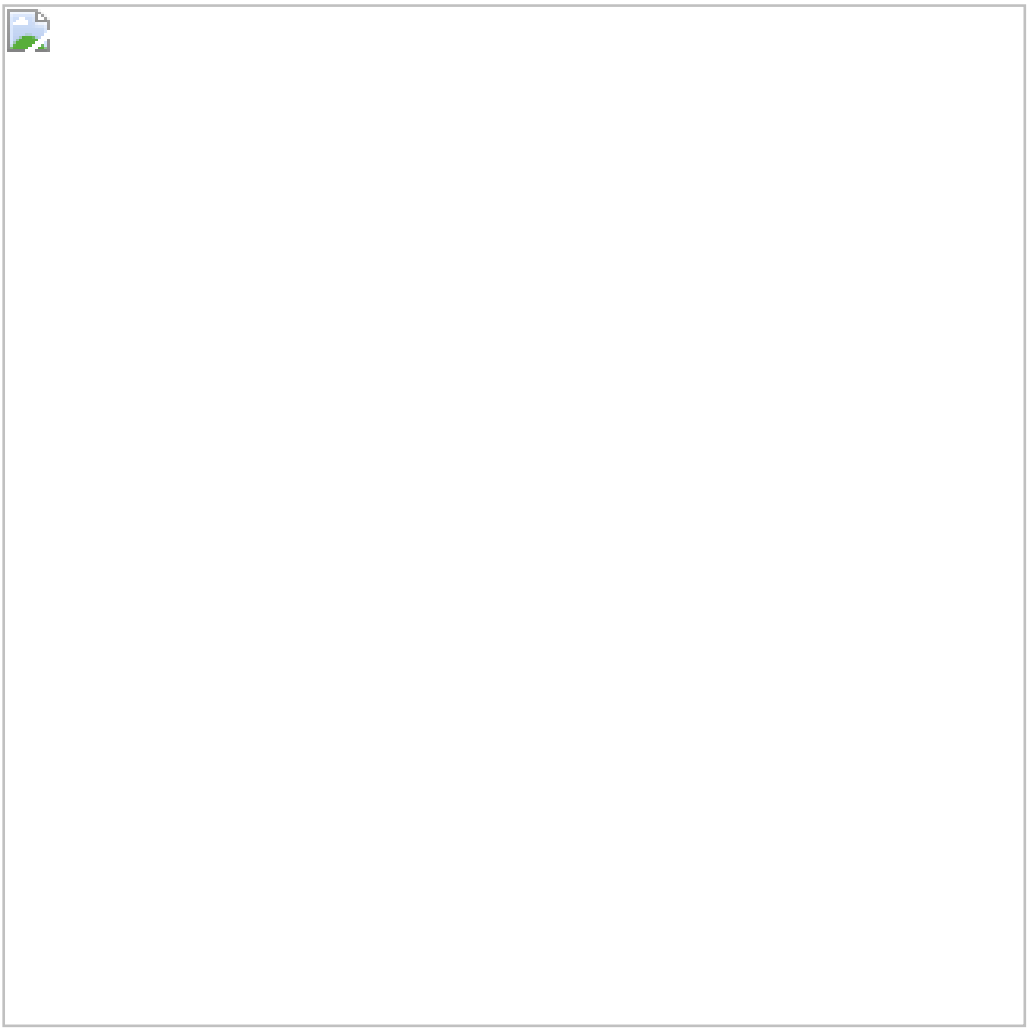

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Diet of adult and juvenile wildcats in Southern Tuscany (Central Italy)

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Abstract. The wildcat is a rare and elusive mammal species, with a broad feeding spectrum. We collected 34 scats of wildcat in the surroundings of a reproductive site to assess the diet of juvenile wildcats and relevant parents in a rural area of Central Italy. The Brillouin diversity index suggested that our sample was large enough to assess the seasonal diet of both age classes. Wood mice were the most preyed species (59.4 %), followed by bank voles (12.5 %). No significant difference was observed between adult and juvenile diet compositions. Birds were rarely consumed and mostly present in the diet of adult individuals, with the exception of the red-legged partridge, observed only in juvenile scats.

