physical conditions). Also, the percentage of pregnant females was correlated with weight. Ovulation rate averaged 2.09 (± 0.93), and 2.83 (±1.03) when only females older than 1 year were considered, with strong annual fluctuations. Positive correlations were found between female weight gain and numbers of piglets per litter and between age and percentage of pregnant sows: these results are confirmed by Saez-Royuela (1987) in Spain and by Mauget (1980) and Gerard *et al.* (1991) in France.

Mean reproduction index was 0.74, *i.e.* 0.74 piglets born per each individual of the living population (similar values were obtained by Kratochvil *et al.*, 1986); the same index was 3 for females older than 1 year, and 5.14 for females older than 2 years.

Births occurred during whole year, but 50% were within the period between April and May (Fig. 3). This pattern agrees with a winter mating season as found by Mauget *et al.* (1984) and by Durio *et al.* (*op. cit.*). In our study, on a monthly basis, 1 peak (April-May) and two lows (February and October) could be identified: this might be explained by the killing of pregnant females during the harvest, the sexual cycle of this species and the summer anoestrus respectively (Durio *et. al.*, *op. cit.*; Mauget *et al.*, *op. cit.*). A second peak, though less obvious, was present in December-January, most probably due to the different environmental conditions. Compared with Mauget's study (*op. cit.*) the sampled population showed a delay of few months in birth distribution, probably owing to different climatic and environmental conditions.

The time specific life table suggests (Fig. 4) that mortality rates for both sexes were highest during the second year of life. However, neonatal mortality was not included in the first year mortality rate. The lowest age-specific mortalities and the greatest mean expectations of further life were found in 2-3 years old animals for both sexes. Life expectancy was slightly higher for females than for males throughout life. The higher nutritional requirements of lactating sows and growing juveniles may be



	84-85	85-86	86-87	87-88	88-89	89-90	90-91
% pregnant sows	26.7	10.8	17.9	18.1	64.5	16.7	20.4
fertilization rate (%)	69	41.9	37.4	55.1	96.1	41.5	52.9
embryos/females	5.8	4.5	4.8	4.5	4,95	4.9	5.2

Figure 2 - Reproduction parameters of the sampled population.

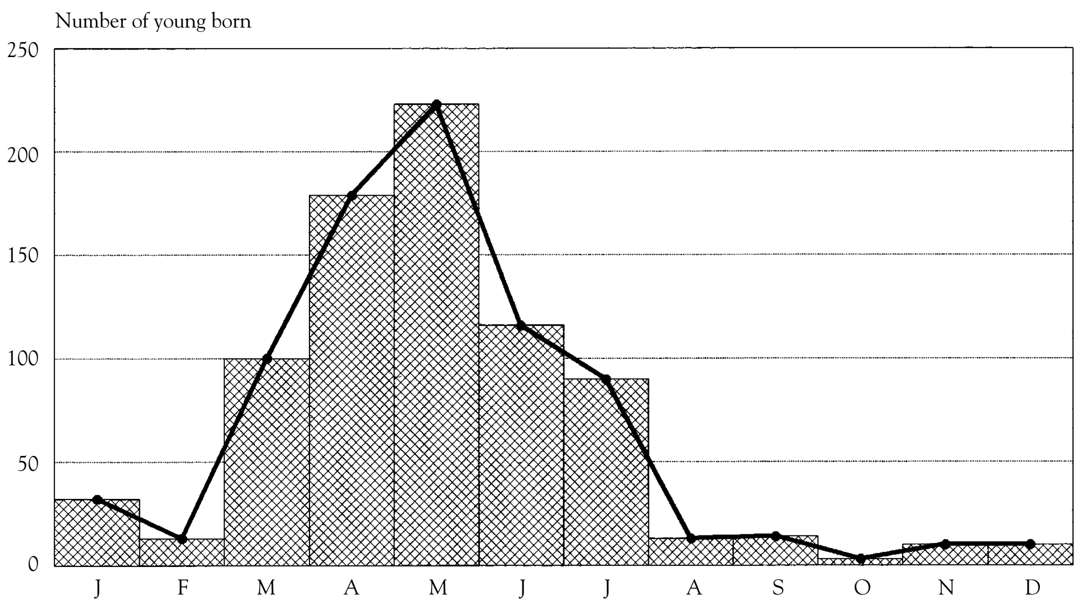


Figure 3 - Birth distribution of the sampled population (n=803).

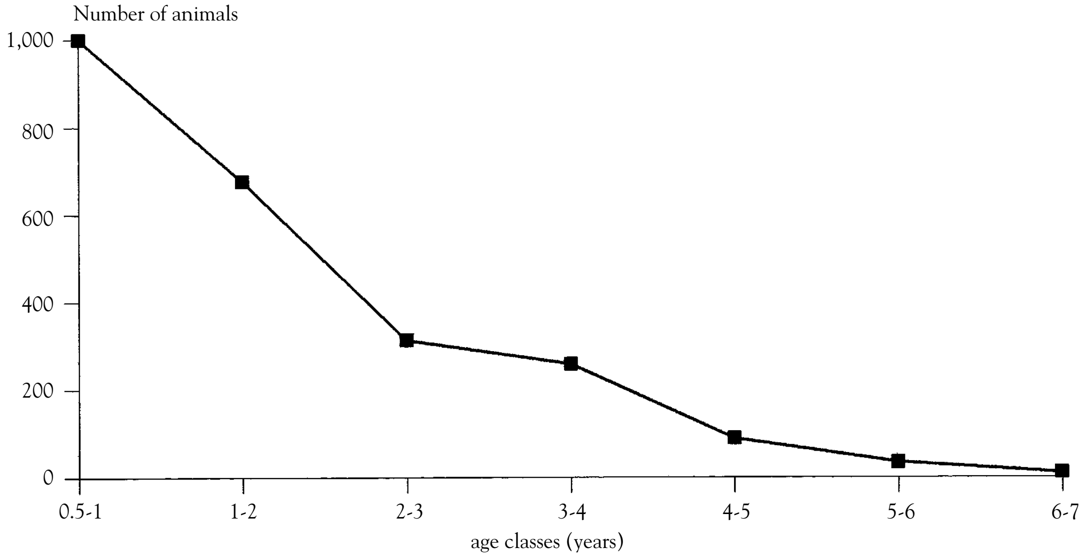


Figure 4 - Survivorship (1000lx) curve for the whole sample.

the causes of an increased vulnerability of these groups to natural as well as to hunting mortality.

