Galemys, 24: 1-11, 2012
ISSN 1137-8700
e-ISSN 2254-8408
DOI: 10.7325/Galemys.2012.A01

How effective and selective is traditional Red Fox snaring?

Jesús Duarte[1, 2]*, Miguel A. Farfán[2, 3], John E. Fa[4, 5] & J. Mario Vargas[2]

1. Biogea Consultores, C/ Federico García Lorca 14, 29400 Ronda, Málaga, España.
2. Depto Biología Animal, Fac. de Ciencias, Univ. de Málaga, 29071 Málaga, España.
3. Biogea Consultores, C/ Navarro Ledesma 243, 29010 Málaga, España.
4. Durrell Wildlife Conservation Trust, Les Augrès Manor, Trinity, Jersey JE3 5BP, UK.
5. ICCS, Division of Biology, Imperial College London, Silwood Park Campus, Buckhurst Road, Ascot SL5 7PY, UK.

* Corresponding author: jddbiogea@gmail.com

Abstract

We followed a red fox culling campaign that employed traditional cable snares to control numbers in a hunting estate in the Serranía de Ronda (Andalusia, southern Spain). We assessed abundance and presence of carnivore species within the area where fox culling took place by means of faecal counts within regularly walked paths. Twenty animals of four different taxa were snared during 238 nights in 36 locations. Through interviews with informed locals we established there were eight carnivore species present in the study area. Capture efficiency was 1.52 foxes per 1,000 trap-nights; the ISO-selectivity was 65% and the negative specific selectivity 50%. Despite daily checks of snares, there was a very high mortality (>80%) of target and non-target species. Moreover, a large proportion of the animals were caught by the neck. Our results suggest that this traditional method (snares without stops) of predator control should not be used.
Key words: Carnivores, culling, neck snares, predators, Red Fox

Resumen

Se ha realizado el seguimiento de una campaña de captura de zorros con lazos tradicionales (sin freno) en la serranía de Ronda (Andalucía, sur de España). En la misma zona de instalación de los lazos se ha muestreado la presencia y abundancia de especies de carnívoros silvestres mediante la detección de excrementos. Se capturaron 20 ejemplares pertenecientes a 4 especies de carnívoros diferentes durante 238 noches de actividad en 36 emplazamientos de lazos en una comunidad formada por 8 especies de carnívoros. La eficiencia de captura de zorros resultó ser de 1,52 zorros/1.000 lazos-noche, la selectividad ISO del 65% y la selectividad específica negativa del 50%. La elevada mortalidad (>80%) que afecta de forma importante al criterio del bienestar animal, tanto de los zorros capturados como de otras especies no objetivo, junto con la baja selectividad del método desaconsejan el empleo tradicional de lazos sin freno, aún realizando revisiones diarias.
Palabras clave: Carnívoros, control, depredadores, lazos, zorro.

Introduction

In many European countries, intensive trapping is a commonly used method to diminish the impact of carnivores on game species or livestock. In particular, small game populations of species such as rabbits and partridges are known to increase when predators are kept in check (Reynolds & Tapper 1995a, Banks *et al.* 1998, Fletcher *et al.* 2010, Smith *et al.* 2010). However, the outcome of predator removal is largely evident for the duration of the culling programme (Coté & Sutherland 1997) and in many cases its effect is restricted to localised areas (Reynolds *et al.* 1993).

Most predator culling programmes in Spain focus on the management of the red fox *Vulpes vulpes* (Linnaeus, 1758). This species, an opportunistic carnivore (Lindstrom 1988, Calisti *et al.* 1990, Reynolds & Tapper 1995b), is regarded by game managers or hunting groups throughout the country as the main cause of decline of populations of small game (Vargas & Muñoz 1996). Intensive fox culling programmes in Spain are largely undertaken within those estates dedicated to hunting of rabbits and partridges, with frequent game restocking, and hence intensively managed (Watson *et al.* 2007, Beja *et al.* 2009). Removal of foxes affects productivity (Heydon & Reynolds 2000, López-Martín *et al.* 2007), as well as the spatial dynamics of populations (Von Schantz 1981, Reynolds 2000). On the other hand, culling of foxes also unleashes undesired effects on the predator and prey community (Palomares *et al.* 1995, Reynolds and Tapper 1996, Virgós & Travaini 2005). Moreover, some culling methods, e.g. snares, are widely criticised by animal welfare groups for their alleged cruelty (Lossa *et al.* 2007).

Shooting foxes for their control is legal in Spain during hunting seasons. Trapping (e.g. with cage traps) and snaring (neck or leg) is also permitted in some administrative regions. Currently, there is an important debate on the adequacy and effectiveness of these control methods, the need for their evaluation (Amar *et al.* 2010, Newson *et al.* 2010) and, where appropriate, the requirement to professionalize the use of these (Vargas 2002). Except for shooting, prey selectivity is low for all methods but species captured will depend on the mechanical characteristics of the method, or its *intrinsic selectivity*, as well as on the efficacy of the person responsible for placing, manipulating and monitoring the technique (*extrinsic selectivity*).

Despite being the most commonly used method, the effectiveness of shooting for fox control in Spain is in the main unevaluated. Assessments of the efficiency of cage trapping are available for some regions in the country (Herranz *et al.* 1999, Herranz 2000, Duarte & Vargas 2001, Ferreras *et al.* 2003, Moleón *et al.* 2003b, Muñoz-Igualada *et al.* 2008). A number of predators other than foxes may be caught in cage traps with their release dependant on the trapper's assessment of whether the species is harmful to game (Duarte & Vargas 2001, Moleón *et al.* 2003b).

