

# Winter distribution of European pine marten (*Martes martes*) scats in a protected area of Galicia, Spain

Isabel BARJA

Departamento de Biología, Unidad de Zoología,  
Universidad Autónoma de Madrid, ES-28049 Madrid (Spain)  
isabel.barja@uam.es

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In the Iberian Peninsula, the European pine marten (*Martes martes*) occupies only the area's northern fringe, though it also is present on the islands of Majorca and Minorca (Clevenger 1990). Excellent ecological studies on the pine marten have been conducted in Europe (Zalewski 1997; Webster 2001), but in the Iberian Peninsula the species' biology and ecology are largely unknown. Information on habitat selection in Spain is scarce; no specific studies on this aspect of the species' ecology have been carried out. Studies on habitat use are essential, however, if that of the pine marten is to be managed and the species' long-term conservation ensured. The aim of the present study was to identify habitat features associated with the presence (i.e. scats) of the European pine marten in winter in a protected area of Galicia.

The study was performed in a 5,200-ha area of the Montes do Invernadeiro Natural Park (Galicia, NW Spain) from October 2001 to March 2002. The topography of the area is rugged, the altitude varying between 850 and 1707 m. Brushwood occupies most of the area,

with heather (*Erica umbellata*), prickled broom (*Pterospartum tridentatum*) and sandling (*Halimium lasianthum*) the dominant species. The native deciduous forest is comprised of oak (*Quercus robur*), birch (*Betula celtiberica*) and holly (*Ilex aquifolium*). Some areas have been reforested with Scots pine (*Pinus sylvestris*).

The study area was gridded into 52 × 100 ha cells (UTM), all of which were surveyed for the presence of pine marten scats. A total of 140 transects 200 m in length were surveyed. The number of transects inspected in each cell was not identical due to the difficult, snow-covered access of some cells during the winter. Transects were surveyed two or three times in each cell over the six-month study period. All were surveyed on foot by a single observer. The transects were stratified to represent all the plant communities present in the area. Each transect surveyed was separated from the next by at least one kilometre in order to avoid problems of spatial dependence. Scat locations were recorded directly on *Instituto Geográfico Nacional [NGI]* maps, scale 1:25,000. Since the number of transects surveyed was not

TABLE 1. — Description of the independent variables taken into account.

Independent variables	Variable measured
<b>Biotic</b>	
Deciduous forest	Deciduous forest cover (oak, birch and holly) in each cell (%)
Mature pine forest	Mature pine forest cover (Scots pine) in each cell (%)
Young pine forest	Young pine forest cover (Scots pine) in each cell (%)
Brushwood	Brushwood cover (heather, prickled broom and sandling) in each cell (%)
<b>Abiotic</b>	
Rocky areas	Presence or absence of rocky areas in each cell
Watercourses	Presence or absence of permanent watercourses less than 100 m from the transects in each cell
Altitude	Mean altitude above sea level in each cell
Orientation of the terrain	Dominant orientation of the terrain in each cell (N, S, E, W)
Slope	Mean slope in each cell

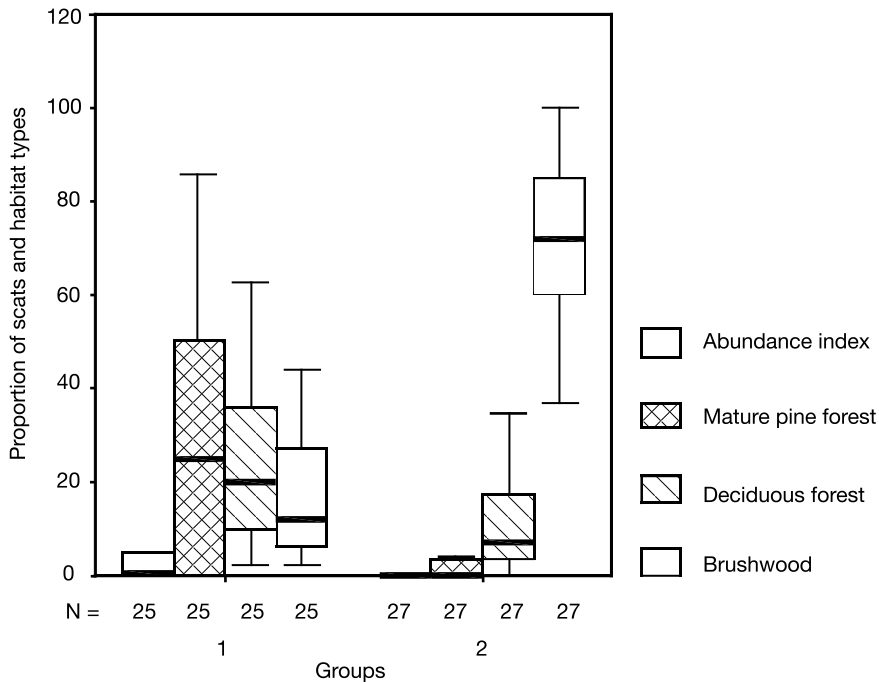


FIG. 1. — K-means conglomerate analysis. Centres of the final conglomerates for abundance index, percentage of mature pine forest, percentage of deciduous forest, and percentage of brushwood.

the same in all cells, the abundance index for each cell was calculated from the total number of scats found divided by the number of kilometres surveyed. Abiotic and biotic variables were considered in each cell (see Table 1). Habitat composition was identified from the maps; data

for abiotic variables were taken directly in the field while sampling.