Acknowledgements

We are indebted to the hunters and the A.R.S. of Monticiano for allowing us to sample their boars. D. Nonis and K. Benvenuto helped in collecting most of the field work.

References

Boisaubert B., Tatin D. & Maillard D., (1987) - Tableaux de chasse nationaux "Grand Gibier". Saisons 1983-84, 84-85, 85-86. *Bull. mens. O.N.C.*, 116: 412.

Boitani L. & Mattei L., (1992) - Aging Wild boar by tooth eruption. In: *"Ongulés/Ungulates 91"*. F. Spitz, G. Janeau., G. Gonzalez & S. Aulagnier (eds), S.F.E.P.M.-I.R.G.M., Paris - Toulouse: 419-421.

Durio P., Gallo Orsi U., Macchi E. & Perrone A., (1992) - Monthly birth distribution and structure of an alpine population of Wild boar in North-West Italy. In: *"Ongulés/Ungulates 91"*. F. Spitz, G. Janeau., G. Gonzalez & S. Aulagnier (eds), S.F.E.P.M.-I.R.G.M., Paris - Toulouse: 395-397.

Gerard J.F., Teillaud P., Spitz F., Mauget R. & Campan R., (1991) - Le Sanglier. *Rev Ecol.*, suppl., 6: 11-66.

Iff U., (1978) - Détermination de l'âge chez le Sanglier. *Diana* (Suisse), 10: 377-381.

Klein F., (1984) - Contribution à l'étude de la croissance du Sanglier par capture et recapture. Symposium International sur le Sanglier. F. Spitz & D. Pépin (eds), Toulouse, *Les Colloques de l'INRA*, n° 22: 57-67.

Kratochvil Z., Kux Z. & Pikula S., (1986) - Age structure and reproduction of a population of *Sus scrofa* in Czechoslovakia. *Folia Zoologica*, 35 (4): 311-324.

Massei G. & Tonini L., (1992) - The management of Wild boar in the Maremma Natural Park. In: *"Ongulés/Ungulates 91"*. F. Spitz, G. Janeau., G. Gonzalez & S. Aulagnier (eds), S.F.E.P.M.-I.R.G.M., Paris-Toulouse: 443-445.

Matschke G.H., (1967) - Aging wild hogs by dentition. *J. Wildl. Manage.*, 31:109-113.

Mattei L, (1987) - *Analisi degli areali (home ranges) in una popolazione di cinghiali (Sus scrofa L)*. Tesi di Laurea, Univ. «La Sapienza» di Roma, Italy.

Mauget R., (1980) - *Régulations écologiques, comportementales et physiologiques (fonction de reproduction) de l'adaptation du Sanglier au milieu*. Thèse Univ. Tours, France.

Mauget R., Campan R., Spitz F., Dardaillon M., Janeau G. & Pépin D., (1984) - Synthèse des connaissances actuelles sur la biologie du Sanglier. Perspectives de recherche. Symposium International sur le Sanglier. F. Spitz & D. Pépin (eds), Toulouse, *Les Colloques de l'INRA*, n° 22: 15-50.

Pikula J., Koubek P., Kratochvil Z. & Kux Z., (1985) - Reproduction of roe deer populations in Czechoslovakia. *Acta Sc. Nat. Brno*, 19(6): 1-47.

Saez-Royuela C., (1987) - Reproductive trends of the Wild boar in Spain. *Folia Zool.* 36(1): 21-25.

Vassant G., Gaillard J.M. & Klein F., (1988) - Impact de la chasse sur la dynamique des populations de Sanglier: premiers résultats. *Bull. mens. O.N.C.*, 122: 17-20.

STRUCTURE AND MONTHLY BIRTH DISTRIBUTION OF A WILD BOAR POPULATION LIVING IN MOUNTAINOUS ENVIRONMENT

Durio P. *, Gallo Orsi U. **, Macchi E. **, Perrone A. **

* Dipartimento Produzioni Animali, Epidemiologia ed Ecologia, via Nizza 52, 10126 Torino, Italy.

** C.R.E.A. - Centro Ricerche in Ecologia Applicata, via Catti, 12, 10146 Torino, Italy.

Abstract: 328 wild boars (*Sus scrofa)* killed during the hunting seasons 1986 - 1992 in two valleys in the South-Western part of Piedmont (Italy) were analyzed. The animals were aged by tooth eruption and wear and the age/sex pyramid was built. Average age of females and males was respectively 17.3 months and 15.2 months. About 76% of the sample was constituted by animals up to 2 years old. 118 animals (under 18 months old) were aged also by eye-lens weight thus allowing to estimate the birth date and to calculate the monthly birth distribution: 56% of births took place between April and July.

Keywords: Wild boar, *Sus scrofa,* Suidae, Sex ratio, Population structure, Age ratio, Italy, Europe.

IBEX J.M.E. 3:202-203

1. Introduction

The knowledge of the size and structure of a population of a wild species is the basis for any correct management plan. In the case of Wild boar, for its life style and for its preference for "closed" habitats, an accurate census can hardly be held on large areas.