The more commonly used snare type, which we refer to as the traditional snare, is a cable or wire loop set in an animal's path to capture it by the neck. Traditional snares are one of the simplest traps, are cheap to produce and easy to set in large numbers. These snares are considered to be less selective than shooting or cage trapping (Orueta & Aranda 2001) unlike the recently developed cable restraint devices, Belisle® (Edouard Belisle, Saint Veronique, PQ, Canada) and Collarum® (Wildlife Control Supplies, East Granby, CT). These devices are much more selective than cage-traps and traditional snares, surpassing international standards for humane trapping (Muñoz-Igualada *et al.* 2008, 2010).

Few studies have evaluated the outcomes, advantages or drawbacks of the use of traditional snares (Herranz *et al.* 1999, Herranz 2000, Muñoz-Igualada *et al.* 2008). Furthermore, little research is available on the relative abundance of other carnivores in areas targeted for fox control (though see Díaz-Ruiz *et al.* 2010). In this paper, we present one of the first studies to report observations of a fox culling campaign in Andalusia carried out by hunters to reduce the effect of predation on small game populations. These campaigns are regularly undertaken within hunting estates in the region. To document the impact of such campaigns on resident predators we record the outcome of all snaring sessions undertaken during one year. From this, we evaluate selectivity and efficiency of target and non-target species within such campaigns taking into account the relative abundance of other carnivores in the study area. Our findings allow evaluation of by-catch effects from fox culling campaigns, as well as determine its efficacy in managing the target species.

Study area

We conducted our study between January and December 2006 within a 650 ha hunting estate in the Serranía de Ronda (Málaga province, Spain). Elevation ranges between 165 and 760 m above sea level. The climate is temperate-subtropical Mediterranean with average temperatures of 11°C in January and 25°C in July, and an annual rainfall of 1,068 mm (Capel-Molina 1981). Topography is mountainous; the geology of the region is dominated by peridotites.

Vegetation is typically Mediterranean. There are forest patches (16% of the area) dominated by maritime pine *Pinus pinaster*, mixed with carob *Ceratonia siliqua*, wild olive *Olea europaea* var. *Sylvestris* and cork oak *Quercus suber*. Gall oak *Quercus faginea* stands occur in the foothills and along the more shaded mountain slopes. Mediterranean shrubland occupies 80% of the study area. This vegetation type is largely composed of rock rose *Cistus sp*., European dwarf palm *Chamaerops humilis*, Labiatae and gorse *Ulex sp*. In some parts, heather *Erica spp*. and strawberry trees *Arbutus unedo* are found.

The red fox is abundant throughout the study area but other potentially susceptible carnivores to capture are also found; Wildcat *Felis silvestris* Schreber, 1755, Stone Marten *Martes foina (*Erxleben, 1777), Polecat *Mustela putorius* Linnaeus, 1758, Badger *Meles meles* (Linnaeus, 1758*)*, Common Genet *Genetta genetta* (Linnaeus, 1758*)*, Egyptian Mongoose *Herpestes ichneumon* (Linnaeus, 1758*),* Eurasian Otter *Lutra lutra* (Linnaeus, 1758) and two even-toed ungulates: Wild Boar *Sus scrofa* Linnaeus, 1758 and Roe Deer *Capreolus capreolus* (Linnaeus, 1758). Domestic dogs *Canis familiaris* Linnaeus, 1758 are also found in the area.

Hunting and some logging are economically important activities in the estate. Hunting is focused on small game (rabbit and partridge primarily) and on the Wild Boar.

Material and methods

Trapping campaign

The campaign was the sole responsibility of the hunters who requested, designed and executed the culling programme without any intervention by the authors. Moreover, the campaign was not instigated by the authors. Our role was merely to observe the operations in place, fundamental to understand their impact.

Snaring occurred within 5 ha of scrub habitat interspersed with maritime pines in the study area. All trapping was exclusively aimed at culling foxes. Each snare consisted of a steel cable around Ø 2-3 mm of the type used for brakes for motorcycles. The total length of the cable was 55-60 cm. There was a sliding stretch of 40-45 cm with a loop of Ø 20-21 cm. The lower edge of the snare was placed 10-15 cm above ground. Snares were anchored to semi-static branches to prevent the trapped animal from escaping.

Trappers established trap lines within which trap locations were chosen based on fox signs and habitat features. The snares were checked each morning to limit the amount of time an animal could be held in a trap to 24 hours. Snares were reset after an animal was caught or if accidentally sprung.

We obtained data on the number and location of trapping sites deployed, number of trap-nights and the number of animals caught of the target and non-target taxa. These data were used to estimate the trapping method efficiency as well as its selectivity (International Organization for Standardization 1999, Ferreras *et al.* 2003, Sectorial Conference of Environment 2011).

We studied the effectiveness of the snares (i.e. the capacity of a snare to capture foxes, the target species) by means of two indices: 1) *Capture rate* - the proportion of fox captures relative to the total number of potential captures (*mechanical efficiency*), expressed as the number of foxes captured divided by the total number of snares deployed; 2) *Capture efficiency*: the number of fox captures per 1,000 trap-nights (Herranz 2000).

We studied selectivity using four measures: 1) *ISO-selectivity index* – the number of foxes captured divided by the total number of captures of all species (target and non-target taxa); 2) *Negative specific selectivity* – the number of non-target taxa captured divided by the total number of potentially trappable species in the study area. For the latter, we employed the species richness determined for the predator community; 3) *Capture rate of non-target species* – the number of snares that captured at least one non-target species divided by the total number of snares set; 4) *Negative efficiency* – the number of captured individuals of non-target species per 1,000 trap-nights.

