Hystrix It. J. Mamm. (n.s.) 18 (1) (2007): 57-68

ZONING AND WILD BOAR MANAGEMENT: A MULTI-CRITERIA APPROACH TO PLANNING

ALESSANDRO MASSOLO[1,3*], ROBERTO MAZZONI DELLA STELLA[2], ALBERTO MERIGGI[3]

[1] Section of Behavioural Ecology, Ethology and Wildlife Management, Department of Environmental Sciences, University of Siena, Via P.A. Mattioli 4, 53100 Siena, Italy
[2] Wildlife Service, Province of Pisa, Via P. Nenni 24, 56125 Pisa, Italy
[3] Department of Animal Biology, University of Pavia, Piazza Botta 9, 27100 Pavia Italy; * present address, e-mail: massolo@eulabs.eu

Received 14 September 2006; accepted 10 Jenuary 2007

ABSTRACT - Wild boar *Sus scrofa* management is a central issue in Europe, particularly in Italy. The problem mainly concerns the impact of wild boar on natural (protected areas) and artificial habitats (cultivated lands), and the demands of hunters, which result in a social conflict. Our study was conducted in Siena Province (central Italy), and mainly aimed to identify areas for hierarchically actions based on both objective and subjective criteria. We collected all available data regarding counts, harvest and hunting effort on the wild boar population (1988-1999), and on damage to cultivation (1996-1999). We performed a habitat analysis by the use of a GIS and numerical data, defining, by means of cluster analysis, 3 homogeneous habitat classes in terms of wooded/natural areas and cultivated lands (cultivated, intermediate, wooded). Subsequently, to better define habitat suitability for the wild boar we used Multiple Logistic Regression. We then formulated an expert model for indexing the vulnerability to damage of each cultivation type, on the basis of the entity and occurrence of damage. All the models were then applied to the Siena Province, and results have been combined in a simple expert model of sustainability, to identify areas of different management priorities. As this approach links both objective predictions gained from different quality field data, and expert and managers criteria coming form political and economic constraints, we believe it to be a useful tool for planning management strategies.

Key words: *Sus scrofa,* wild boar, management, habitat modelling, population sustainability

RIASSUNTO - ***Zonazione e gestione del cinghiale: un approccio multicriteri alla pianificazione***. Il problema della gestione del cinghiale *Sus scrofa* è molto attuale in Europa e riguarda principalmente l'impatto che la specie ha sulle coltivazioni e sugli habitat naturali, e la richiesta da parte dei cacciatori di mantenere le popolazioni a elevati livelli demografici. Il nostro studio è stato condotto su dati provenienti dalla Provincia di Siena (Italia centrale), con l'obiettivo di individuare delle aree di gestione differenziale sulla base di criteri definiti in maniera formale. A tale scopo abbiamo raccolto i dati relativi a conteggi in battuta, a transetti e agli abbattimenti (1988-1999), e anche relativi ai danni alle coltivazioni (1996-1999). Abbiamo quindi condotto un'analisi ambientale su tutto il territorio provinciale e individuato 3 unità ambientali omogenee (UAO), tramite l'analisi di raggruppamento, a partire dall'abbondanza dei boschi e/o aree naturali e delle coltivazioni (UAO coltivate, intermedie, boscate). Successivamente, abbiamo valutato la qualità del

territorio per la specie formulando un modello di Regressione Logistica. E' stato quindi formulato un modello logico-concettuale per ranghizzare le colture sulla base della loro vulnerabilità al danneggaimento in termini di frequenza ed entità dello stesso. I modelli sono stati applicati a tutto il territorio provinciale e i risultati ottenuti sono stati combinati a un semplice modello di sostenibilità per la specie, la cui applicazione ha consentito di individuare aree a differente priorità di gestione. Riteniamo che questo approccio possa essere un utuile strumento per pianificare la gestione di popolazioni selvatiche, dal momento che integra predizioni oggettive con criteri di gestione forniti da esperti e da gestori e amministratori locali.