It is possible to use hunt bags data to built an age/sex population pyramid and such data set can be used as an indirect method to study population trends provided that the hunting effort has been constant along the years. As in most areas of South Europe, the hunt in Piedmont is performed by drives with hounds; this method may be considered as a random sampling of the population since hunters do not seem to prefer any particular age/sex class.

2. Study areas, material and methods

Study areas are two valleys in South-West Piedmont (NW Italy):

- Varaita Valley is a typical alpine valley running West-Eastwards showing strong climatic differences between the North- and South-facing sides. Annual rainfall is 800-1,000 mm (150 mm in summer). Scots pine (*Pinus sylvestris*) on the warmer side and Fir (*Abies alba*) on the cooler one are the dominant trees. A large *Pinus cembra* wood is located on the South-facing side. Animals from this area were killed between 400 and 2,700 m u.s.l. (average 1,000 m).
- Tanaro Valley is located in the southernmost part of Piedmont, in the Maritime Alps. It runs SSE-NNO and it is characterised by an apenninic-mediterranean climate. *Pinus sylvestris* is the dominant tree in pure stands or mixed with *Castanea sativa* or *Betula sp*. On the bottom of the valley *Quercus pubescens* is widespread. This valley represents the southern limit in the distribution of some typical alpine species, like *Lagopus mutus*.

Wild boars killed during the hunting seasons 1986 - 1992 were analysed. 328 of them were aged by tooth eruption and tooth wear following Iff (1978).

Aging Wild boar by the eye-lens weight is the more precise available method: its precision decreases while the age of the animal increases (Pépin *et al*., 1987). In order to obtain a reliable birth distribution only 118 animals that were under 18 months of age have been considered. The limit of 18 months was fixed in order to obtain data from any month.

3. Results and discussion

The regional hunting regulation protects striped piglets, so the first age class (up to 6 months of age) is strongly underestimated (Fig 1). Nevertheless the population of hunted animals is fairly young: about 76% of the sample is constituted by animals up to 2 years old and only 5.2% is more than 3 years old. Average age was 17.3 months for females and 15.2 months for males. The oldest male was 6-7 years old and 125 kg of undressed weight. The fact that the sex ratio on the whole sample is almost 1:1 (considered to be the natural ratio) indicates that the hunters do non discriminate between sexes (Tab. 1).

During the period 1986 - 1992, 162 animals were collected in the Varaita valley while the collection of 166 wild boars in Tanaro valley took place in the years 1991-1992. So in the

Table 1: Sample size and sex ratio in the two study areas, (N = 328).

Age (months)	Sample size (n)	Males/Females Ratio (M/F) Total	Tanaro	Varaita
≤6	60	0.82	0.94	0.66
7-12	75	1.50	1.05	1.72
13-18	57	0.90	1.00	0.73
19-24	65	0.85	0.85	1.00
25-30	41	0.64	0.61	0.70
31-36	13	0.85	0.33	4.00
≥37	17	0.54	1.00	0.33

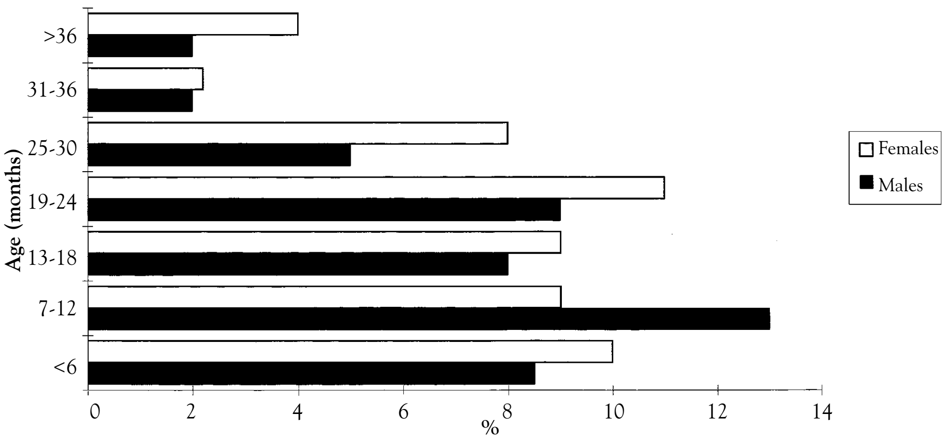


Figure 1 - Age/sex composition of total sample (N = 328).

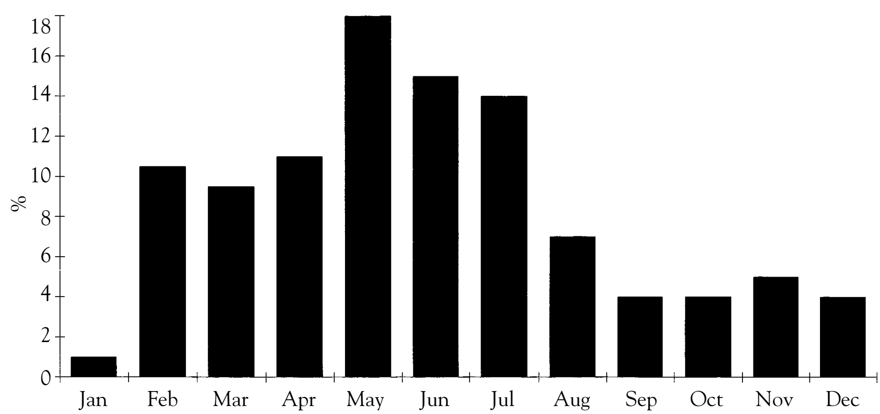


Figure 2 - Monthly distribution of births. (N = 118)

first study area data might have been affected by population changes, nevertheless shooting effort and bag size during this period have been constant and we have no evidence of any changes in population size or structure.
The monthly distribution of births (n = 118) shows a typical seasonal pattern with 56% of the births concentrated between April and July (Fig 2). Anyway births took place all around the year and this confirms the observations of "striped" piglets that have been done in all months.