Additionally, we reported the number of animals found alive or dead in snares. Specifically for foxes, we recorded the number of animals caught by the neck, abdomen or elsewhere in the body. No veterinary inspections or necropsies were performed to determine the condition of captured animals or cause of death. To assess efficiency and selectivity of the trapping method we used threshold values established by the International Organization for Standardization (1999) and in Spain by the Conferencia Sectorial de Medio Ambiente (2011). According to these welfare standards, a trapping method can be considered humane if at least 80% of the captured animals, out of a minimum of 20 individuals caught of the target species, do not show injuries or are found dead. For comparison purposes, we transformed the capture rates and efficiency values reported in the literature (many of them for 100 trap-nights) to captures per 1000 trap-nights.

To compare our results with other culling campaigns undertaken in the region we interviewed a sample of rangers and hunters familiar with the methods used (see Moleón *et al.* 2003a for a similar method). Those cross-examined were asked for information on the number of animals captured in snares during the previous year. Due to the lack of data on effort within these other campaigns we were only able to estimate campaign selectivity for comparison with our study.

Carnivore relative abundance

We assessed presence and abundance of foxes and other predators via direct observations of tracks and signs of all species, and through interviews with persons working in the estate (Beltrán *et al.* 1991). During each season, we walked a 7.1 km path within the 5 ha trapping area. We noted the presence of faeces and other signs of resident carnivores along the path. Two of us (JD, MAF), familiar with tracking techniques and ecology of carnivores, identified the species present. We walked the path in two separate occasions. During the first walk all faeces detected were removed. In the second (30 days later), new faeces were counted. We estimated a relative abundance index for carnivores (IAc) in the study area based on the average number of faeces (Nf) detected for each species, divided by the number of days (d) between the removal of faeces and subsequent detections, and the length (L) of the path (Cavallini 1994).

$$IAc = Nf / (d \times L)$$

At the end of the study period, we interviewed 10 people employed in the study estate (game keepers, hunters, shepherds, authority figures, and environmental rangers) to complete the inventory of carnivores present (Arques *et al.* 2009). Most carnivore observations reported by the interviewees were incidental sightings made at night, except in one case where animals were trapped with cage-traps. Cage-trapping had occurred simultaneously to our study in adjacent areas of the estate. These data points supplemented information obtained from the faecal count walks.

Statistical analyses

Capture frequency and species detection data were compared by contingency tables using a Yates's χ^2 test (Fowler & Cohen 1992). A similar procedure was employed to compare the ratio of capture frequencies and abundance per species against an expected ratio for 1:1. Arithmetic means and standard errors are used throughout.

Results

Animals captured

A total of 20 individuals of 5 species were trapped during the study period; 13 individuals were foxes. There were 7 animals of four non-target species caught: 3 dogs, 2 stone martens, one mongoose and one juvenile wild boar.

Capture rates of foxes and non-target species were 36.1% and 11.1% respectively (Table 1). Almost a third of all captures (30%) were alive: 2 foxes (15.4%), 3 dogs (100%) and one mongoose (100%). The dogs (which had known owners) as well as the mongoose were released unharmed. However, all stone martens caught and 84.6% of foxes were found dead despite daily checks. A total of 77% of the trapped foxes were caught by their necks, the remaining 23% by the abdomen.

Three reliable interviewees that had set snares in study area during previous years reported having captured 42 individuals of 6 species: 29 foxes, 7 badgers, 2 juvenile wild boar, 2 genets, 1 wildcat and 1 stone marten. The ISO-selectivity index for these captures was 69.0% while the negative specific selectivity index was 62.5%. Differences in capture frequency of foxes and other carnivores (Figure 1) did not differ significantly between our direct observations and from interviews (χ^2= 0.274; d.f.= 1; p> 0.05).

Relative abundance of carnivores

The most abundant mammalian carnivore detected during our walks was the red fox, followed by the stone marten, the common genet and the polecat (Table 2). From interviews (five of these considered reliable) observations (n= 23) of 8 species of carnivores were reported. The most common species mentioned by the interviewees were the fox, stone marten and common genet. Less common encounters were for the badger, wildcat, polecat and otter. From our tracking data (5 species) and interviews (3 species) we established that there were 8 mammalian carnivore species resident in our study area.

Data from cage-trapping in adjacent areas indicated that 24 individuals of five different species had been caught in cage-traps. The commonest species trapped was the common genet (45.8% of all captures), followed by the domestic cat (20.8%), mongoose (16.7%), fox (12.5%) and wildcat (4.2%). Trapping effort for these operations could not be determined.

Table 1. Summary of the Red Fox culling campaign observed in the study area.

Number of capture periods	1
Period of capture dates	January-December 2006
Number nights with active snares	238
Number of trapping sites	36
Number of foxes caught	13
Number of specimens caught of non-target species	7
Non-target species	4
Non-target species found in the study area	8
Capture rate of the target species	36.1%
Capture efficiency (per 1,000 trap-nights)	1.52
ISO selectivity	65.0%
Negative specific selectivity	50.0%
Capture rate of non-target species	11.1%
Negative efficiency (per 1,000 trap-nights)	0.82

