Published by Associazione Teriologica Italiana
Hystrix, the Italian Journal of Mammalogy
Volume 25 (1): 45–46, 2014
Available online at:
http://www.italian-journal-of-mammalogy.it/article/view/9437/pdf
doi:10.4404/hystrix-25.1-9437

Short Note

Effect of wildlife refuges on small carnivores in a hunting area in Mediterranean habitat

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Keywords:
carnivores
predator control
camera trapping

Article history:
Received: 16 December 2013
Accepted: 14 March 2014

Acknowledgements
Comments from Germán Garrote helped us greatly improve this short note. We wish also to express our gratitude to two anonymous reviewers and the associate editor, who provided valuable comments on an earlier draft of this manuscript.

Abstract

Most of Spain is managed for game hunting, an economic activity that is commonly related to predator control. This practice can affect the diversity and abundance of wild carnivores if, despite that hunting is legally focused on some target species, other species are illegally removed. This note evaluates the changes in the structure of carnivore assemblage between wildlife refuges (no predator control) and private areas managed for game production where, because of little regulation, foxes and crows can be eliminated. Our aim is to test if predator control produces a significant change in the presence of foxes (the target species) or whether it also affects other carnivores.

Most of Spain is managed for game hunting, an economic activity that is commonly related to predator control (Villafuerte et al., 2000). This practice can affect the diversity and abundance of wild carnivores (Virgos and Travaini, 2005) if, despite that hunting is legally focused on some target species, other species are illegally removed (Ferreras et al., 1992). This note evaluates the changes in the structure of carnivore assemblage between wildlife refuges (no predator control) and private areas managed for game production where, because of little regulation (Law 2/1993 of the Autonomous Community of Castilla-La Mancha, Spain), foxes (*Vulpes vulpes* (Linnaeus, 1758)) and crows (fam. Corvidae) can be eliminated. Our aim is to test if predator control produces a significant change in the presence of foxes (the target species) or whether it also affects other carnivores.

We used the GLM module of Statistica 7.1 for analysis with carnivore presence as the dependent variable and wildlife refuges and management (hunting area vs. wildlife refuge) the categorical variable to be tested.

In addition, we controlled for the potential effects of vegetation cover and food abundance (two main determinants of carnivore distribution). We sampled carnivores with camera traps (Pettorelli et al., 2010) within two wildlife refuges and the surrounding matrix in the center of the Iberian Peninsula (Navalcan lake 40.0384° N, 5.1132° E, and Dehesón del Encinar 39.9923° N, 5.1109° E, Toledo, Spain).

The area (around 120 km^2) is dominated by holm oak (*Quercus ilex* (Linnaaeus, 1753)) and rockrose (*Cistus ladanifer* (Linnaeus, 1753)) patches interspersed with pasturelands. We placed 26 LTL Acorn camera-traps (LTL Accorn Outdoors, Green Bay, Wisconsin, USA) within the refuges (1.7 cameras/km^2) and 22 cameras in the surrounding areas where hunting and other management is permitted (1.1 cameras/km^2) for 5 nights in September 2011 (130 and 110 nights/trap, respectively). We put scented bait (sardine oil cans) in front of the cameras to increase the probability of sampling carnivores (Long et al., 2008). The cameras were programmed to take three photographs separated by 20 s for each sensor stimulus to improve the identification of the carnivore species (Fandos et al., 2012). The total number of series recording carnivores per camera was used as a dependent variable reflecting carnivore activity, and the total number of species recorded per camera was used to assess the species richness. Each sampling point was marked by GPS (Garmin eTrex). To control the effect of vegetation structure on carnivore distribution, we measured the vegetation cover between 0.5-2 m in a radius of 25 m around each camera, as the shrub cover may be important for the distribution of carnivores in the Iberian Peninsula (Mangas et al., 2008). To assess the effect of rabbit abundance (the main prey in the Mediterranean) we used a previous characterization of the abundance of rabbits in the study area (García et al., 2011) establishing two levels around the mean score: low ($\leq$ 13.2 latrines/km) and high (> 13.2 latr./km) rabbit abundance (Guzmán et al., 2004).