References

IFF U., (1978) - Détermination de l'âge chez le Sanglier. *Diana*, 95 (10): 377-381.

PÉPIN D., SPITZ F., JANEAU G. & VALET G., (1987) - Dynamics of reproduction and development of weight in the Wild boar *(Sus scrofa)* in south France. *Z. Säugetierk.*, 52: 21-30.

METHODS OF POPULATION ESTIMATES OF A HUNTED WILD BOAR (*Sus scrofa* L.) POPULATION IN TUSCANY (ITALY)

Boitani L., Trapanese P., Mattei L.

Dipartimento di Biologia Animale e dell'Uomo, Viale dell'Università 32, 00185-Roma, Italy.

Abstract: On the basis of demographic data on 1253 wild boars hunted in Monticiano (Siena) from 1984 to 1991, age, sex and life tables were computed. Demographic parameters in combination with hunting effort provided the basic data to check the population trends year by year. Estimates of the population were computed through 9 different methods which fall into three general classes (Catch per Unit Effort, Population Reconstruction, Lang and Wood's Pennsylvania method). An evaluation of these methods is provided.

Keywords: Wild boar, *Sus scrofa,* Suidae, Population estimates.

IBEX J.M.E. 3:204-208

1. Introduction

An important source of information on wildlife populations is often the hunters' harvest and a variety of techniques and methods has been developed to analyse these data. Several techniques of analysis should always be tested and evaluated using a population of known composition and size. As an alternative a population should be monitored over a long period of time, using independent methods and data sets (Roseberry & Woolf, 1991). We present here different techniques which were applied to the study of a Wild boar population over a seven years period. A combination of demographic parameters and data on hunting effort and success provided the basic input data (Boitani *et al.*, this volume).

2. Methods

Demographic data of 1253 wild boars hunted in Monticiano (Siena, Italy) from 1984 to 1991 were used to compute age, sex and life tables (Boitani *et al.*, *op. cit.*). Wild boars are hunted by driving them against a line of posted hunters. Traditionally, hunting occurs three times a week from November to January. Hunting effort is significant (about 1,000 hunters afield per a total 30 days), rather constant and uniformly distributed on the 4,840 ha study area. Estimates of the population trend were calculated using nine different methods: these are grouped for similarity of inputs and assumptions into 3 classes (following Roseberry & Woolf, *op. cit.*):

1) CATCH PER UNIT EFFORT

The ratio of animals caught to effort expended is proportional to the number of animals in the population at the beginning of capture period (N). The primary variable influencing the number of wild boars killed is the number of individuals in the population; in fact hunting, the major cause of mortality during winter, takes a random (and therefore representative) sample of the living population. A basic assumption is that the population must be closed between capture/killing events: in our area we can accept the assumption as immigration equals emigration and very few births occur at that time of the year (Boitani *et al.*, *op. cit.*). Probability of capture between November and January remains constant (except for little individual variations due to behavioural and/or physiological reasons), as hunters do not operate any significant selection on wild boars. Zero to five months old piglets are rarely killed because of hunting tradition and the difficulties in catching them.

- *Catch Method* (Zippin, 1956). When two catches (C_1; C_2) are taken with equal effort, population size prior to the first catch (first half of hunting season) can be estimated as: $N=C_1^2/(C_1-C_2)$.
- *Leslie Method* (Leslie & Davis, 1939). Catch per unit of effort (y) plotted against the previous cumulative catches (x) provides a straight line cutting the x-axis at the population size prior to harvesting (Caughley, 1977). If the trend of the points is not linear (as in our case) the method should be abandoned.

- *Direct Index* (Eberhardt, 1960). The catch per unit effort (C) is a function of population size and can therefore serve as an index to the latter. Mathematically this method states: $C(t) = K \cdot N(t)$, where K = constant, N = catchability (total catch/ hunters)

- *De Lury Method* (De Lury, 1947). Log of catch per unit effort is a linear function of cumulative effort. Eberhardt (*op. cit.*) modified De Lury's (1951) exponential equation to estimate prehunt population size: $N = C/1 - (e^{-cE})$, where C = total catch, c = proportion of population caught per unit of effort, and E = total effort. Each unit of effort (1,000 hunters or 100 days hunted) was assumed to take on average 18-20% of the living population each year: these percentages were determined by trial and error and the obtained values of "c" were tested against reconstruction population results to check for minimum population homology.

2) POPULATION RECONSTRUCTION

Numbers of animals dying in each sex and age class are required for at least two subsequent years. As the basic input is harvest data, *i.e.* only a portion of winter total deaths, reconstruction represents only a portion of the living animals. In our sample the annual cohort harvest was relatively constant in time, as the annual kill was proportional to the living population. Age determination was accurate up to the age of 3 years, for older animals a potential error can occur (Boitani *et al.*, *op. cit.*).

- *Standard reconstruction* (Fry, 1949). The minimum possible number of animals alive in a given cohort for a given year is determined summing all the individuals from that cohort retrieved in subsequent years. For cohorts not completely passed throughout the year/population matrix, the proportion of the population harvested per unit of effort (based on previous reconstruction and harvest data) in combination with current harvest and effort estimates is used to obtain pre-hunt population size (Fryxell *et al.*, 1988). Alternatively, an average harvest rate from previous reconstruction and harvest is computed and divided into current harvests (Creed *et al.*, 1984).