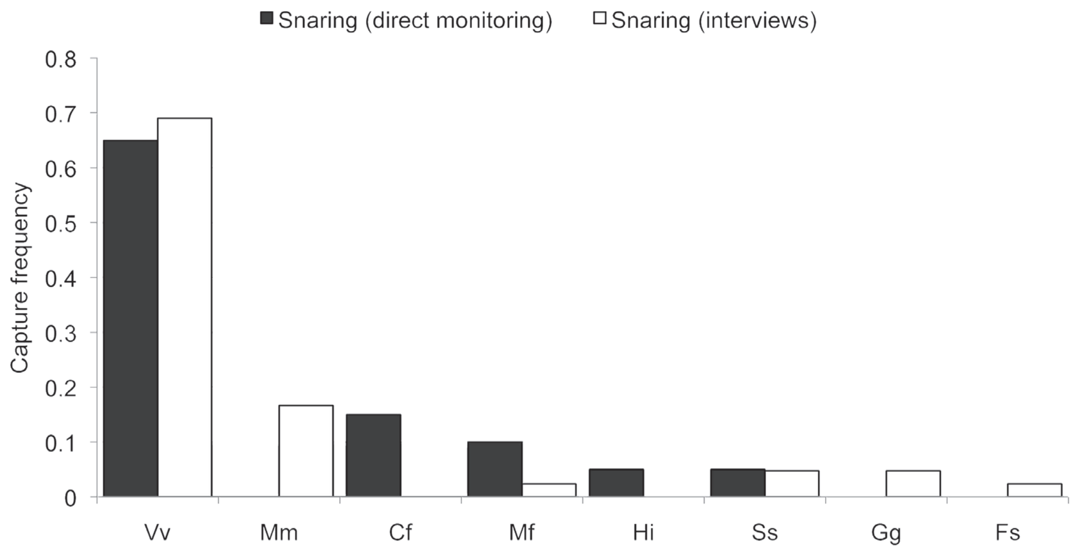

Figure 1. Capture frequency of carnivore species within the study area during 2006. Results are based on direct monitoring of a fox culling campaign and through interviews. VV: Fox (n= 13-29). Mm: Badger (n= 0-7). Cf: Domestic dog (n= 3-0). Mf: Marten (n=2-1). Hi: Mongoose (n= 1-0). Ss: Boar (n= 1-2). Gg: Genet (N= 0-2). Fs: Wildcat (n = 0-1).

Capture rates and relative abundance of carnivores

We found no significant difference (χ^2= 1,683; d.f.= 1; *p*> 0.05) in capture rates between fox and other species snared in the culling campaign and their relative abundance (Figure 2). The capture rate/abundance ratio was not significantly different from the expected for the fox (χ^2= 0.675; d.f.= 1; *p*> 0.05), mongoose (χ^2= 0.137; d.f.= 1; p> 0.05) or common genet (χ^2= 0.132; d.f.= 1; *p*> 0,05), but differed significantly in the case of the stone marten (χ^2= 10.687; d.f.= 1; *p*< 0,01).

Table 2. Results of carnivore relative abundance monitoring in the study area. Number of faeces (Nf) detected per species and its relative abundance index faeces (IAc: faeces/day/km).

		Winter (January)	Spring (April)	Summer (July)	Autumn (October)	Mean ± SE
Fox	Nf	49	51	54	45	50 ± 2
	IAc	0.230	0.239	0.254	0.211	0.234 ± 0.009
Marten		24	35	32	26	29 ± 3
		0.113	0.164	0.150	0.122	0.137 ± 0.012
Mongoose		7	8	6	5	7 ± 1
		0.033	0.038	0.028	0.023	0.031 ± 0.003
Genet		1	4	3	2	3 ± 1
		0.005	0.019	0.014	0.009	0.012 ± 0.003
Polecat		1	3	4	1	2 ± 1
		0.005	0.014	0.019	0.005	0.011 ± 0.004

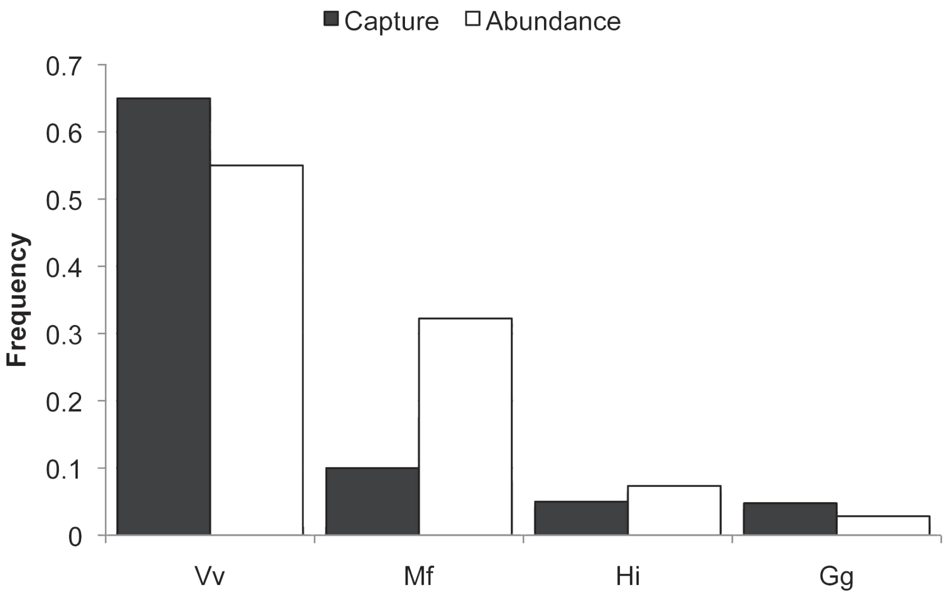

Figure 2. Relationship between capture rates and relative abundance of all carnivore species encountered in the study area. Vv: Fox. Mf: Marten. Hi: Mongoose. Gg: Genet.

