SPACE USE BY PEN-RAISED WILD BOARS (Sus scrofa) RELEASED IN TUSCANY (CENTRAL ITALY) - II: HOME RANGE

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Abstract: The purpose of this study is investigating space occupation patterns shown by pen-raised wild boars released into the wild for restocking. Fourteeen pen-raised wild boars, released for restocking near Siena (Tuscany), were radiocollared and monitored from March 1990 to January 1991. Spatial exploration, determined by weekly convex polygons, chronological linked fixes, weekly geometric center trends and home range formation processes were studied for each individual. Total explorated and weekly used area (Minimum Convex Polygon method) were compared between sexes. Males and females displayed different space use. Total home ranges of males (mean area = 11.48 km^2) were significantly ($P<0.01$) larger than those of females (mean area = 3.77 km^2). No significant differences ($P>0.05$) were found between used area and distance moved by males and females during first week. From second week on females concentrated their movement and stabilized their use of space while males were more explorative during the whole observation period.

Keywords: Wild boar, *Sus scrofa,* Suidae, Restocking, Movements, Space utilization.

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1. Introduction

During last decades in Italy Wild boar populations have rapidly increased, mainly because of environmental changes and human handling. The natural expansion of populations from bordering countries and the wide use of restocking for hunting purposes caused the observed extension of geographical distribution (Spagnesi & Toso, 1991).

The present italian Wild boar populations show genetic effects of the past introduction of individuals belonging to different subspecies or crossed with domestic pigs, released by hunters with the aim of increasing body and litter size of animals (Apollonio *et al.*, 1988).

In spite of the wide use of restocking practice, we found no published reports concerning fate of pen-raised wild boars after release.

McCall *et al.* (1988) observed higher mortality rate in pen-raised White-tailed deer released into the wild, than in their wild counterparts. From this study results high mortality of pen-raised deer for hunting and poaching occurred during the first four months after release.

Ecological and spatial aspects involved have been not studied, so home range formation process and space use in pen-raised released into the wild are unknown.

The purpose of this study is to investigate about space occupation shown by pen-raised wild boars released into the wild, that is to analyze their spatial exploration, home range formation process, sex-related differences and eventual interactions with free wild boars, and to compare these processes and patterns of pen-reared wild boars to those of free wild ones.

2. Study Area

The study was conducted in the Siena farmland (Tuscany) in a low-hill area (190 km^2). Elevation range from 200 to 600 m u.s.l. Annual precipitation averages 1,160 mm with most occurring in late spring and fall. Annual average temperatures range from 4.6°C in January to 24°C in July. The area is covered by 68% woods and 32% open habitat type. Predominant plant communities are formed by woodland and include coppice and old-growth oak-chestnut woods and pine forest. In the study area traditional Wild boar hunting is open from November to January.

3. Material and Methods

From March 1990 to January 1991 fourteen pen-raised wild boars (8 males of which 5 three years old and 3 twenty months old; 6 females of which 1 three years old and 5 twenty months old) were fitted with radio-collars and released into the wild. Movements of each individual were sampled by daily radio-location conducted throughout a 24-hour period and by continuous 24-hour monitoring. Information on eventual association with free Wild boar population were obtained from sight record, when possible, or from observations of animals' tracks. Results obtained for each individual

were employed to investigate differences between sexes.
Spatial analyses were carried out using a G.I.S. (Geographical Information System), radiolocations were reported on an habitat map built for the area, habitat analysis is still in elaboration.
Home range evolution for each individual was investigated by total and weekly home range analysis (Minimum Convex Polygon method; Schoener, 1981). "Total home range" represents cumulative explored area from release moment and "weekly home range" the area used during every successive week after release. Area/ time curves were plotted for each individual in order to compare total and weekly areas trends and to identify, if asymptotic trends were found, the end of exploration movements and the achievement of stable use of areas. Total and weekly convex polygons were built for each individual because useful for a quick graphical estimate (Jennrich & Turner, 1969); from that, information about shifts or stability in use of areas during successive weeks after release were obtained (Boitani *et al.*, 1992).
In order to investigate the spatial exploration pattern expressed by each individual, chronologically linked fixes (CLF) were plotted, where consecutive locations are connected with distinguishing lines; actually CLFs proved to be very useful in separating periods of stable range from periods of range expansion (Voigt & Tinline, 1980).
To help the comparison, the locations of range weekly geometric centers were calculated. The geometric centre is a 2-dimensional average of the locations occupied by an animal during a period without other biological implications (Stickel & Warbach, 1960). In the present study geometric centre has been employed to describe movements inside total explorated area and to investigate eventual removal tendencies from release point, also furthest distances traveled by animals from release site (FDR) to death site or location at end of the study were calculated.

