A preliminary camera trapping study of mammals of Monti Lepini (Central Italy)

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Abstract - We used 52 camera traps to survey mammal species in the Lepini Mountains (Lazio, Central Italy) during three trapping sessions. Thirteen mammal species have been recorded. Compared to data based on previous opportunistic observations (2000-2018), camera trapping has quickly increased knowledge about the distribution of species, especially for elusive ones. We modelled species and average community occupancy also considering habitat covariates in a hierarchical modelling framework. Occupancy at community level was positively impacted by woods and negatively impacted by open habitats, indicating that the ongoing reforestation of the area may favour mammal diversity. Open surfaces have a negative effect on the presence of *Sciurus vulgaris*, a species for which our study confirms extensive recolonization of the area. We have also shown that woods increase the probability of occupation by *Canis lupus* and *Felis silvestris*, confirming that these species could be negatively impacted by increased deforestation.

Keywords: central Italy, habitat covariates, Lepini Mountains, mammals, occupancy.

Riassunto - Studio preliminare mediante fototrappolaggio dei mammiferi dei Monti Lepini (Lazio, Italia centrale).

Per questo studio sui mammiferi dei Monti Lepini abbiamo utilizzato 52 postazioni di fototrappolaggio per tre sessioni di (video)cattura. È stata registrata la presenza di 13 specie. In confronto con i dati ottenuti da osservazioni opportunistiche raccolte tra il 2000 e il 2018, il fototrappolaggio ha velocemente incrementato le conoscenze sulla distribuzione delle specie, specialmente quelle elusive. La presenza (*occupancy*) delle singole specie e quella media a livello di comunità è stata modellizzata in un contesto gerarchico (*hierarchical modelling*) anche considerando le covariate ambientali. L'*occupancy* a livello di comunità è risultata influenzata positivamente dalla presenza di boschi e negativamente dagli ambienti aperti, facendo ipotizzare che la corrente riforestazione dell'area di indagine possa favorire la diversità teriologica. Gli ambienti aperti paiono influenzare negativamente anche la presenza di *Sciurus vulgaris*, specie per la quale il nostro studio conferma l'estesa ricolonizzazione dell'area. Mostriamo anche che i boschi aumentano le probabilità di presenza di *Canis lupus* e *Felis silvestris*, confermando che la deforestazione potrebbe evere un effetto negativo su queste specie.

Parole chiave: covariate ambientali, Italia centrale, mammiferi, Monti Lepini, *occupancy*.

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INTRODUCTION

Camera trapping is a powerful tool for wildlife research, especially for medium and large mammals (Littlewood *et al.*, 2021). It offers a favourable trade-off between research efforts and outcomes, and it allows to gather from basic species presence data to more particular and richer in biological information (Rovero *et al.*, 2013): the kind of outcomes largely depends on the choice of study designs and on the analyses applied to the data. In this note, we report the results from a preliminary camera trapping study carried out in the Lepini Mountains (Lazio, Central Italy) focused on mammals. Knowledge on the mammals of this representative area, although not poor, is mostly based on opportunistic and temporally sparse observations (cfr. Amori *et al.*, 2002; Mastrobuoni & Capizzi, 2020). Our study is based on a spatial and temporal sampling design and has the twofold purpose of increasing the knowledge on mammal species distribution available for a local atlas (Corsetti & Marozza, 2020) and assessing their occupancy pattern considering habitat preference.

MATERIALS AND METHODS

The Lepini Mountains is a mountain range about 50 km South-East of Rome, occupying an area of about 880 km^2 and ranging from a few meters to an elevation of 1536 m. It is a carbonate ridge, with both underground and surface karst features; the deep Carpineto-Montelanico tectonic valley identifies an eastern and a western chain (Cosentino *et al.*, 1993). In the western chain, climate is mitigated by the proximity of the Tyrrhenian Sea, whereas the eastern one has a more continental climate (Tomaselli *et al.*, 1973). The Carpineto-Montelanico valley, along with many secondary valleys, creates local climates that determine different plant associations: garrigue, maquis shrubland, grassland, holm oak wood, heathland, broad-leaved forest with *Acer* spp., *Carpinus* spp., *Fraxinus* spp., and beech *Fagus sylvatica* L. subsp, *sylvatica* (Copiz *et al.*, 2018). Due to the limestone nature of the area, there are small scattered (though sometimes numerous) water bodies and a few seasonal streams. One Special Protection Area and nine Special Areas of Conservation (mostly included in the SPA) protect about 470 km^2 of the whole Lepini Mountains area.