Parole chiave: *Sus scrofa*, gestione, analisi ambientale, modelli di idoneità ambientale, sostenibilità della popolazione

INTRODUCTION

Several factors have resulted in a dramatic increase in the European wild boar *Sus scrofa* populations from the '60s to nowadays: environmental changes, countryside desertion, artificial restocking, decrease in number of direct predators, and a consequent deep modification in breeding strategies have synergistically contributed to this phenomenon (e.g. Saez-Royuela and Telleria, 1986; Csányi, 1995; Moretti, 1995; Fruzinski, 1995; Herrero *et al*.,. 1995; Neet, 1995; Nores *et al*., 1995; Welander, 1995; Massei and Genov, 2000; Wilson, 2003). The situation in Italy is in agreement with the European trend (Boitani *et al*., 1995a; Debernardi *et al*., 1995; Durio *et al*., 1995; Gallo Orsi *et al*., 1995; Mignone *et al*., 1995; Pedone *et al*., 1995; Massei and Genov, 2000; Monaco *et al*., 2003; Brangi and Meriggi, 2003), and the Italian population recently has been roughly estimated to consist of 300.000-500.000 individuals (Monaco *et al*., 2003).

Wild boar management is a critical issue in Italy, and particularly in Tuscany (central Italy), where the local population is abundant even though no consistent estimate has ever been carried out. In Tuscany, the problem is mainly related to the high commercial value of cultivations (yearly more than 350.000 € of refunded damages in the Siena Province; Mazzoni della Stella *et al*., 1995a), and to the deep-rooted hunting tradition of this region: in the 1985-86 hunting season, in Siena Province alone more than 10.000 wild boars were killed, whilst in a single hunting area of this Province the mean culling density from 1990 to 1993 was 10 ind./100 ha (Mazzoni della Stella *et al*., 1995b). Unfortunately, untill now no studies have been conducted in Italy to evaluate the impact on natural ecosystems, though more data are available for other countries (see Massei and Genov, 2000 for a review). However, it is clear that the wild boar causes dramatical changes in the ecosystem when at high density, particularly as a consequence of its rooting activities.

The investment relating to hunting activity is wholly driven and the management is partially driven by socio-economic requirements, more than by scientific and technical considerations. Many interest groups

are thus involved in wild boar management as hunters and hunting managers, land owner organisations, and protected areas managers, so that a rationale for management has to take into account many aspects (Vassant, 1994).

Our purpose was to identify both objective and subjective criteria for simple habitat classification for wild boar management reasons. In particular, we aimed to classify areas at different sustainability levels and to define management plan priorities and actions for these different levels.

STUDY AREA AND METHODS

The proposed management zonation was based on data coming from hunting areas located in the Siena Province (about 3,820 km^2), and on expert advice from technicians of the Provincial Admini-stration. In the Siena Province, a rational organisation of wild boar hunting has been carried out since 1990 (Mazzoni della Stella, 1990 and 1995). During the study period, the territory has been divided in 3 main Hunting Administrative Districts (HAD), and within each one many hunting districts/consortia have been identified mainly according to homogenous land use/cover criteria (Mazzoni della Stella, 1995 and 2001). In each hunting district, a hunting team was formed with a minimum of 30 hunters per team and several dogs. Hunting districts were managed directly by hunter teams. Neither premiums nor rewards were paid to hunters for carcasses (Mazzoni della Stella, 1995 and 2001).

We collected wild boar harvest data (total harvest and hunting effort expressed as number of hunters and number of hunting days per hunting area) for the period from 1988 to 1999. We also collected all the available data relating to the frequency and amount of damage to cultivations (1996-1999), and to the species abundance, assessed by line transects and drive counts in Sampling Units (SU) between 1988 and 1999 (Mazzoni della Stella 1995 and 2001). Unfortunately, we were not able to consider neither the impact of the wild boar population on natural ecosystems nor its sustainability.

We divided the entire Siena Province into Application Units (AU) of 400 ha. For each SU and each AU we collected geographical data relating to the second half of the '90s, mainly by means of CORINE LandCover (III level; 1:100000), and by the Regional Forestry Inventory (1:25000; RFI). For each area we measured 38 habitat parameters concerning land use, forest structure, hedgerow extent, and 14 concerning altitude, slope and orographic roughness.