Discussion

Efficiency and capture rates

Herranz (2000) using snares without stops estimated an efficiency rate of 1.8 foxes per 1,000 trap-nights. Muñoz-Igualada *et al.* (2010) found values of 1.1 foxes per 1,000 trap-nights. The value obtained in our study 1.5 foxes per 1,000 trap-nights is similar to these previous experiences.

Muñoz-Igualada *et al.* (2010) showed that 2.8-3.1 foxes per 1,000 trap-nights were typical for Wisconsin devices (Association for Fish and Wildlife Agencies 2008) with stops, but lower (0.3 foxes per 1,000 trap-nights) for traditional snares without stops and for the Wisconsin devices without stops (1.0 foxes per 1,000 trap-nights). Trapping efficiencies were highest for Collarum® (5.6-18.8 foxes per 1,000 trap-nights) and Belisle® (3.1-24.2 foxes per 1,000 trap-nights) (Muñoz-Igualada *et al.* 2008). In France, Ruette *et al.* (2003) obtained efficiencies of 1.2-17.9 foxes per 1,000 trap-nights and 0-31.7 foxes per 1,000 trap-nights, using neck or leg snares, respectively. Efficiencies calculated for Australia and US using different kind of snares varied from a minimum of 2.1 to as much as 21.6 foxes per 1,000 trap-nights (Litvaitis *et al.* 1984, Meek *et al.* 1995, Bubela *et al.* 1998, Fleming *et al.* 1998, Shivik *et al.* 2005). Efficiency obtained in this study falls within the ranged observed by other authors in Europe using similar devices. Ruette *et al.* (2003) argues trapping efficiency is affected by fox density, habitat type, the device used, but also by trapper experience in setting devices.

Ferreras (2007) found that cage-trapping efficiency in Spain could range from 3 to 10 foxes per 1,000 trap-nights. Muñoz-Igualada *et al.* (2008) obtained values of 0-5.6 foxes per 1,000 trap-nights for cage traps. Results show that some snare types (those with stops and automatic ones) are more efficient than cage-traps.

Trapping mortality

In a study on the impact of predator culling on small game in Castilla-La Mancha (central Spain), Herranz (2000) showed that almost half of all foxes captured were found dead in snares. The same proportion appeared abdominally strangled, regardless of whether or not the snares had a stop. In contrast, Muñoz-Igualada *et al.* (2008, 2010) in four sites in Castilla-León (NW Spain) found very low mortality rates (<10% with Wisconsin snares with stops and <14% for automatic devices). Regardless of the type of device used, 61-68% of the animals trapped were caught by the neck, the rest by the abdomen. In our study also, most foxes were caught by the neck. Moreover, overall mortality was much higher than reported elsewhere (84.6% of captured foxes). Such mortality rate means that trapping within our study does not meet the acceptable threshold level for animal welfare methods established by ISO (1990) or the Conferencia Sectorial de Medio Ambiente (2011), even though less than the minimum number of individuals (20) was captured.

Explanations of higher mortality in snared foxes have been related to the use of a longer length of cable and/or branches as an anchoring system (Herranz 2000). In our study, branches were applied as semi-static anchor points, though the total length of the restraint cable used was almost half of that in previous studies. Given this, it is likely that the type of anchor employed is more important in determining snare mortality. In fact, semi-static anchor points allow the animal to pull away until the loop closes and the animal is immobilised.

The snaring of animals across the abdominal region can be explained by the animal attempting to go through the loop if the loop diameter is too large (Proulx & Barrett 1990). To avoid capture of the animal along the abdomen, the loop diameter recommended by the Office National de la Chasse (1987) is 20-23 cm. Snares used in this study were within the recommended loop diameter, slightly smaller than those used by Herranz (2000). This smaller diameter may explain the larger proportion of animals caught by their necks and also higher mortality of captured foxes. In any case, it is clear that the addition of stops and security devices to the snares reduces mortality among catches of foxes and non-target species.

Selectivity

Published figures for snare selectivity of foxes were 66% (Herranz 2000), but significantly higher, 74.4-88.8% for traditional snares and Wisconsin models, and 91.7-100% for Collarum devices (Muñoz-Igualada *et al.* 2008, 2010). Our results, ISO-selectivity of 65%, are similar to those published by other authors for both foxes and other canids outside Spain (Guthery & Beasom 1978, Proulx & Barrett 1990, Skinner & Todd 1990, Phillips 1996, Reynolds 2000). These results suggest that the traditional snare does not comply with the recommended standard of a minimum selectivity of 80%, though it is much more selective than cage-traps which in Spain have had reported selectivity values of 0-60% (Ferreras 2007, Muñoz-Igualada *et al.* 2008).

According to Leger *et al.* (1985), the height above ground where the snare is placed can prevent the capture of smaller carnivores. In this study, only three individuals of small carnivore species were caught (two stone martens and one mongoose), a much lower figure than the higher numbers of Viverrids, Herpestids and Mustelids caught in cage-traps (Duarte & Vargas 2001, Moleón *et al.* 2003b, Muñoz-Igualada *et al.* 2008). Placing the snare higher (20 cm) than in our study (10-15 cm) Muñoz-Igualada *et al.* (2010) was able to reduce the capture of smaller carnivores and hence lower the negative selectivity values.