Camera-trapping data were collected between February 2019 and March 2020. The area was divided into 52 squares of 12.25 km^2 (side 3.5 km), and the cameras were placed as close as possible to the centre of each square, unless the centre was in an urban area. The final average distance between each camera and the adjacent ones was 4.2±0.1 SE km (1.4 - 7.4 km). The cameras placed on the perimeter, delineated a polygonal area of 454 km^2. Camera traps were utilized in two sequential arrays, each containing 26 traps, across three trapping sessions (Tab. 1). The traps were arranged in a chequerboard pattern to avoid any spatial biases (Fig. 1).

Each set of 26 camera traps operated for a period of 21 consecutive days, followed immediately by another array. In total, the camera traps were active for a duration of 3,276 days, with intervals of 77 and 182 days between the last and first days of the two consecutive sessions, respectively.

The short time interval between the placement of the two consecutive groups of traps during the same session allowed us to consider them as having worked simultaneously.

We used camera traps equipped with PIR and invisible IR flash (Apeman H68 [n = 16]), Apeman H45 [n = 2], Acorn 5310A, Boskon Guard BG529, Crenova rd1000, HC-800A Trail Camera, Trail Camera 3G 3.0CG HD, Suntek HC 700G, Toguard H45, Victure HC400; nominal trigger times range from 0.3 to 0.8 sec; cameras were never used for the same location across different sessions), set for recording 20'' videos during the whole day. The few videos that did not allow discrimination between *Canis lupus* / *C. l. familiaris, Felis silvestris* / *F. catus* and *Martes foina* / *M. martes* were discarded.

Tab. 1 - Operational periods of the camera traps during the two consecutive arrays of each session. / Periodi di funzionamento delle fototrappole durante le due disposizioni consecutive (*array*) di ogni sessione.

Session	Array	Start	Finish
1	A	24 February 2019	16 March 2019
	B	17 March 2019	7 April 2019
2	A	23 June 2019	13 July 2019
	B	14 July 2019	4 August 2019
3	A	2 February 2020	22 February 2020
	B	23 February 2020	15 March 2020

Information obtained from camera traps was used in two ways in the analyses. First, we compared the occurrence data from the videos with data based on opportunistic observations collected for the faunal atlas edited by Corsetti & Marozza (2020) from 2000 to 2018. In the atlas, data were plotted on a grid consisting of 44 squares of 5×5 km, of which 27 were occupied by 1 to 4 camera traps (1.9 ±0.2 SE). Below, we refer only to these 27 squares and evaluate where the presence of each species has been confirmed or recorded for the first time by camera trapping.

Second, we analysed the data in a hierarchical modelling framework to take into account species detection probability (p) for estimating species occupancy (ψ) (MacKenzie *et al*., 2002). In doing so, we summarized the data from two consecutive three-weeks arrays as a unique sampling occasion, thus obtaining an amount of three sampling occasions. We used a single-species/single season occupancy model for each species detected by camera traps (except for those with too sparse data). Further, in order to evaluate whether the average occupancy at community level was affected by the environment (i.e. the buffer area around the camera traps: see below), we used a latent factor multi-species occupancy model (Doser *et al.*, 2022a).

We also evaluated the effect of habitat on occupancy, by using as covariates the CORINE land cover 2018 (100 m resolution, CLC in the following) occurring in a circular buffer area of about 1 km^2 (565 m radius) centred on the camera trap placement point. We used four covariates: artificial surfaces (CLC class 1), agricultural areas (CLC class 2), forest and maquis (CLC classes 3.1 and