With the aim of providing some indications of use for the new management plan of the Siena Province, starting from the analysis of biological and ecological data, habitats were classified according to their suitability to sustain defined wild boar density levels (suitability), and in terms of habitat vulnerability, due to crop damage.

To achieve this goal, we first classified the whole territory into 3 categories of *a priori* sustainability using clustering processes from land cover data: null sustainability (areas mainly characterised by cropfields: cultivated), intermediate sustainability (areas with intermediate cover of croplands: intermediate), and high sustainability areas (mainly covered by woods: wooded). To identify homogeneous land use areas we used the *K*-Means Clusters Analysis on the CORINE Land Cover data (CA; SPSS Inc., 1999a), considering arable lands, woods and bushy or herbaceous areas with scattered trees as clustering variables. The territory classified as unsuitable at this level was excluded from further analyses.

Secondly, we developed a logistic regression model to classify more precisely the remaining territory into different levels of

suitability. The basic assumption was that more suitable areas were those where the species was more abundant; for this reason we developed a model using the habitat variables as independent and a dichotomic variable of wild boar abundance (class 1 ≤ 20 ind./100 ha; class 2 > 20 ind./100 ha) assessed by data collected in 26 sampling units (SUs; mean ± SE area = 63.6 ± 10.9 ha) by drive counts. The density threshold was chosen on the basis of the observed density data distribution (mean ± SE = 24.5 ± 4.1 ind./100 ha), and considering that in recently colonized areas of the Siena Province densities were below that threshold. To find the environmental predicting variables, we entered the variables into the model by stepwise selection criteria (Hosmer and Lemeshow, 1989).

Thirdly, we formulated a logical frame-work (Tab. 1, step 1) for the assessment of the vulnerability of damage to crops.

Table 1 - The three steps of the logical framework for the formulation of the model developed to assess wild boar sustainability of the Siena Province (see methods).

STEP 1

Crop vulnerability			
Constraints			Level
DF = Relative Damage Frequency (%)		≤ availability	1
		> availability	2
DE = Relative Damage Entity (%)		≤ 20%	1
		> 20%	2
Conditions			Index
if	No damage		0
	DF and DE both at level 1		1
	DE level 1 and DF level 2		2
	DE level 2		3

STEP 2

	Crop vulnerability	Habitat suitability	Sustainability	Index
if	0	2	5	3
		1	4	
	1	1	3	2
		2	2	
	2	1	2	1
		2	1	
	3	1	1	0
		2	0	

STEP 3

	Sustainability	HLU	Management priority level
if	High (3)	Woods	1
		Intermediate	1
		Arable lands	3
	Intermediate (2)	Woods	1
		Intermediate	2
		Arable lands	3
	Low (0 or 1)	Woods	2
		Intermediate	3
		Arable lands	3

RESULTS

The cluster analysis highlighted that 39.6% of AUs of the Siena Province were not suitable for wild boar as a consequence of their high percentage of arable land cover (mean = 58%; Tab. 2, Fig. 1).
In the remaining territory of the Siena Province, the suitability analysis by the logistic regression model defined two more classes of suitability (Fig. 2), and the model showed a positive effect of underwood on wild boar abundance, and a converse effect of woods (Tab. 3). Globally, the model classified correctly 73.9% of the original SUs, and allowed us to estimate that apart the above mentioned unsuitable territory, the remainder was equally distributed in the 2 classes of habitat suitability: 32.6% low suitability, and 27.8% medium-high suitability (Fig. 2).

Table 2 - Results of the cluster analysis performed to define Homogeneous Land use Units (HLU).

		% Mean (min-max)	Area (%)
HLU Cultivated	Arable land	58 (21.9-84)	39.4
	Wood	0.4 (0-32)	
HLU Intermediate	Arable land	23.9 (0-57.1)	34.7
	Wood	14.8 (0-60.3)	
HLU Wooded	Arable land	7.7 (0-44)	25.8
	Wood	73.9 (56-88.4)	