Data on the species snared in our study areas obtained through interviews correspond well with our direct observations of the snaring campaign. Although our interview data lacked any detail of devices used or trapping effort employed, they are interesting in that badgers were the second most caught species (16.6% of total captures). In other countries, badgers are reported as frequently snared (Harris *et al.* 1994, Woodroffe *et al.* 2005). Because badgers have well-defined territories, live in family groups (Revilla & Palomares 2005) and are of a similar body size to foxes, this species is likely to be highly affected by snaring campaigns targeted for foxes. Therefore, the presence of the badger in a potential fox culling area must be taken into account when authorizing and, where appropriate, undertaking these campaigns.

Capture rates and carnivore abundance

Abundance indices derived from faecal counts is considered a valid method to compare abundance with capture rates (Cavallini 1994, Webbon *et al.* 2004, Baker & Harris 2006, Barea-Azcón *et al.* 2007). We found no significant difference between the capture rate of foxes and their relative abundance, suggesting that the capture rate for the species was correlated with its abundance in the study area. However, if the method was highly selective for foxes, their capture rate should be significantly higher than their relative abundance, thus suggesting that there is a need for minimum threshold of selectivity to be established for the method.

Final considerations

The culling of generalist predators is an activity which is legally regulated in most countries where these species come into conflict with livestock or hunting interests. However, it is necessary to ensure that such management procedures are carried out in a rigorous, selective and humane way. Nonetheless, predator culling should not be the easy option when improvement of habitat quality and the status of alternative prey populations should be the main focus (Ferreras 2007).

In other European Union countries the use of snares to culling foxes is legally allowed, but subject to good practice and the application of highly professionalised procedures (DEFRA 2005). In Spain, in spite of the fact that snaring is a contentious issue, most administrative regions allow its use as exceptions to the norm. The better option would be regularise these activities in each region and develop a corps of professional predator culling personnel as recommended by the Conferencia Sectorial de Medio Ambiente (2011). The need for trained persons is clear since for trapping methods to be successful (increased extrinsic selectivity) the experience of the person who manages them is fundamental (Ruette *et al.* 2003). Phillips (1996) and Kirkwood *et al.* (2005) point out that the experience of the trapper is crucial to minimize unwanted captures of animals not subject to control. However, the intrinsic or mechanical selectivity of any method should be linked to a minimum threshold that allows it to be considered an approved and standard method of capture (Conferencia Sectorial de Medio Ambiente 2011).

Our research clearly illustrates that traditional snares do not meet the accepted requirements set out by the Conferencia Sectorial de Medio Ambiente (2011). This method does not reach the minimum selectivity threshold, are inhumane, and above all have low capture efficiency. We therefore recommend that traditional snares without stops should not be authorised. However, the use of snares with adequate security devices, can increase efficiency and selectivity of the culling method, as well as help reduce mortality and injuries to target and non-target species (Frey *et al.* 2007). We are, therefore, strongly in favour of the legal authorisation of improved snares for fox culling that should be deployed by trained personnel in specific localities and within set time periods.

Acknowledgements

We are grateful to Dr. José María López and Dr. Pablo Ferreras for their valuable comments on an earlier version of the manuscript.

References

Amar A., Redpath S., Sim I. & Buchanan G. 2010. Spatial and temporal associations between recovering populations of common raven *Corvus corax* and British upland wader population. *Journal of Applied Ecology*, 47: 253-262.

Arques J., Belda A., Martínez J.E., Peiró V., Jiménez D. & Seva E. 2009. Análisis de encuestas como herramienta de gestión sostenible de especies cinegéticas en agrosistemas del este de la provincia de Alicante (Marina Baja): estudio del caso del jabalí *Sus scrofa* Linnaeus, 1758. *Galemys*, 21 (NE): 51-62.

Association of Fish and Wildlife Agencies. 2008. Furbear management resources. Best management practices: trapping red foxes in the United States. http://fishwildlife.org/furbear_resources.html.

Baker P. J. & Harris S. 2006. Does culling reduce fox (*Vulpes vulpes*) density in commercial forests in Wales, UK? *European Journal of Wildlife Research*, 52: 99-108.

Banks P., Dickman C. & Newsome A. 1998. Ecological costs of feral predator control: foxes and rabbits. *Journal of Wildlife Management*, 62: 766-772.

Barea-Azcón J.M., Virgós E., Ballesteros, E., Moleón M. & Chirosa M. 2007. Surveying carnivores at large spatial scales: a comparison of four broad-applied methods. *Biodiversity and Conservation*, 16: 1213-1230.

Beja P., Gordinho L., Reino L., Loureiro F., Santos-Reis M. & Borralho R. 2009. Predator abundance in relation to small game management in southern Portugal: conservation implications. *European Journal of Wildlife Research*, 55: 225-238.

Beltrán J.F., Delibes M. & Rau J.R. 1991. Methods of censusing red fox (*Vulpes vulpes*) populations. *Hystrix*, 3: 199-214.

Bubela T., Bartell R. & Müller W. 1998. Factors affecting the trappability of red foxes in Kosciusko National Park. *Wildlife Research,* 25:199-208.

Calisti M., Ciampalani B., Lovari S. & Lucherini M. 1990. Food habits and trophic Niche variation of the red fox *Vulpes vulpes* in a Mediterranean coastal area. *Revue d'Ecologie. (la Terre et al Vie)*, 45: 309-320.

Capel-Molina J. J. 1981. *Los climas de España*. Ed. Oikos-Tau, Barcelona. 294 pp.

Cavallini P. 1994. Faeces counts as an index of abundance. *Acta Theriologica*, 39: 417-424.

Conferencia Sectorial de Medio Ambiente. 2011. Directrices de aplicación de la Ley 42/2007. *Directrices técnicas para la captura de especies cinegéticas predadoras: homologación de métodos y acreditación de usuarios.* Documento aprobado 13 de Julio de 2011. Ministerio de Medio Ambiente, Rural y Marino.