We recorded 905 series (622 foxes; 127 beech martens *Martes foina* (Erxleben, 1777); 16 badgers *Meles meles* (Linnaeus, 1758); 120 genet *Genetta genetta* (Linnaeus, 1758); 4 Egyptian mongooses *Herpestes ichneumon* (Linnaaeus, 1758) and 16 polecats *Mustela putorius* (Linnaeus, 1758)). Results show that the protection status (wildlife vs. game areas) was the only feature related to the activity of carnivores, even when foxes were removed from analyses (Tab. 1, Fig. 1). The species richness was also related to the protection status, except when removing the fox, the most abundant and widespread species. Moreover, we observed that both richness with and without foxes decreased outside protected areas (Fig. 1).

These results suggest that predator control not only affects the target species (foxes in this case) but also other carnivores, all of them protected and some of them threatened (e.g. *Mustela putorius*). This suggests two main possibilities: first, legal predator control is not selective, so it is important to reinforce the control of and proper application of this management technique. Second, predator control is carried out illegally, either exceeding the amount of trap allowed or by the use of poisoning or snares. In this context, camera trapping may be a useful method for monitoring carnivore communities where legal/illegal predator control occurs and to evaluate habitat management for non-target species.

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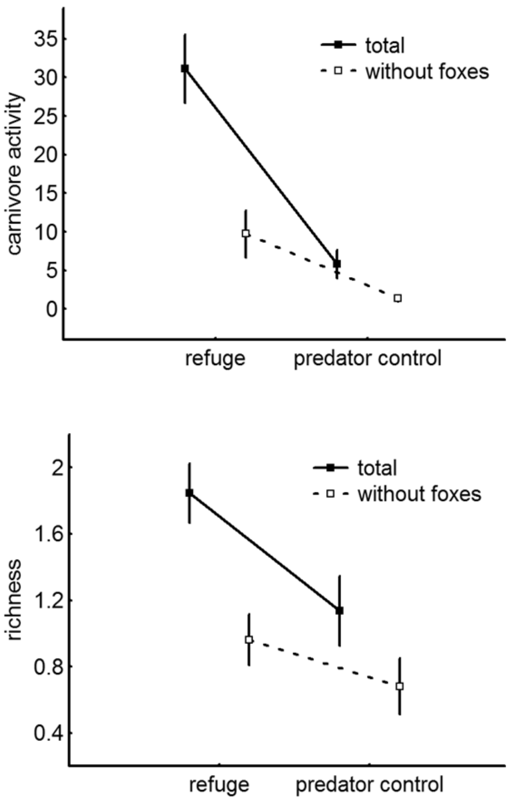

Figure 1 – Variation in activity and richness of carnivores depending on management. Vertical lines indicate standard error.

Table 1 – Effects of management (hunting vs. protected area) on carnivore activity and richness, rabbit abundance and shrub cover in the study area.

	Carnivore activity						Richness					
	total			without foxes			total			without foxes		
	Beta	*F*	*p*	*Beta*	*F*	*p*	*Beta*	*F*	*p*	*Beta*	*F*	*p*
Management	0.61	25.34	0.01	0.30	4.59	0.04	0.36	6.97	0.01	0.17	1.49	0.22
Rabbit	0.15	1.53	0.22	-0.06	0.22	0.64	-0.26	3.57	0.06	-0.33	5.40	0.02
Shrub	0.01	0.02	0.89	0.26	3.53	0.07	0.14	1.06	0.31	0.13	0.82	0.37
Model	F=6.89 $p<0.01$ $R^2=0.33$			F=2.58 $p=0.05$ $R^2=0.11$			F=3.39 $p<0.01$ $R^2=0.16$			F=2.30 $p=0.07$ $R^2=0.10$		

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Associate Editor: L.A. Wauters