Key words: *Felis silvestris*, age classes, scat analysis

Diet analysis of rare or protected species is a basic tool to define addressed and effective management plans (e.g. Palomares et al. 2002, Shehzad et al. 2012). The European wildcat *Felis silvestris* is a medium-sized, elusive carnivore widely but patchily distributed throughout the Palaearctic (Yamaguchi et al. 2015). Its conservation deserves a high effort due to low population density and sensitivity to habitat loss and human persecution (Apostolico et al. 2015, Yamaguchi et al. 2015). Three fragmented populations are present in the Italian peninsula (thus excluding those in Sardinia and Sicily: Mattucci et al. 2013). The wildcat feeds on a large spectrum of prey, but the staple of its diet is represented by small mammals or by the wild rabbit *Oryctolagus cuniculus* (for review studies see Lozano et al. 2006, Apostolico et al. 2015). Therefore, the wildcat may behave as a facultative rodent or rabbit-specialist, depending on the local availability of each prey type (Moleón & Gil-Sánchez 2003, Malo et al. 2004, Lozano et al. 2006). Where available, wildcats select rabbits over other small mammals because of their large body size (Aymerich 1982, Gil-Sánchez et al. 1999). By contrast, voles (Rodentia, Microtinae) represent the most frequent prey in review studies (Lozano et al. 2006, Apostolico et al. 2015). Wildcats may increase their feeding spectrum depending on local availability of prey (Apostolico et al. 2015): differently from the 1970s and 1980s, when main prey of wildcats were voles, at the end of the 1990s, mice built up the staple of the diet of this wild felid in Italy (n = 214 scats collected by Apostolico et al. 2015, in seven years in Central and Southern Italy), maybe because of their changed availability due to rodent population fluctuations (Apostolico et al. 2015). In our work, we aimed to assess the diet of juvenile wildcats and relevant parents in a rural area of Central Italy. The mother uses to bring still alive prey (or dead ones, if they are large) to juveniles (Harrison 1940, Kitchener 1995). We predicted that the number of prey items per scats and diet composition is different between juveniles and adults, as already observed for other felid species (cf. Fritts & Sealander 1978).

Our study site, called "Poggi di Prata", is a Site of Community Importance (herafter SCI, Tuscany Regional Law 56/2000) located in the area of the Metalliferous Hills (Province of Grosseto, Southern Tuscany), with a total extension of about 1.350 ha (Mori et al. 2014). Climate shows sub-montane features: average annual precipitation is about 1000

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mm with rare episode of snowfall. The average annual temperature is about 12 °C with an average annual excursion of 18 °C. Most of the study area (67 %) is covered by deciduous woodlands, mainly composed by *Quercus cerris*, *Castanea sativa*, *Ostrya carpinifolia*, *Carpinus betulus*, *Fraxinus ornus* and *Robinia pseudoacacia*. Scrubwoods (*Juniperus* spp., *Rubus* spp., *Erica scoparia* and *Spartium junceum*: 1.71 %) and pinewoods (*Pinus nigra* and *Cupresuss arizonica*: 2.02 %) are also present. Wetlands are represented by a river (Merse), six ditches and several ponds, both natural and artificial. A total of 38 mammal species are recorded within the study area (Mori et al. 2014). Among those, rats (*Rattus rattus* and *R. norvegicus*), *Mus musculus*, *Myodes glareolus* and *Apodemus* spp. are the most abundant small rodent species (Mori et al. 2014). Human activities, including agriculture, sheep/cattle husbandry and lumber trade, are limited to the downstream part and to the immediate surroundings of the village of Prata (Mori et al. 2014).

We studied the diet of wildcats through morphological scat analysis. Scats were collected in the surroundings of places where wildcats were camera trapped (Mori et al. 2014, for camera trapping study design). Litters of wildcats usually born in the first days of May; therefore, in summer they are still living in the den or in its immediate surroundings (Harrison 1940). We opportunistically collected scats between the 15th of July and the 31st of August 2012, to compare the diet of adults and juveniles within the same period of the year. In late August, juveniles are partially able to hunt and independent from the mother (Harrison 1940, Ragni 1978). Cat scats were distinguished from those of other carnivores on the basis of morphology and associated footprints (Apostolico et al. 2015). Scats of wild and domestic cat and their hybrids are very similar and their differentiation is challenging (Biró et al. 2005). During the survey period, wildcats were camera-trapped 17 times and all of them showed the typical wildcat morphology (Ballesteros-Duperón et al. 2015, Yamaguchi et al. 2015; Fig. 1). By contrast, domestic (or feral) cats were a very rare occurrence (3 out of 4322 photos obtained through camera trapping, and no more than 200 metres far from farmlands). Genetic analyses carried out in the same study area (northern province of Grosseto) showed that wildcats are almost widespread, whereas free-ranging domestic and hybrid ones are unlikely to occur (Mattucci et al. 2013).