Coté I.M. & Sutherland W.J. 1997. The effectiveness of removing predators to protect bird populations. *Conservation Biology*, 11: 395-405.

DEFRA. 2005. Defra code of practice on the use of snares in fox and rabbit control. Departament of environment, food and rural affairs (UK).www.defra.gov.uk. Accessed 20/12/09.

Díaz-Ruiz F., García J., Pérez-Rodríguez L. & Ferreras P. 2010. Experimental evaluation of live cage-traps for black-billed magpies *Pica pica* management in Spain. *European Journal of Wildlife Research*, 56: 239-248.

Duarte J. & Vargas J.M. 2001. ¿Son selectivos los controles de depredadores en los cotos de caza? *Galemys*, 13(NE): 1-9.

Ferreras P. 2007. Especies amenazadas y control de predadores: criterios de calidad. Pp. 81-86. En: J. Carranza y J.M. Vargas (eds.). *Criterios para la certificación de la calidad cinegética en España*. Universidad de Extremadura, Cáceres.

Ferreras P., Terriza J.M., López-Precioso B., Rodríguez O., Reglero M. & Castro F. 2003. Homologación de métodos de control de predadores en castilla la mancha: bases científicas. Informe inédito. IREC-UCLM, Ciudad Real, 88 pp.

Fleming P.J.S., Allen L.R., Berghout M.J., Meek P.D., Pavlov P.M., Stevens P., Strong K., Thompson J.A. & Thomson P.C. 1998. The performance of wild-canid traps in Australia: efficiency, selectivity and trap-related injuries. *Wildlife Research,* 25:327-338.

Fletcher K., Aebischer N.J., Baines D., Foster R. & Hoodless A.N. 2010. Changes in breeding success and abundance of ground-nesting birds in relation to the experimental deployment of legal predator control. *Journal of Applied Ecology*, 47: 263-272.

Fowler J. & Cohen L. 1992. Practical statistics for field biology. Wiley, New York. 227 pp.

Frey S.N., Conover, M.R. & Cook G. 2007. Successful use of neck snares to live-capture red foxes. *Human-Wildlife Conficts*, 1: 21-23.

Guthery F.S. & Beasom S.L. 1978. Effectiveness and selectivity of neck snares in predator control. *Journal of Wildlife Management*, 42: 457-459.

Harris S., Jefferies D., Cheeseman C. & Booty C. 1994. *Problems with badgers?* 3rd Edition. Royal Society for the Prevention of Cruelty to Animals, London. 87 pp.

Herranz J. 2000. *Efectos de la depredación y del control de predadores sobre la caza menor en Castilla-La Mancha.* Tesis Doctoral. Universidad Autónoma de Madrid. 337 pp.

Herranz J., Yanes M. & Suárez F. 1999. *Efecto de los predadores sobre la caza menor y evaluación de sistemas* *selectivos para regular los niveles de predación*. Informe inédito CSIC, Madrid. 123 pp.

Heydon M.J. & Reynolds J.C. 2000. Demography of rural foxes (*Vulpes vulpes*) in relation to cull intensity in three contrasting regions of Britain. *Journal of Zoology*, 251: 265-276.

International Organization for Standardization (ISO). 1999. TC191. *Animal (mammal) traps. Part 5: methods for testing restraining trap*. International Standard ISO/DIS 10990-5. International Organization for Standardization, Geneva, Switzerland.

Kirkwood J.K., Best D., Gregory N., MacDonald D., Mitchell-Jones T., Nodder C., Reynolds J.C., Scull S., Thomas H., Waters M., Booty C., Inglis I. & Owen D. 2005. *Report of the independent working group on snares.* Department of Environment, Food and Rural Affairs (DEFRA), UK. 101 pp.

Leger F., Artois M. & Stahl P. 1985. La capture experimentale de carnivores de taille moyenne. *Acta Oecologica, Oecolia applicata*., 6: 287-302.

Lindstrom E. 1988. Reproductive effort in the red fox, *Vulpes vulpes*, and future suply of a fluctuating prey. *Oikos*, 52: 115-119.

Litvaitis J.A., O'Donoghue M., Miller M. & Sherburne J.A. 1984. An evaluation of trapping efforts to capture bob-cats, coyotes and red fox. In: D.J. Decker (ed*.). Proceedings of the Eastern Wildlife Damage Control Conference* 1:125-127.

López-Martín J.M., Mañas S. & López-Claessens S. 2007. Parámetros reproductivos y estructura de edad del zorro *Vulpes vulpes* (Linnaeus, 1758) en el NE de España: efectos del control de sus poblaciones. *Galemys*, 19 (NE): 25-36.

Lossa G., Soulsbury C.D. & Harris S. 2007. Mammal trapping: a review of animal welfare standards of killing and restraining traps. *Animal Welfare*, 16: 335-352.

Meek P.D., Jenkins D.J., Morris B., Ardler A.J. & Hawksby R.J. 1995. Use of two humane leg-hold traps for catching pest species. *Wildlife Research,* 22:733-739.

Moleón M., Ballesteros-Duperón E., Barea-Azcón J.M., Acevedo J., Sánchez-Clemot J.F., Gil-Sánchez J.M. & Chirosa M. 2003a. Mortalidad de mamíferos carnívoros en la provincia de Granada (SE de España). *Resúmenes VI Jornadas SECEM.* Ciudad Real, pp. 123.