- *Downing Method* (Downing, 1980). Similar to the previous one, this technique computes survival rates by the number of dead animals in the last inclusive age category, instead of arbitrarily proportioning this class into older ones. These rates and the number of dead animals in these classes are used to estimate numbers alive at the beginning of the year. Younger age classes are reconstructed by simple addition.

- *Cohort Analysis* (Fryxell *et al.*, *op. cit.*). This method combines Cohort analysis or Reconstruction with the Catch per unit effort method. For cohorts passed through the population (1984, 1985, 1986), estimates of age-specific mortality are used to compute past abundance. For recent years (1987, 1988, 1989, 1990) a vulnerability coefficient *q* (proportion of population killed per unit of effort) is estimated for each cohort using the average of data from several past years: $q = \log_e\{(\text{reconstruction-harvest})/\text{reconstruction}\}/\text{effort}$. Following Vassant *et al.* (1988) and Spitz *et al.* (1984), average harvest mortality rate is 80%, and age-specific survival rates are assumed to decrease with increasing age.

- *Winsconsin Method* (Creed *et al.*, *op. cit.*). Minimum population estimate for males (TM) is obtained by Standard Reconstruction of annual harvest data. TM, multiplied by an expansion factor (EF = a measure of adult sex ratio), gives estimate of total population size (TP). When years are too recent to be included in the reconstruction, TM is estimated by dividing the male harvest for that year by the average of male harvest rates in the previous 3-years (obtained by dividing actual harvest by TM for that year).

3) LANG AND WOOD'S PENNSYLVANIA METHOD (Lang and Wood, 1976)

The average annual reduction rate (AARR) for adult males is computed from the male harvest age structure (following Downing, *op. cit.*):

$AARR = 1- \{(H2.5+H{\geq}3.5)/(H1.5+H2.5+H{\geq}3.5)\}$

where H1.5, H2.5, ≥H3.5 = number of hunted wild boars 1.5, 2.5 and ≥3.5 years old respectively. Adult male harvest is divided by AARR to obtain pre-hunt adult male population. Adult-female:adult-male ratio (FA/MA) is computed using Severinghaus and Maguire's technique (1955) and multiplied by the female-fetus:male-fetus ratio to adjust for possible unequal recruitment into the yearling class. Pre-hunt adult male population is multiplied by FA/MA to obtain pre-hunt adult female population. Piglets: adult females ratio (P/FA) is computed by harvest data. Estimated pre-hunt adult female population is then multiplied by P/FA to give piglets crop. The sum of adult males, adult females and piglets gives total pre-hunt population.

COMPARATIVE EVALUATION OF TECHNIQUES

When more than one estimates were obtained from each technique, the chi-square test of homogeneity was run and the confidence limits computed. A comparative evaluation of the results obtained by the different methods was tested using the χ^2 test of homogeneity (to analyse the annual variability among estimates) and the variance test (to check for trend similarities among results obtained from each technique).

3. Results and discussion

Our results (Tab. 1) are not absolute population estimates, as information on crippling losses, natural mortality and piglets younger than 6 months were missing. However, estimates are comparable, as all were biased in the same direction. In order to obtain statistical significance some values were excluded from the averages (Tab. 1).

Out of nine methods, only eight gave acceptable estimates: our data did not fit the Leslie method assumptions (*i.e.*, the series of catches must have decreasing values).

χ^2 and variance tests show that the different estimates are reasonably homogeneous: results can then be lumped to track a final population trend over time (Fig. 2). All methods, although slightly different in numbers, show similar fluctuations of the population: a peak in 1985, a low in 1988, followed by a new peak. The only discrepancy is in 1986-87 trends, when the *Cohort Analysis* and the *Downing Method* are the only methods showing a decrease (Fig. 1f and 1e). The former is probably justified by arbitrarily selected non-harvest mortality rates, while no explanation, other than sampling bias, was found for the second technique's disagreement.

As stated by Roseberry and Woolf (*op. cit.*), *Catch per unit effort* variations (Fig. 1a, 1b,1c) offer a useful tool to monitor population estimates with limited input data, while *Population Reconstruction* models (Fig. 1d, 1e, 1f, 1g) are appealing because of their underlying simplicity and logic, although they are sensitive to changes of the numbers of harvested boars. When such fluctuations reflect changes in harvest intensity rather than population size, trends will be biased. A constant fraction of all deaths is needed in order to carry out a minimum reconstruction. This requirement may be violated by any change in hunting regulations during the study period, and also by weather or other conditions affecting hunting success. Minimum reconstruction is expected to perform best when hunting is the principal cause of death, as harvest is relatively easy to measure and the remaining deaths may not be numerous enough to significantly increase the size of the reconstructed population. However, the relative importance of the harvest can not be evaluated until the other causes of death have been measured at least once. *Lang and Wood* method was the most difficult to compute for its mathematical requirements and appears to be less sensitive, precise and robust than the previous ones (Roseberry & Woolf, *op. cit.*).

4. Acknowledgements

We are indebted to the hunters and the A.R.S. of Monticiano for allowing us to sample their boars. D. Nonis and K. Benvenuto helped in collecting most of the field data.

Table 1: Population estimates using eight different methods.