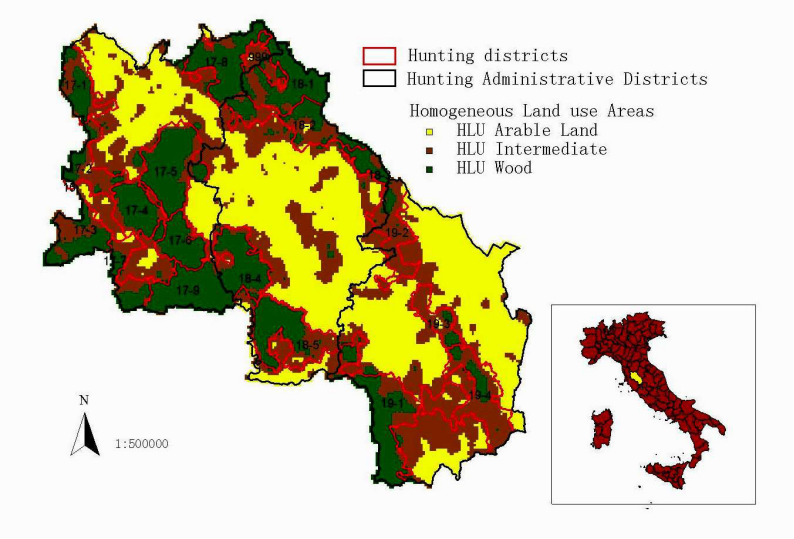

Figure 1 - Homogeneous Land use Units (HLU) in the Siena Province.

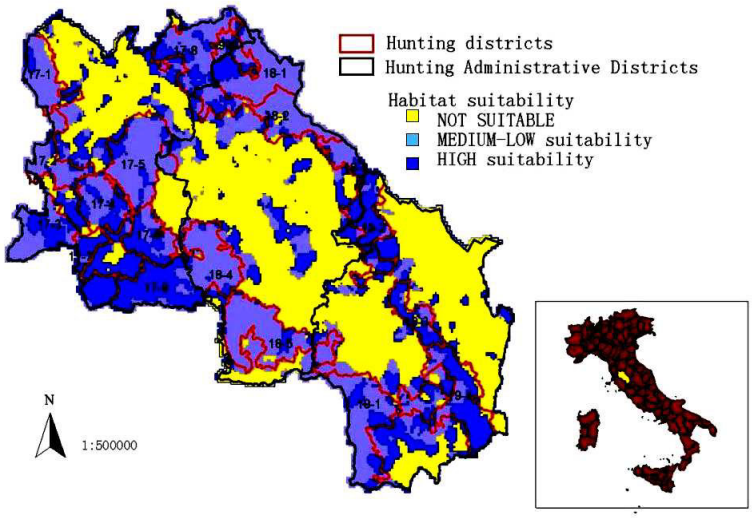

Figure 2 - Habitat suitability for wild boars in the Siena Province.

Table 3 - Results of the Logistic Regression Analysis model of habitat suitability for the wild boar; * transformed [ln(x+0.0001)].

Variable	B	S.E.	Wald	df	P	R	Exp(B)
Underwood*	1.902	1.063	3.198	1	0.074	0.194	6.698
Wood*	-2.887	1.441	4.012	1	0.045	-0.251	0.056
Constant	0.773	1.326	0.340	1	0.560		
-2LogLikelihood	26.202						
Goodness of fit	22.214						
Model χ^2	5.640			1	0.018		

Moreover, the application of the quantitative-logic model of sustainability allowed us to assign to each cultivation of the Siena Province a degree of sustainability ranging from 0 to 3. Also in this case we could evaluate the comprehensive situation and compare the 3 HADs. We therefore were able to highlight that the most vulnerable cultivations of the Siena Province were the arable lands and the vineyards, which represented the most critical cultivations for 2 HADs (17 and 18) out of 3. Furthermore, we were able to calculate the proportion of each cultivation type that was unsustainable in the whole Province (Table 4).

Most of the territory of the Province (83.3%) was found to need urgent management actions, or, at least, to be

drastically managed to reduce the impact of wild boar populations. As most of this territory was occupied by arable lands and therefore classified as unsuitable for the species, we chose to outline management priorities in those areas where the species was more abundant, thus focusing on hunting districts (Tab. 5). On the basis of the above results, we mapped 3 Population Management Units (PMU; Fig. 3) where to plan different population management strategies could be developed in order to reduce, maintain or increase the local wild boar sub-populations.