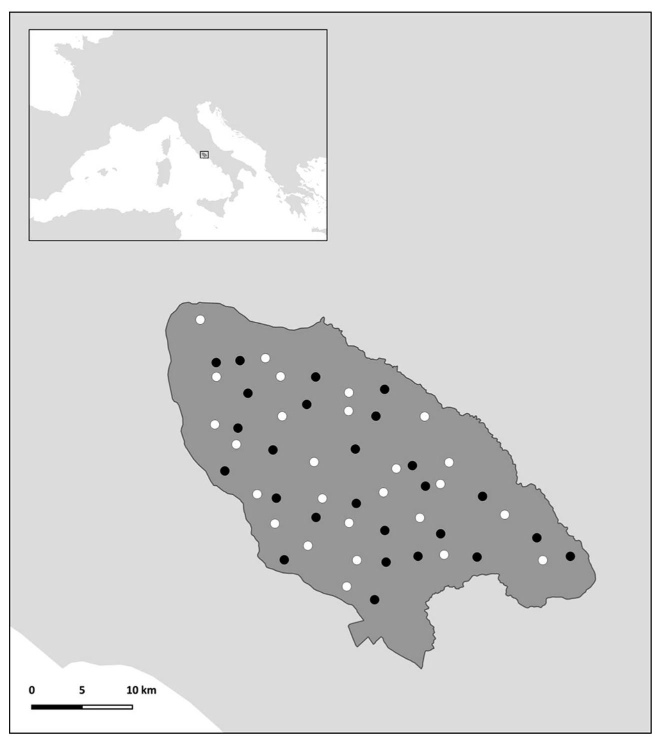

Fig. 1 - Geographical location of the Lepini Mountains area and positions of the camera traps (the different colours group the two arrays of cameras). / Collocazione geografica dei Monti Lepini e schema di posizionamento delle fototrappole (i colori differenti sono per le due disposizioni consecutive di ogni sessione).

3.2.3.1; wood in the following), open space and shrub or herbaceous vegetation (CLC classes 3.3 and 3.2 – except 3.2.3.1; open space in the following) (no other CLC classes occurred in the buffer areas). These classes occurred in the 52 buffer areas and in the Lepini Mountains as a whole (in brackets) with the following total percentages: artificial surface 2.2% (2.5%), agricultural areas 19.5% (41.2%), woods 56% (37.5%), open areas 22.3% (18.8%). Each kind of CLC class was used separately as a covariate on occupancy. This procedure has been carried out using QGIS ver. 3.16.7 (< www.qgis.org >).

We modelled species occupancy as constant or impacted by covariates, and detection probabilities as constant or time dependent, thus obtaining ten candidate models for each species. Program PRESENCE 13.10 (Hines, 2006) has been used for running all models, and the Akaike Information Criterion (AIC) has been used for model selection. The goodness of fit of the most global model was evaluated by the variance inflation factor ($\hat{c}$) assessed using a bootstrap method (10000 replicates); when $\hat{c} > 1$ data were considered over-dispersed, and its value was used for obtaining the quasi-likelihood AIC (QAIC), that was then used for model selection (MacKenzie & Bailey, 2004). Models with ΔAIC (or ΔQAIC) > 2 were considered as having little or no support; however, we always used model averaging for the estimation of detection probability and occupancy. Occupancy at community level was analysed by mean of multi-species occupancy model (MSOM) with species correlations, using the function lfMsPGocc (with two latent factors and default values) implemented in the R package spOccupancy (Doser *et al*., 2022a, 2022b; R Core Team, 2022). Comparison among the ten candidate MSOM models was based on the Widely Available Information Criterion (WAIC). Hierarchical modelling for estimation of detection probability and thus of occupancy is nowadays widely implemented in mammal studies based on camera trapping (e.g. O'Connell *et al*., 2011).

RESULTS

During the study period, camera traps recorded 13 species (Tab. 2). Also, *Apodemus* spp. were recorded, but it was not possible to distinguish between *A. flavicollis* and *A. sylvaticus*, the two species occurring in the area (Amori *et al*., 2002; Capizzi *et al*., 2012; Corsetti & Marozza 2020). Videos of unidentifiable micromammals were also recorded. Six domesticated mammal species were recorded too. Compared with the data already collected before our camera trap study, the camera trap study resulted in new spatial records for 11 wild species, with an average of 5.1±1 squares per species, and it confirms the occurrence in 7.9±2.3 squares per species.

Basing on model fitting, most species substantially showed constant detection probabilities among capture sessions, but *M. meles*, *S. scrofa* and *S. vulgaris* had variable detection probabilities as a function of time (Tabs. 3, 4). Capture probabilities ranged from 0.12 to 0.77. Occupancy probability ranged from 0.1 (*L. europaeus*) to 0.99 (*V. vulpes*). The species with the main differences between naïve and estimated occupancy are *C. lupus* and *F. silvestris.* Occupancy of *V. vulpes*, *M. meles*, *S. scrofa* and *L. europaeus* were only marginally affected by environmental covariates; woods positively affected the occupancy of *C. lupus*, *F. silvestris* and *S. vulgaris*; open spaces negatively affected the occupancy of *C. lupus* and *S. vulgaris*; agricultural surfaces positively impacted the occupancy of *M. foina* and *R. rattus*; artificial surfaces positively affected the occupancy of *H. cristata*, and negatively that of *C. lupus* (Tab. 4).