4. Results

A total of 868 locations was collected. Tracking period was interrupted about 4-8 weeks after release for 78.6% of animals. For animals n°4 and n°14 were employed only fixes collected during six weeks after release, to make the data comparable with those of the other animals; animal n°7, died after only six days after release, was ignored (Tab. 1). The end of tracking period for 75% of cases was due to animals' death.
From analysis of total cumulative area/time curves results that curves level off for 46.2% of individuals (n = 6, of these 2 are males and 4 are females) (Fig.1), while the curves do not for 53.8% of individuals (n = 7, of these 5 are males and 2 are females) (Fig.2).
From the analysis of weekly used area/time curves, animal's weekly convex polygons, animal's

Table 1: Individual results of total observation days and fixes number collected, total home range area and furthest distance from release site (FDR). (Adult: three years old, Juveniles: twenty months old).

Animal n° sex and age	Observation days (n)	Fixes tot (n)	Total h. r. area (km^2)	FDR (km)
1 m A	50	36	14.468	3.024
2 m A	37	28	13.027	4.257
3 m A	35	33	9.187	4.630
4 m A	42	34	8.765	4.965
5 m A	42	36	11.984	3.598
6 f J	25	19	4.750	2.245
8 f J	44	33	4.546	4.099
9 f J	54	48	5.562	2.853
10 f J	25	17	1.664	1.748
11 f J	26	18	2.343	2.302
12 m J	62	42	8.125	4.828
13 m J	57	38	3.937	2.461
14 f A	42	29	1.187	1.748

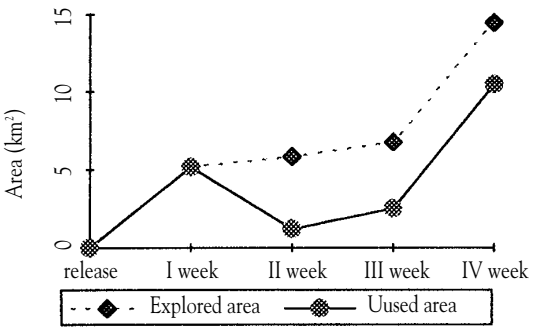

Figure 1 - Comparison of total cumulative explored and weekly used area occupied by male n° 1.

trails (CLF) and weekly geometric centres trends, two different space uses result: 61.5% of individuals (n = 8, of these 2 are males and 6 are females) explore most of the space during a short period after release and movements are concentrated inside the initially visited area, while 38.5% of individuals (n = 5), all males,

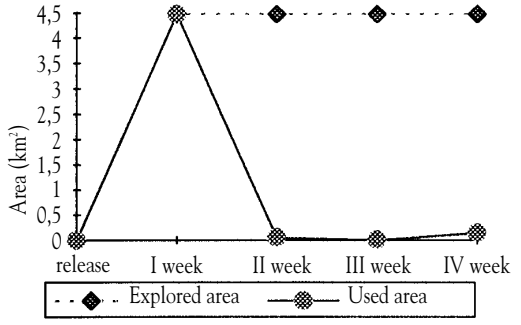

Figure 2 - Comparison of total cumulative explored and weekly used area occupied by female n° 8.

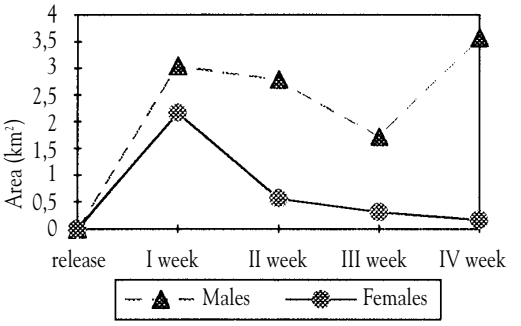

Figure 3 - Comparison between sexes of mean weekly used areas.