Table 4 - Results of the application of the model for assessing the sustainability of each cultivation in the three Hunting Administrative Districts (HAD). (DE: D. Entity; DF: D. Frequency) classes, along with the vulnerability classes (from 0 to 3) in the 3 HADs. In the lower part of the table the percentages of crops at different vulnerability levels are reported.

	Hunting Administrative Districts (HAD)								
	Damage level						Vulnerability		
	17		18		19		17	18	19
Crop type	DF	DE	DF	DE	DF	DE			
Trees	1	1	2	1	2	1	1	2	2
Horticulture	1	1	1	1	1	1	1	1	1
Meadows and Pastures	1	1	1	1	1	1	1	1	1
Arable lands with trees, olive groves, orchards	1	1	1	1	1	1	1	1	1
Arable lands	2	2	1	2	1	2	3	3	3
Vineyards	1	2	2	2	2	1	3	3	2

	Sustainability			
	0	1	2	3
Trees	28.9	13.4	43.3	14.4
Horticulture	53.9	-	33.3	12.7
Meadows and Pastures	35.4	-	33.8	30.8
Arable lands with trees, olive groves, orchards	46.2	-	23.8	30.0
Arable lands	87.2	12.8	-	-
Vineyards	64.2	33.5	2.3	-

Table 5 - Results of the application of the model for management priorities. For each hunting district the percentage of crops needing management actions (according to three different levels of urgency) is reported.

	Management priority levels		
Hunting Districts	1	2	3
17-1	12.1	18.6	69.3
17-2	5.2	12.5	82.3
17-3	10.0	40.0	50.0
17-4	6.3	46.9	46.9
17-5	27.0	38.2	34.8
17-6	33.3	66.7	0.0
17-7	0.0	35.0	65.0
17-8	16.4	42.5	41.1
17-9	24.0	72.0	4.0
18-1	27.2	40.2	32.6
18-2	17.6	26.1	56.3
18-3	9.5	38.1	52.4
18-4	35.6	40.7	23.7
18-5	25.0	20.2	54.8
19-1	22.1	15.5	62.4
19-2	9.3	24.6	66.1
19-3	1.4	9.5	89.2
19-4	22.8	14.0	63.2

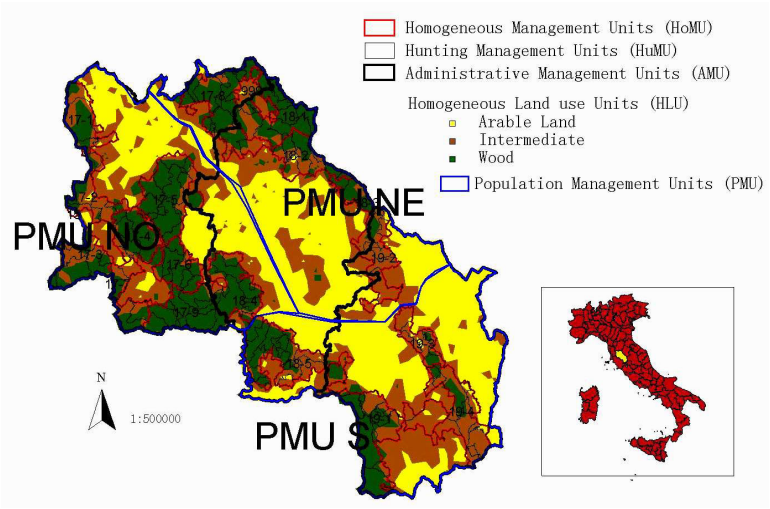

Figure 3 - Population Management Units (PMU) for the wild boar in the Siena Province.

DISCUSSION

Since each suitability class predicted by the model corresponded to a density estimate of species abundance by line transect data and drive counts in hunting sample units, our approach allowed us to roughly estimate the population of wild boars over the whole Province. This model application suggests that, by rule of thumb, the size of the overall population may reach 48.000 individuals. The estimate is, in our opinion, quite optimistic, but offers the possibility of comparing the 3 Hunting Administrative Districts (HAD); the wild boar sub-population of the HAD 17 (the north-western one) amounts to about 43% of the total population of the Province. The three Population Management Units, traced considering both wild boar abundance and environmental analysis, do not correspond to the actual HADs.