Tab. 2 - Comparison among species' distribution collected from 2000 to 2018 in 27 5x5-km-squares basing on opportunistic searches (Corsetti & Marozza, 2020) and distribution data from camera trapping (this study) in the Lepini Mountains. (increases due to camera trapping with reference to 2000-2018 are reported as percentages in the last column). / Confronto fra i dati sulle distribuzioni delle specie raccolti in 27 maglie di 5x5 km in modo opportunistico tra il 2000 e il 2018 (Corsetti & Marozza, 2020) e i dati raccolti tramite questo studio basato sul fototrappolaggio nei Monti Lepini. Nell'ultima colonna sono riportati gli incrementi percentuali in rapporto ai dati del 2000-2018).

Species	**2000-2018 squares**	**Squares confirmed by camera trapping**	**Squares added by camera trapping**
Erinaceus europaeus Linnaeus, 1758	25	6 (24%)	0
Canis lupus Linnaeus, 1758	8	0	5 (62.5%)
Vulpes vulpes (Linnaeus, 1758)	20	19 (95%)	7 (35%)
Felis silvestris Schreber, 1777	5	0	7 (140%)
Martes foina (Erxleben, 1777)	15	13 (86.7%)	12 (80%)
*Martes martes (*Linnaeus, 1758)	1	0	2 (200%)
Meles meles (Linnaeus, 1758)	18	15 (83.3%)	9 (50%)
Sus scrofa Linnaeus, 1758	26	23 (88.5%)	0
Myodes glareolus (Schreber, 1780)	7	0	3 (42.9)%
Hystrix cristata Linnaeus, 1758	18	15 (83.3%)	9 (50%)
Rattus rattus (Linnaeus, 1758)	11	3 (27.3%)	6 (54.6%)
Sciurus vulgaris Linnaeus, 1758	21	9 (42.3%)	3 (14.3%)
Lepus europaeus Pallas, 1778	19	0	4 (21%)

Model selection for MSOM (Tab. 5) showed that the agricultural surfaces positively affected the occupancy at community level, and also woods had a secondary positive effect on average occupancy, while open habitats only marginally affected it negatively.

DISCUSSION

Camera trapping allowed for the detection of 13 species, representing 43.3% of wild mammal species occurring in the Lepini Mountains (30 species, with the exception of bats) (Mastrobuoni & Capizzi, 2020). Out of the ten micromammal species detected in the previous study, only *Myodes glareolus* was positively identified. However, other micromammals were observed in the video recordings, but unfortunately, we were unable to identify them. The previous study has reported the presence of fossorial *Talpa caeca* and *T. romana*, as well as the arboreal *Glis glis*, which could not be captured in the video traps due to the positioning of the devices just above ground level. Among the species known to occur in the Lepini Mountains, only *Mustela nivalis*, *M. putorius*, *Rattus norvegicus* and *L. corsicanus* were actually not recorded. *M. putorius* and *L. corsicanus* are relatively rare and localised species in the study area, as reported by Mastrobuoni (2020a) and Mastrodomenico (2020). On the other hand, *R. norvegicus* is mainly found in anthropised habitats (Mastrobuoni, 2020b), which we excluded from our camera trapping efforts.

M. nivalis, as other small and fast-moving mammals, is not likely to be detected by camera traps (Mos & Hofmeester, 2020) and we think this is a possible explanation for the absence of this species from the footage, despite its apparent abundance in the area (Amori et al., 2002; Mastrobuoni, 2020c). We advance a similar explanation also for the small, but slow *E. europaeus*, which was filmed only a few times, compared to its apparent abundance in the area (Pietrocini, 2020) (Tab. 1).

With respect to the data collected in the period 2000-2018, our lower duration camera trap study confirmed the presence of species in 42.6% of the area on average and recorded species for the first time in 57.7% of the area on average (Tab. 2). Furthermore, camera trapping was particularly effective for elusive species, with a substantial increase of the previously assessed local ranges of *C. lupus* (in more than 62.5% of the squares), *F. silvestris* (140%) and *M. martes* (200%). These results are impressive, considering that finding species in new parts of the area was not our primary target, since the camera trapping protocol we used was tailored for an occupancy study and was limited by logistic and economic resources. Such outcome supports the effectiveness of camera trapping and suggests that in relatively small areas (such as the Lepini Mountains), if adequate resources are available, in relatively short time, camera trapping could improve the knowledge of the local ranges of several species. In contrast, it should be considered that very common species could escape detection, as mentioned above.