We also avoided to collect scats around farmlands or where domestic cats were camera-trapped. Other carnivores observed where wildcat scats were collected are the Eurasian badger *Meles meles* (n = 522 photos) and martens *Martes* spp. (n = 147 photos), which faeces are very different from those of cats (Roper et al. 1986, Serafini & Lovari 1993). The red fox *Vulpes vulpes* (n = 471 photos), rarely occurs in close habitats in summer where wildcats usually occur. By contrast, they are much more common around farmlands and meadows (Ciampalini & Lovari 1985, Cavallini & Lovari 1991, 1994, Mori et al. 2014). Diet of red foxes in late summer in Central Italy was mainly composed by fruits (Ciampalini & Lovari 1985), that is why this species is uncommon within woodlands (Cavallini & Lovari 1991). Thus we assume that foxes are uncommon and leave only rarely scats within woodlands during summer (Cavallini & Lovari 1991). Therefore, even if we are aware that scat morphology may be not sufficient to identify wildcats (cf. Monterroso et al. 2013), we were almost confident that our scats belonged to wildcats. Age classes were identified according to scat diameters (cf. Weaver & Fritts 1979, for canids). Faecal samples which could not be attributed to cats (i.e. those detected in meadows) were not taken into account. Subsequently, scats were dissected, and contents separated into mammals and birds. Subsequently, faeces were washed in a 0.5 sieve under a stream of hot water and all items (hair, feathers, skulls and mandibles) were separated. We used a Mann-Whitney U-test to verify the occurrence of differences in number of food items

Fig. 1. Some of the wildcats photographed during the camera-trapping survey. According to their body-size, the first and the third were adult, the second was a juvenile.

presents in scats of both age classes. The trophic niche breadth (B) was estimated through the Levins' index *B* (Levins 1968):

$$B = \frac{1}{\Sigma p_i^2}$$

where p_i is the proportion of each food item *i* identified in every scat.

Food remains in each scat were assessed by absolute (AF = number of occurrences of each food category when present/total number of scats × 100) and relative (RF = number of occurrences of each food category when present/total number of occurrences of all food items × 100) frequencies of occurrence (Hart et al. 2002) and volumetric percentage (VP, expressed as percentage of the volume of food items: Angerbjörn et al. 1999, Elmhagen et al. 2000, Hart et al. 2002). All the statistical analyses were performed through the software R 3.2.3.

We collected a total of 34 scats (adults: 16, juveniles: 18). The Brillouin diversity index (Hass 2009) suggested that our sample was large enough to assess the seasonal diet of both age classes (Fig. 2).

The mean number of food items per scats was 1.29. Scat of adults showed a larger diameter with respect to those ascribed to juveniles (adult median = 2.1, Q_1-Q_3 = 2.0-2.2, juvenile median = 1.6, Q_1-Q_3 = 1.5-1.8).

The diet of the wildcats during the first half of summer period consisted mainly of rodents (Table 1). A total of 46 prey individuals were identified by skulls remains (67.6 %), hair (29.4 %) and feathers (26.5 %). Wood mice *Apodemus* spp. (43.2 % *A. flavicollis*, 27.3 % unidentified species) built up the staple of the diet of both adults and juveniles (Table 1).

The mean number of food items belonging to the different species consumed (±SD) showed no significant differences between age classes (adults = 1.31 ± 0.47, juveniles = 1.28 ± 0.48, U = 4.02, df =