METHOD	1984	1985	1986	1987	1988	1989	1990
Catch Method	444	515	482	493	327	487	620
Direct Index	487	527	425	453	328	469	602
De Lury Method	414	573	480	477	294	473	573
Standard Reconstruction	407	560	451	462	[262]	[393]	525
Downing Method	420	518	486	476	365	519	596
Cohort Analysis	451	[471]	466	430	334	503	561
Winsconsin Method	440	510	482	497	[276]	430	551
Land and Wood Method	441	587	442	495	[397]	516	617
AVERAGE	**438**	**541**	**464**	**473**	**330**	**485**	**581**
± SE	±22	±29	±19	±20	±31	±29	±28

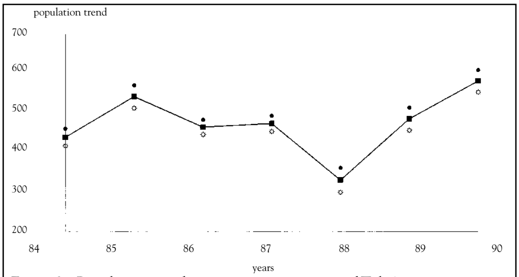


Figure 2 - Population trend using average estimates of Tab 1.

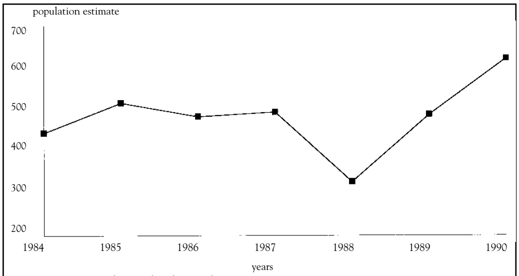


Figure 1a - Catch method trend

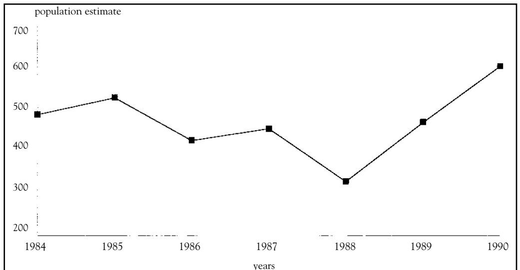


Figure 1b - Direct index trend

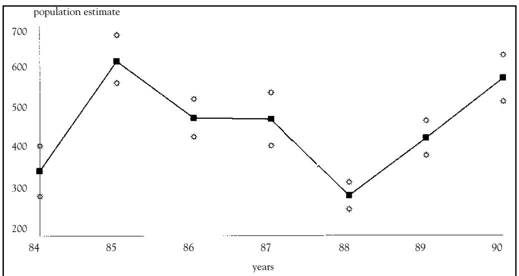


Figure 1c - De Lury method trend

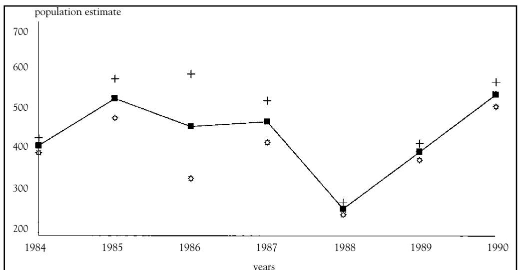


Figure 1d - Standard reconstruction trend

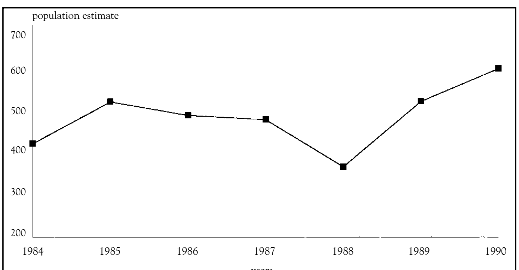


Figure 1e - Downing method trend

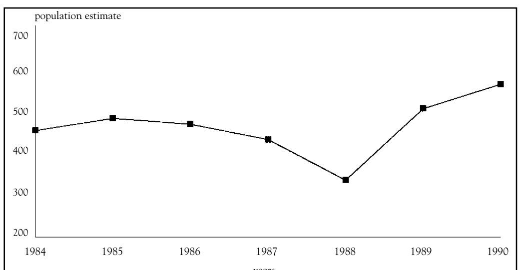


Figure 1f - Cohort analysis trend

Figure 1g - Winsconsin method trend

Figure 1h - Lang and Wood method trend

References

BOITANI L, TRAPANESE P. & MATTEI L., this volume- Demographic patterns of a Wild boar (*Sus scrofa* L.) population in Tuscany, Italy.

CAUGHLEY G., (1977) - *Analysis of vertebrates populations*. J. Wiley & Sons, New York, NY.

CREED W.A, HABERLAND F., KOHN B.E. & MCCAFFERY K.R., (1984) - Harvest management: the Wisconsin experience. In: *White-tailed deer: ecology and management*, Stackpole Books, Harrisburg, Pa: 243-260.

DE LURY D.B., (1947) - On the estimation of biological populations. *Biometrics*, 3: 145-167.

DE LURY D.B., (1951) - On planning of experiments for the estimation of fish populations. *J. Fish. Res. Board Can*, 8: 281-307.

DOWNING R.L, (1980) - Vital statistics of animal populations. In: *Wildl. Manage. Techn. manual*, S.D. Schemnitz (ed), The Wildlife Society, Washington: 247-267.

EBERHARDT L.L., (1960) - *Estimation of vital characteristics of Michigan deer herds*. Mich. Dep. Conserv. Game Div. Rep. 2282, 192 pp.

FRY F.E.J., (1949) - Statistics of a lake trout fishery. *Biometrics*, 5: 27-67.

FRYXELL J.M., MERCER W.E. & GELLATELY R.B., (1988) - Population dynamics of newfoundland moose using cohort analysis. *J. Wildl. Manage.*, 52(1): 14-21.

LANG L.M. & WOOD G.W., (1976) - Manipulation of the Pennsylvania deer herd. *Wildl. Soc. Bull.*, 4: 159-166.

LESLIE P.H. & DAVIS P.H., (1939) - An attempt to determine the absolute number of rats on a given area. *J. Anim. Ecology*, 8: 94-113.