In our opinion the actual HADs should be rearranged to better manage the sub-populations, or our Population Management Units should be taken into account when programming the hunting activity for each hunting area. Similarly, the existence of critical areas where the sustainability is actually very low (i.e. hunting districts 17-1, 17-2, 19-3), should be considered, increasing control efforts.

Furthermore, as expected, the application of the conceptual model showed a high vulnerability and low sustainability along the transition areas between intermediate and wooded HLU (Fig. 1). Most of the cultivated lands are in a critical state and a coherent management policy should follow.

Our approach was an attempt to treat the large amount of data that are usually collected by hunting managers, to provide more objective indications for management planning.

Particularly, we aimed to organise a plan for the attainment of five main targets. First of all, we believe that (1) continuous population monitoring based on a standardised protocol would provide consistent data for the whole area; (2) hunting activities should be adequately organised, or present organisations optimised to ensure an equal distribution of game resources among hunters, and the contemporaneosly (3) reducing of damage to artificial and natural ecosystems. For this last point a continuous (4) monitoring of habitat changes in terms of both land use and vegetation patterns is necessary, and a (5) standard protocol of data collection, organisation and analysis is required. We believe that only through the continuous monitoring of the status of wild boar population and of habitat variations may we provide a dynamic management strategy adaptable to changing environmental and/or population conditions.

To reach these goals, we believe that a 5 year period is necessary to gain basic information for the whole Province. First of all, an educational campaign for the hunters, concerning species biology and management techniques, should be carried out. At the same time, a precise protocol of data collection should be prepared and concretely realised. Data collection should be finalised to assess a consistent estimate of the overall wild boar population, considering its structure, dynamics, its

impact on the cultivations and on natural ecosystems, and the factors that shape population fluctuations. All data should flow into a unique database for further analyses at a provincial scale. This would allow a new zoning with the definition of new management units (population management units, administrative districts, hunting districts, and hunting areas), each one with specific targets to be reached following a previously defined timetable. The achievement of the predetermined targets should be regularly checked during the 5-years period. Successively, the management strategy could be based on 3-years cycles, and adapted according to the results of previous strategies and to the variation of wild boar and environmental conditions.

Unfortunately, along with technical advice, the political counterpart has to be taken into great account, since sometimes it is more relevant then the former. In our case, the management plan was commissioned by the Siena Province Council in 1999, and completed at the end of 2001. Till now, no consequent decision has been taken and one is not expected in the near future.

ACKNOWLEDGEMENTS

We are grateful to Prof. S. Lovari for his useful suggestions during the whole project. Thanks are due to Dr. G. Romeo, Dr. M. Mattii, and Dr. L. Cimino, for their continuous collaboration. G. Plantamura and Dr. D. Pierucci helped for data input and organization. A great appreciation to all the hunters of the Siena Province hunting teams, for their enthusiastic cooperation in data collection.

The Game and Fish Council of Siena Province (Italy) funded to Professor S. Lovari our research.

REFERENCES

Almon C. 1988. The craft of economic modelling. GINN Press.

Boitani L., Trapanese P., Mattei L. and Nonis D. 1995. Demography of a wild boar (*Sus scrofa*, L.) population in Tuscany, Italy. *Gibier Faune Sauvage*, 12: 109-132.

Brangi A. and Meriggi A. 2003. Espansione del cinghiale (*Sus scrofa*) e danni alle coltivazioni in un'area delle prealpi occidentali. *Hystrix It. J. Mamm.*, 14(1-2): 95-105.

Csányi S. 1995. Wild boar population dynamics and management in Hungary. 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. Ibex J. M. E., 3: 222-225.

Debernardi P., Macchi E., Perrone A. and Focardi F. 1995. Distribution of Wild boar (*Sus scrofa*) in Piedmont and Aosta Valley (NW Italy). 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. Ibex J. M. E., 3: 141-144.

Durio P., Gallo Orsi U., Macchi E. and Perrone A. 1995. Structure and monthly birth distribution of a wild boar population living in mountainous environment. 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. *Ibex J. M. E.*, 3: 202-203.