Moleón M., Barea-Azcón J.M., Ballesteros-Duperón E., Gil-Sánchez J.M., Virgós E. & Chirosa M. 2003b. ¿Es apropiado el uso de jaulas-trampa para el control selectivo de carnívoros? Resultados de una campaña de trampeo en la provincia de Granada. *Resúmenes VI Jornadas SECEM.* Ciudad Real, pp. 124.

Muñoz-Igualada J., Shivik J. A., Domínguez F.G., Lara J. & González L.M. 2008. Evaluation of cage-traps and cable restraint devices to capture red foxes in Spain. *Journal of Wildlife Management*, 72: 830-836.

Muñoz-Igualada J., Shivik J.A., Domínguez F.G., González L.M., Moreno A.A., Olalla M.F. & García C.A. 2010. Traditional and new cable restraint systems to capture fox in central Spain. *Journal of Wildlife Management*, 74: 181-187.

Newson S.E., Rexstad E.A., Baille S.R., Buckland S.T. & Aebischer N.J. 2010. Population change of avian predators and grey squirrels in England: is there evidence for an impact on avian prey populations? *Journal of Applied Ecology*, 47: 244-252.

Office National de la Chasse. 1988. Pièges et tecniques de piégeage. *Bulletin Mensuel* nº 122. Fiche nº 42.

Orueta J.F. & Aranda Y. 2001. Methods to control and eradicate non-native terrestrial vertebrate species. Convention on the Conservation of European Wildlife and Natural Habitats. Council of Europe Publishing. *Nature and Environment*, 118: 1-64.

Palomares F., Gaona P., Ferreras P. & Delibes M. 1995. Positive effects on game species of top predators by controlling smaller predator populations: an example with lynx, mongooses and rabbits. *Conservation Biology*, 9: 295-305.

Phillips R.L. 1996. Evaluation of 3 types of snares for capturing coyotes. *Wildlife Society Bulletin*, 24: 107-110.

Proulx G. & Barrett M.W. 1990. Assessment of power snares to effectively kill red fox. *Wildlife Society Bulletin*, 18: 2-30.

Revilla E. & Palomares F. 2005. Patrones generales de organización social en el tejón euroasiático (*Meles Meles*). Pp. 197-222. En: E. Virgós, E. Revilla, J. G. Mangas y X. Domingo-Roura (eds.). *Ecología y conservación del tejón en ecosistemas mediterráneos.* SECEM, Málaga.

Reynolds J.C. 2000. *Fox Control in the Countryside*, The Game Conservancy Trust, Fordingbridge, Hants, UK. 56 pp.

Reynolds J.C., Goddard H.N. & Brockless M.H. 1993. The impact of local fox (*Vulpes vulpes*) removal on fox populations at two sites in southern England. *Gibier Faune Sauvage*, 10: 319-334.

Reynolds J.C. & Tapper S.C. 1995a. The ecology of the red fox *Vulpes vulpes* in relation to small game in rural southern England. *Wildlife Biology*, 1: 105-119.

Reynolds J.C. & Tapper S.C. 1995b. Predation by foxes *Vulpes vulpes* on brown hares *Lepus europaeus* in central southern England, and its potential impact on population growth. *Wildlife Biology*, 1: 145-158.

Reynolds J.C. & Tapper S.C. 1996. Control of mammalian predators in game management and conservation. *Mammal Review*, 26: 127-156.

Ruette S., Stahl P. & Albaret M. 2003. Factors affecting trapping success of red fox *Vulpes vulpes*, stone marten *Martes foina* and pine marten *M. martes* in France. *Wildlife Biology*, 9: 11-19.

Shivik J.A., Martin D.J., Pipas M.J., Turman J. & De Liberto T.J. 2005. Initial comparison: jaws, cables and cage-traps to capture coyotes. *Wildife Society Bulletin*, 33: 1375-1383.

Skinner D.L. & Todd A.W. 1990. Evaluating efficiency of footholding devices for coyote capture. *Wildlife Society Bulletin,* 18: 166-175.

Smith R.K., Pullin, A.S., Stewart G.B. & Sutherland W.J. 2010. Effectiveness of predator removal for enhancing bird populations. *Conservation Biology*, 24: 820-829.

Vargas J.M. 2002. *Alerta cinegética. Reflexiones sobre el futuro de la caza en España*. Otero Ediciones. Málaga. 398 pp.

Vargas J. M. & Muñoz A. R. 1996. Panorámica de la caza menor en Andalucía. Pp. 1-19. En: *La caza en Andalucía y su problemática*. Federación Andaluza de Caza. Archidona (Málaga).

Virgós E. & Travaini A. 2005. Relationships between small-game hunting and carnivore diversity in central Spain. *Biodiversity and Conservation*, 14: 3475-3486.

Von Schantz T. 1981. Female cooperation, male competition and dispersal in the red fox *Vulpes vulpes*. *Oikos*, 37: 63-68.

Watson M., Aebischer N.J., Potts G.R. & Ewald J.A. 2007. The relative effects of raptor predation and shooting on overwinter mortality of grey partridges in the United Kingdom. *Journal of Applied Ecology*, 44: 972-982.

Webbon C.C., Baker & Harris S. 2004. Faecal density counts for monitoring changes in red fox numbers in rural Britain. *Journal of Applied Ecology*, 41: 768-779.

Woodroffe R., Bourne F. J., Cox D.R., Donnelly C.A., Gettinby G., McInerney J.P. & Morrison W.I. 2005 Welfare of badgers (*Meles meles*) subjected to culling: patterns of trap-related injury. *Animal Welfare,* 14: 11-17.

Associate Editor was L. Javier Palomo