Pine marten scats were distinguished from those of other medium-sized carnivores by their characteristic size, appearance and pleasant scent. Pine marten scats are very similar to those of the beech

marten (*M. foina*). However, beech martens are not known to occupy the study area; this was confirmed by visual surveys and the use of camera-traps (unpublished data).

Fleshy fruits make up the major part of the pine marten's diet during summer (May-September) (Braña & Del Campo 1982). Differences in the defecation rate between seasons might therefore occur, depending upon fruit availability (Andelt & Andelt 1984). In order to minimise the effect of this, the study was conducted in winter when the species' diet is composed basically of small mammals.

A total of 61 pine marten scats was present in 19 of the 52 cells surveyed by transect. The mean number of scats per surveyed kilometre was 2.17. No inter-dependence was seen between the abundance index and orientation of the terrain ( $\chi^2 = 24.0$ ,  $df = 33$ ,  $p = 0.773$ ,  $n = 52$ ). However, the abundance index was positively related to the presence of permanent watercourses ( $r_s = 0.480$ ,  $p = 0.000$ ,  $n = 52$ ), the proportion of deciduous forest ( $r_s = 0.352$ ,  $p = 0.011$ ,  $n = 52$ ), the proportion of mature pine forest ( $r_s = 0.302$ ,  $p = 0.029$ ,  $n = 52$ ) and the presence of rocky areas ( $r_s = 0.350$ ,  $p = 0.011$ ,  $n = 52$ ). The abundance index was negatively related to the proportion of brushwood ( $r_s = -0.390$ ,  $p = 0.004$ ,  $n = 52$ ) and altitude ( $r_s = -0.358$ ,  $p = 0.009$ ,  $n = 52$ ). Neither the percentage of young pine forest per cell ( $r_s = 0.059$ ,  $p = 0.677$ ,  $n = 52$ ) nor the mean slope of the cells ( $r_s = 0.162$ ,  $p = 0.252$ ,  $n = 52$ ) correlated with the abundance index.

K-means conglomerate analysis revealed two habitat groups. Group 1 included 25 cells, all with a high abundance index, a high percentage of deciduous and mature pine forest, and a low proportion of brushwood. Group 2 was comprised of 27 cells, with low abundance indices, a low proportion of deciduous and mature pine forest, and a high percentage of brushwood (Fig. 1). The differences between Groups 1 and 2 with respect to these variables were significant statistically ( $p < 0.05$ ).

In this study, pine marten scats occurred disproportionately more in areas with high proportions of mature pine and deciduous forest, and less in

areas with a high proportion of brushwood. Rocky areas, permanent watercourses and low altitude areas also had relatively more scats. Thus these animals seem to preferentially selected forest habitats, as recorded in other studies from Europe (O'Sullivan 1983; Brainerd 1990). In Catalonia, the pine marten is more abundant in coniferous forests than in deciduous forests (Ruiz-Olmo *et al.* 1988), while in the Basque Country and the Cantabrian Mountains the species is associated with deciduous forest (Ruiz-Olmo *et al.* 1988). However, in Minorca, pine martens occupy a great variety of forest and shrubland habitats, possibly due to a lack of competitors (Clevenger 1990, 1993).

Studies on the pine marten diet show that small mammals and fruits are their main foods (Braña & Del Campo 1982; Clevenger 1990). In a preliminary trapping campaign in a 480-ha sector of the study area, the aim of which was to determine the relative abundance of small mammals in the deciduous forest, mature pine forest and brushwood habitats, 48 small mammals were captured. The brushwood and deciduous forest had the highest relative abundance of small mammals (22/75 and 21/75 trap-nights respectively) (Barja & Rosellini unpubl. data). This supports the idea that deciduous forests are selected for the abundance and diversity of food (small mammals, fruits and birds). Small mammal abundance was also high in the brushwood, but this habitat was negatively selected by the pine martens, perhaps because preys are more difficult to detect and capture in this setting. Mature pine forests showed a low prey abundance, but prey animals may be more easy to observe and capture than in brushwood areas. Habitat use by pine martens therefore seems to be largely determined by the abundance and capturability of preys.

Forested and rocky areas also offer refuge to the pine marten, which makes its home between the rocks and in hollow tree trunks (Cabrera 1914). In the present study the animals selected areas with good shelter from harsh weather and which offered protection from predators (Helldin 1998). Both deciduous and mature pine forests provide protection from inclement weather. In

addition, the pine martens of the study area were more common in the warmest areas (low latitude areas). Previous studies, however, have shown that pine martens select colder areas in the winter time (Nesvadbova & Zejda 1984; Ruiz-Olmo *et al.* 1988).

The apparent association of pine martens with watercourses was not reported by either Ruiz-Olmo *et al.* (1988) or Clevenger (1993). The selection of such areas might enhance the availability and diversity of food resources.

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