Fruzinski B. 1995. Situation of Wild boar populations in western Poland. 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. *Ibex J. M. E.*, 3: 186-187.

Gallo Orsi U., Macchi E., Perrone A. and Durio P. 1995. Biometric data and

growth rates of a wild boar population living in the Italian Alps. 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. *Ibex J. M. E.*, 3: 69-70.

Herrero J., Garcia-Serrano A. and Garcia-Gonzalez R. 1995. Wild boar (*Sus scrofa*) hunting in south-western Pyrenees (Spain): preliminary data. 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. *Ibex J. M. E.*, 3: 228-229.

Hosmer, D.W. and Lemeshow S. 1989. Applied Logistic Regression. - John Wiley & Sons, New York.

Massei G. and Genov P. 2000. Il cinghiale. Calderini Edagricole, Bologna, Italy, pp. 189.

Massolo A. and Meriggi A. 1995. Modelli di valutazione ambientale nella gestione faunistica. Supplemento al n. 1 1995 di *Ethology Ecology & Evolution*, 1: 2-11.

Mazzoni della Stella R. 1990. Piano Faunistico Venatorio della Provincia di Siena. Amministrazione Provinciale di Siena.

Mazzoni della Stella R. 1995. Piano Faunistico Venatorio della Provincia di Siena. Amministrazione Provinciale di Siena.

Mazzoni della Stella R., Calovi F. and Burrini L. 1995a. Wild boar management in a Province of the central Italy. 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. *Ibex J. M. E.*, 3: 213-216.

Mazzoni della Stella R., Calovi F. and Burrini L. 1995b. Wild boar management in an area of Southern Tuscany (Italy). 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. *Ibex J. M. E.*, 3: 217-218.

Mazzoni della Stella R. 2001. Piano Faunistico Venatorio Provinciale 2001-2005. Provincia di Siena, Sevizio Risorse Faunistiche – Vigilanza – Riserve Naturali. 303 pp.

Mignone W., Poggi M., Pistone G.C., Caramelli M., Bollo E. and Biolatti B. 1995. Pathology of Wild boar (*Sus scrofa*) in Liguria, Italy, between 1989 and 1992. 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. *Ibex J. M. E.*, 3: 85-87.

Monaco A., Franzetti B., Pedrotti L. and Toso S. 2003. Linee guida per la gestione del cinghiale. Min. politiche Agricole e Forestali – Ist. Naz. Fauna Selvatica, pp. 116.

Moretti M. 1995. Birth distribution, structure and dynamics of a hunted mountain population of wild boars (Sus scrofa), Ticino, Switzerland. 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. *Ibex J. M. E.*, 3: 192-196.

Neet C.R. 1995. Population dynamics and management of *Sus scrofa* in western Switzerland: a statistical modeling approach. 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. *Ibex J. M. E.*, 3: 188-191.

Nores C., González F. and García P. 1995. Wild boar distribution trends in the last two centuries: an example in northern Spain. 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. *Ibex J. M. E.*, 3: 137-140.

Pedone P., Mattioli S. and Mattioli L. 1995. Body size and growth patterns in Wild boars of Tuscany, central Italy. 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. *Ibex J. M. E.*, 3: 66-68.

Sáez-Royuela C. and Telleria J.L. 1986. The increased population of the wild boar (*Sus scrofa*) in Europe. *Mammal Rev.*, 16(2): 97-101.

SPSS Inc. 1999a. SPSS Base 9.0 Application Guide. SPSS Inc., Chicago. 412 pp.

SPSS Inc. 1999b. SPSS Regression Models™ 9.0. SPSS Inc., Chicago. 201 pp.

Vassant J. 1994. Notions de base pour la gestion. Office National de la Chasse. Numéro spécial 191: 48-57.

Welander J. 1995. Are wild boars a future threat to the Swedish flora? 2nd International Symposium on Wild boar (*Sus scrofa*) and on sub-order Suiformes. *Ibex J. M. E.*, 3: 165-167.

Wilson C. J. 2003. Distribution and status of feral wild boar Sus scrofa in Dorset, southern England. *Mammal Review*, 33: 302–307.