ROSEBERRY J.L. & WOOLF A., (1991) - A comparative evaluation of techniques for analysing White-tailed deer harvest data. *Wildl. Monographs*, 117: 1-59.

SEVERINGHAUS C.W. & MAGUIRE H.F., (1955) - Use of age composition data for determining sex ratios among adult deer. *N.Y. Fish and Game J.*, 2: 242-246.

SPITZ F., JANEAU G. & VALET G., (1984) - Eléments de démographie du Sanglier dans la région de Grésigne. *Acta Oecologica (Oecol. Appl.)*, 5(1): 43-59.

VASSANT G., GAILLARD J.M. & KLEIN F., (1988) - Impact de la chasse sur la dynamique des populations de sangliers. Premiers résultats. Bull. mens. *O.N.C.*, 122: 17-20.

ZIPPIN C., (1956) - An evaluation of the removal method of estimating animal populations. *Biometrics*, 12: 163-189.

DISTRIBUTION AND DENSITY OF WILD BOAR (Sus scrofa) THROUGH TRACKS SURVEY IN THE ORSIERA ROCCIAVRE NATURAL PARK, PIEDMONT (ITALY)

Alpe D.

Parco Naturale Orsiera Rocciavrè, via Pacchiotti 51, 10094 Giaveno (To), Italy.

Keywords: Wild boar, *Sus scrofa,* Suidae, Distribution.

IBEX J.M.E. 3:209-210

The accurate cartographical survey of species Wild boar (*Sus scrofa*) inside the protect area and in the neighbouring zones started in 1990 at the same time as other ungulates surveys. Since 1985 the ungulate observations made by the Park Guards were noted down, but unfortunately the observations from 1985 to 1990 were not easy to read because their comparative inexactness.

Since 1990 for all animal surveys in the Park, including ungulates, the method of cartography with U.T.M. squares was adopted. Every U.T.M. square was still divided in four parts, called A - B - C - D, to obtain more accuracy (so every square has a side of 500 m). The Park Guards during their usual watching service or during the censuses of other ungulates noted down on special cards not only the place of the observed animals, but also other notes, like sex and presumed age, altitude, habitat and possible snow, in order to have a complete line for every observation. Then these data were filed with the software Rapid File (an advanced Data Base on purpose built by the Park) to be tested and looked up easier. A first result of this work was the compilation of a map with the distribution of Wild boar in the Park and in the neighbouring zones.

In 1987 a study based on the tracks survey following the I.C.A. system (Index Kilometric of Abundance) began. This research, initially born for a study on the wintering of the Red deer (*Cervus elaphus*), was immediately extended to all other ungulates. Also for these surveys, since 1991 the method of cartography with U.T.M. squares was used. Two paths were individuated: I.C.A. 1 and I.C.A. 2, to run 24 hours after the last snowfall. During this journey all the tracks crossing the paths perpendicularly, in ascent and in descent, were noted. This system surely doesn't allow to make exactly census of every species, but enables to have useful knowledge on their movements, on the presumable plenty and on possible fluctuation of wild population.

The data picked since 1987 are shown in figure 1. The map of distribution of Wild boar (Fig. 2) was write only on the ground of certain observations. Really, the tracks survey and the "ploughings" allowed to verify that the Wild boar haunts all the Park area and the neighbouring zones, between 400 m u.s.l. in valley bottom and 2000 m u.s.l. and more, especially in summer.

The observations in the Susa Valley slope of the Park are relatively more plentiful, because the border of the Park runs along lower average height than Sangone Valley and Chisone Valley.

Besides, in the Susa Valley slope the more spread arboreal covering and vast chestnut-tree areas give land more suitable for the Wild boar diffusion. In the Chisone and Sangone Valley slopes the wood and bush areas are especially out of the Park territory, and so the observations normally happen out of the protected area or near the borders.

Data till now collected allow us to draw some conclusion; the Wild boar presence inside the protect area is conditioned principally by climate. As a rule during the winter the Wild boar population inclines to move from up to down, like other ungulates (Red deer, Roe deer). It must be noted that these movements are especially conditioned by the snowfall consistence. If the precipitations are not much plentiful the wild boars incline in any case to remain inside the protect area, moving only to feed in the lower zones out of the Park, and they come back before dawn. If snowfalls are abundant and continuous the wild boars come resolutely down the valley, remaining out of

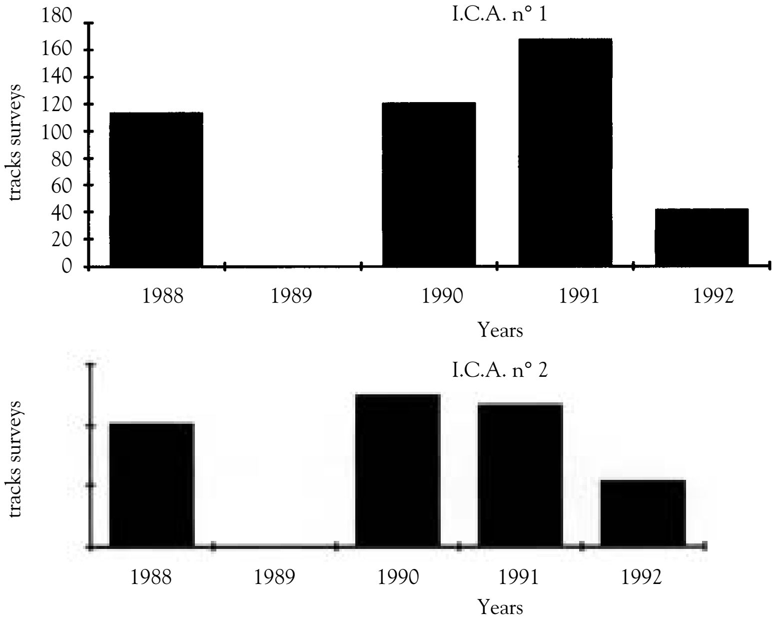


Figure 1 - Tracks survey from 1988 to 1992 on two different paths.