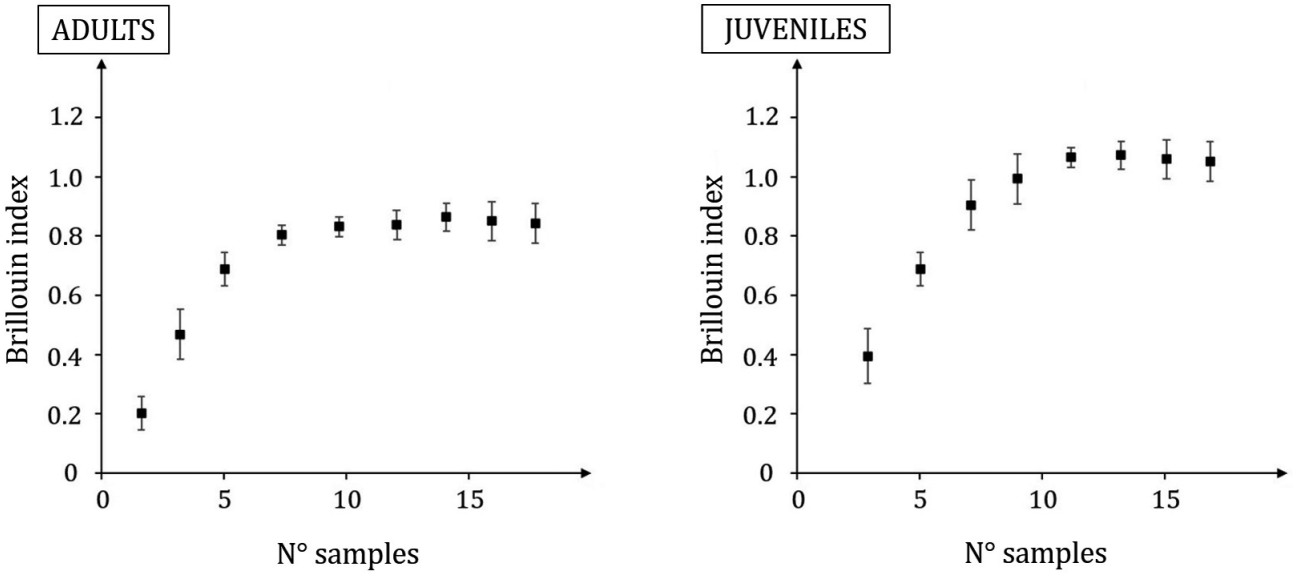

Fig. 2. Brillouin diversity index for the adult (left) and kitten (right) wildcat.

Table 1. Diet composition of wildcats (n = 34 scats) depending on age classes. RF = relative frequency of occurrence, AF = absolute frequency of occurrence, VP = volumetric percentage, NA = not applicable.

Prey	Adults (n = 16 scats)			Juveniles (n = 18 scats)		
	RF (%)	AF (%)	VP (%)	RF (%)	AF (%)	VP (%)
Apodemus sp.	19.0	16.1	16.1	36.8	71.9	24.3
Apodemus flavicollis	42.9	37.4	20.2	36.8	65.6	25.2
Myodes glareolus	14.3	15.8	19.7	5.4	14.6	23.5
Garrulus glandarius	14.3	29.3	22.0	NA	NA	NA
Turdus merula	4.8	14.3	8.0	10.5	14.3	3.9
Columba palumbus	4.8	14.3	14.0	NA	NA	NA
Alectoris rufa	NA	NA	NA	10.5	11.1	23.1

1, $p > 0.05$). Accordingly, the trophic niche breadth of adults was similar to the juvenile one (Levins' index values = 2.33 and 1.97, for adults and juveniles respectively).

The study showed that wildcats in Southern Tuscany prey mainly on rodents with wood mice and bank voles being the most predated species. These results agree with those realized in previous studies from other regions of Europe (Biró et al. 2005, Lozano et al. 2006, Apostolico et al. 2015). Nevertheless, this study differs from those where rabbits were the most predated species (Gil-Sánchez et al. 1999, Malo et al. 2004, Lozano et al. 2006). In our sample, no food items attributable to lagomorphs were recorded. In our work, birds were found in only nine faecal samples, confirming that these are important prey only when rodents are unavailable (Sládek 1973, Gil-Sánchez et al. 1999). The importance of rodents in the predator diet could be a result of food availability determined by: (i) high abundance of rodents or (ii) low availability of other food categories, such as rabbits (Gil-Sánchez et al. 1999, Malo et al. 2004, Lozano et al. 2006). Predators are generally able to supplement their diets with one or two secondary prey types (Carvalho & Gomes 2004). In August, juvenile wildcats are still dependent by the mother for food provisioning (Stephen & Derek 2008). The comparison of the diet between adults and juveniles emphasized the importance of rodents in the diet of both age classes. Eurasian jays, blackbirds and wood pigeons were recorded only in adult scats, whereas remains of red-legged partridge were detected only in juvenile scats. This study was carried out in a short temporal scale and the sample size is very small, so each result presented need to be considered as preliminary. Detailed studies are strongly recommended to provide further information inherently the behavioural ecology of this elusive small carnivore.

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