keep on visiting new areas and these ones, used in subsequent weeks, are only partially overlapped. Mean total area explored by adult males (n = 5, x = 11.48 km²) is significantly greater (t-test, P< 0.01) than area explored by young females (n = 5, x = 3.77 km²).
Comparing total cumulative explored and weekly used areas' values between sex and age classes (Fig.3) no significant differences result during first week after release, while during the following weeks mean area of males is significantly greater (t-test, P< 0.05) than that of females. There is also a significant decrease (t-test, P< 0.05) of mean area used by females from first to second week after release. Furthest distance travelled by males from the release site (x = 4.094 km) is significantly greater (t-test, P< 0.05) than that travelled by females (x = 2.649 km); also, all females cover the greatest distance from the release site during first week, while males do it during the whole observation period (Tab.2).

5. Discussion

In the present study the high mortality rate prevented longer sampling, so the number of

Table 2: Comparison between sexes of mean total and weekly home range area (km²) and further distance from release site, FDR (km).

Mean Values	Males	Females	Statistical values (t-test)
Total h. r. area	11.486	3.773	P<0.01
I° week h. r. area	3.043	2.165	n.s.
II° week h. r. area	2.780	0.555	P<0.05
III° week h. r. area	1.717	0.312	P<0.05
IV° week h. r. area	3.574	0.175	P<0.05
FDR	4.094	2.649	P<0.05

observations allowed only a partial vision. Nevertheless results offer some information.
In the study about wild animals the achievement of an asymptote in cumulative area/time curve, as sampling goes on, permitted to determine the space habitually used by an animal; in the present study it points out the end of explorative phase: as sampling goes on there is no increase in total visited area. Cumulative area estimates final home range that is total space visited by an individual, where the curve levels off the home range is a stable one. Expansion dynamics around release site allows to better understand space use shown by pen-raised wild boars.
Considering wild boars' spatial and social organization, the two sex and age classes examined in this study (adult males and young females) can be considered representative of the two sexes in spatial occupation, in fact adult males show the spatial pattern of the solitary males, while the young females that of social groups of females and young.
Two prevalent trends were found in space use, these appeared in close relation with sex. Also considering results of sex classes analysis different space use shown by sexes after release can be focalized.
During first week differences between sexes were not found. From second week on females concentrated their movements inside the explored area without going further afield, on the contrary males kept on exploring new areas and moved long distances. So at end of tracking period females ended explorative phase and became stable in the space use, while males did not: they used larger area than females and died (mainly due to poaching and hunting), so their stabilization pattern is still unknown.
In the present study space use shown by animals is due to two factors: the impact with a new unknown environment and biological differences between sexes. The captivity and the release are common to all animals and cause homogeneity during the first week; from second week both sexes space use appeared similar to that of free wild boars described in literature, also females appeared most rapidly adapted to new condition.
Inside a wild boars free population each individual uses its own space in close relation with the spatial structure of population and piglets learn resource distribution and location of seasonal range from older animals; exploration connected with dispersal tendencies is more common in males (Singer *et al.*, 1981; Spitz, 1992).
Several authors found in the Wild boar free populations the size of the home range larger for males than for females (Mauget, 1980; Singer *et al.*, 1981; Mattei, 1987; Spitz, *op. cit.*). Mean total home range size visited by all animals in present study ($x = 9.9$ km^2) appeared similar to home range area occupied by free ranging wild boars ($x = 7.5$ km^2) previously studied in the same study area (Mattei, *op. cit.*) in relation to the different tracking period (respectively about one and three years).
In the case of free wild boars, Mattei (*op. cit.*) found that groups of females, yearlings and young used total home range size similar to that of solitary males; therefore nocturnal home range, corresponding to actively occupied range, resulted greater for males. Such differences in space use shown by sexes were in close relation with different use of resources and with social structure. Groups of females used zones with high concentration of resources while males used resources widely scattered so they moved uniformly inside their home range occupying an area greater than that occupied by females. Different space and resource use displayed by sexes has been observed in many ungulates and serves to reduce competition among males and other groups; also, a solitary male requires considerably less food than a group of females, yearlings and young (Singer *et al.*, *op. cit.*).
The hypothesis of an association between pen-raised females and social groups of the free Wild boar population can not be rejected, it may be the cause of the rapid stabilization observed for females.

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