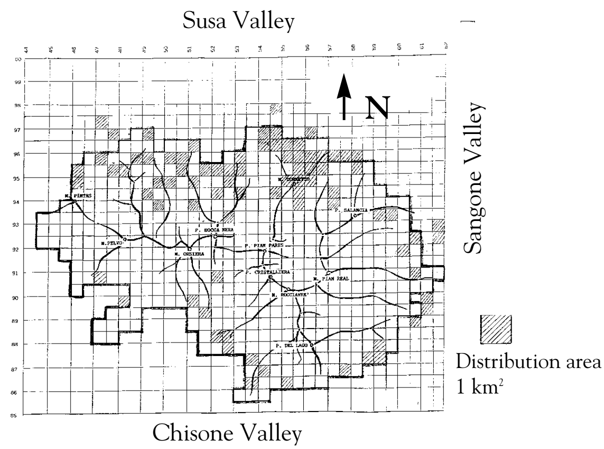


Figure 2 - Orsiera Rocciavré Natural Park

protect area until the climate improves, remaking possible feeding also in the upper zones.
The zones where the Wild boar passes are nearly always the same. If the animals are not frequently bothered, they incline to be very habit-loving during their movements and in the "mudding" areas.
Animal groups had been observed to run along the same paths from one year to another, and often at the same time. The horizontal movements are very restricted and are especially done by subjects trying to colonize new lands or searching for food, particularly in winter.
The tracks number in 1992 is very low in comparison to those obtained between 1988 and 1991 (Fig. 1). Increased hunting pressure and poaching probably took part to this drop but more observations are needed to conclude anyway.

Acknowledgements
The tracks survey was made by the Park Guards: Giuseppe Ferrero, Elio Giuliano, Luca Giunti, Marino Miletto and the author.

FACTORS THAT LIMIT THE NUMBER OF WILD BOARS (Sus scrofa L.*) IN THE REPUBLIC OF MOLDOVA*

Lozan M.
State University of Moldova, Kishinau, Cogalniceanu, str. 65, Republic of Moldova.

Keywords: Wild boar, *Sus scrofa,* Suidae, Environmental factors, Health, Human effect, Population.

IBEX J.M.E. 3:211

Observations carried out in the course of more than 30 years on the Wild boar in natural conditions in Moldova allow us to express our opinion about factors limiting the numerical strength of this species. The number of wild boars varies from several hundreds to 10-12 thousands in Moldova. This variation depends on climatic, anthropogenic, epidemic and, to a certain degree, biocenotic factors.

The climatic factors play a decisive role; a humid and fresh climate is favourable for wild boars. This fact obviously leads to a widening of the habitat and intense reproduction of the species. Drowning of numerous sucking boars from populations of reed plantations has been registered (Pruth river valley). Winters with too much snow have a negative effect: 40 cm layer limits Wild boar movements (e.g. when searching for food).

The anthropogenic factors have a many sided action and alongside a decisive role in the determination of the numbers of the wild boars. Poaching is very spread in Moldova. Feral dogs and foxes represent a danger for young specimens.

Epidemics can have a negative influence with a cyclic effect. From the sixties to the nineties two plague epidermics have been registered and in both cases the numerical effective have reached the minimal level.

WILD BOAR AS THE MAIN PREY SPECIES OF WOLF IN AN AREA OF NORTHERN APENNINES (ITALY)

Mattioli L. *, Apollonio M. **, Lovari C. *, Siemoni N. *, Crudele G. ***

* D.R.E.A.M., Settore Fauna, via Roma 157, Ponte a Poppi (Arezzo), Italy.
** Dipartimento di Scienze del Comportamento Animale e dell'Uomo, Università di Pisa, via Volta 6, 56126 Pisa, Italy.
*** Ex A.S.F.D. Pratovecchio (Arezzo), Italy.

Keywords: Wild boar, *Sus scrofa,* Suidae, Ungulates, Wolf, Age related predation, Europe.

IBEX J.M.E. 3:212

Wild boar was the most important food item in Wolf diet in the southern side of the Casentinesi Forest, a protected area of northern Apennines ranging from 400 to 1,520 m u.s.l. The age of wild boars consumed by wolves vas estimated using teeth and bone fragments compared with a reference collection. Data about live weights of boars at various ages allowed to infer the weight of preyed individuals. On the basis of 240 Wolf scats analysis we determined for Wild boar a frequency of occurrence of 52.5%, a mean relative volume of 45.6% and a relative biomass of 39.9% This species was increasingly used from 1988 to 1992. Moreover taking into account the availability of Wild boar in the study area also a significant increase of selection (expressed as use/availability ratio) for this prey species was evident. Its use by Wolf was inversely correlated with the occurence of cervids in the diet.
Adult boars, over 40 kg, appeared infrequently in Wolf diet, *i.e.* less than 6%, conversely piglets (less than 25 kg) represented the more used age class with over 77% of occurencies. Taking into account data on population structure we found that piglets were consumed 1.8 times more than their frequency in the population. They seemed to be preyed more between July and October than before, even if the peak of births took place in April. This was confirmed by the finding that weight classes between 13 and 23 kg (*i.e.* 6 to 12 months of age) were the most used. The result may suggest an active selection towards easy but also remunerative preys and/or a more active defence of piglets by sows in their first months of life. Wild boar confirmed to be a key prey species for wolves also in highly natural environments with large populations of other wild ungulates. This species with his large productivity may buffer the effects of Wolf predation on cervids populations helping to maintain a rich and diverse ungulates community.