In general, we found that agricultural areas and woods positively impacted the occupancy at community level, while open habitats negatively impacted it. This result is interesting in perspective, since the area is undergoing reforestation (Buccomino, 2005). Concerning the single species, the presence of *S. scrofa* and *V. vulpes* was not affected by any environmental covariate, consistently with their wide ecological adaptability (Apollonio, 2003; Boitani & Ciucci, 2003), and confirmed also by the high occupancy probability. Similarly, the presence of *M. meles* was seemingly not affected by the habitat, contrary to the expected preference for woods with low or any human disturbance (De Marinis & Genovesi, 2003). A possible explanation may be the limestone substrate of the area, often with a thin or absent soil layer, which limits the extension of setts, something that forces badgers to move frequently among small setts (Brøseth *et al*., 1997). Future research could address if the high occupancy rate depends on the density of this species. Interestingly, the occupancy of two opportunistic species such as *M. foina* and especially *R. rattus* is favoured by agricultural surfaces.

Tab. 3 - Naïve occupancy and estimation of detection probability (p) and occupancy (ψ) (with Standard Error, SE) obtained by model averaging from ten candidate models for each species of mammals detected by camera trapping in the Lepini Mountains. / *Naïve occupancy* e stima della probabilità di rilevamento (p) e dell'*occupancy* (ψ) (con i relativi errori standard, SE) ottenute tramite *model averaging* da 10 modelli differenti per ciascuna specie rilevata tramite fototrappolaggio nei Mont Lepini.

Species	**Naïve occupancy**	***p* (SE)**	***ψ* (SE)**
Erinaceus europaeus	0.11	too sparse data	
Canis lupus	0.11	0.12 (0.12) - 0.15 (0.14)	0.33 (0.08)
Vulpes vulpes	0.96	0.76 (0.04) - 0.77 (0.04)	0.99 (0.00)
Felis silvestris	0.21	0.21 (0.11) - 0.29 (0.14)	0.38 (0.22)
Martes foina	0.79	0.56 (0.07) - 0.61 (0.07)	0.88 (0.04)
Martes martes	0.02	too sparse data	
Meles meles	0.75	0.53 (0.1) - 0.69 (0.09)	0.8 (0.02)
Sus scrofa	0.85	0.58 (0.1) - 0.72 (0.08)	0.88 (0.01)
Myodes glareolus	0.08	too sparse data	
Hystrix cristata	0.75	0.64 (0.07) - 0.69 (0.07)	0.79 (0.04)
Rattus rattus	0.23	0.41 (0.12) - 0.43 (0.12)	0.29 (0.19)
Sciurus vulgaris	0.35	0.35 (0.11) - 0.60 (0.15)	0.41 (0.05)
Lepus europaeus	0.08	0.43 (0.21) - 0.45 (0.22)	0.10 (0.01)

Tab. 4 - Single-species single season occupancy model selection summary table of mammals detected by camera trapping in the Lepini Mountains. Reported values are the ΔAIC or ΔQAIC and relative model weight (second line, in italics) of each model for each species. Codes for environmental covariates for occupancy: “ag”: agricultural land, “ar”: artificial surface, “o”: open habitats, “w”: woods; “+” or “-” indicate if the covariate impacts positively or negatively the occupancy. Models having Δ(Q)AIC > 3 are not reported. / Sommario dei modelli di *occupancy* per le singole specie di mammiferi rilevate tramite fototrappolaggio nei Monti Lepini. Sono riportati i valori di ΔAIC o ΔQAIC e il relativo peso del modello (seconda linea, in corsivo) per ogni modello per ciascuna specie. Abbreviazioni per le covariate ambientali applicate all’*occupancy*: “ag”: aree agricole, “ar”: superfici antropiche, “o”: ambienti aperti, “w”: boschi, “+” o “-” indicano se la covariata ha un effetto positivo o negativo sull’*occupancy*. I valori dei modelli con Δ(Q)AIC > 3 non sono riportati.

	Model									
Species	ψ(.) *p*(.)	ψ(ag) *p*(.)	ψ(ar) *p*(.)	ψ(o) *p*(.)	ψ(w) *p*(.)	ψ(.) *p*(t)	ψ(ag) *p*(t)	ψ(ar) *p*(t)	ψ(o) *p*(t)	ψ(w) *p*(t)
C. lupus ΔAIC	0.6 *0.18*	2.38 - *0.07*	1.02 - *0.14*	1.11 - *0.14*	0 + *0.24*	3 *0.05*				2.43 + *0.07*
V. vulpes ΔQAIC 1.56	0 *0.31*	1.24 + *0.17*	2 + *0.11*	2 - *0.11*	2 - *0.11*					
F. silvestris ΔAIC					0 + *0.53*					1.32 + *0.27*
M. foina ΔQAIC 1.03	0.38 *0.17*	0 + *0.20*	0.75 + *0.14*	0.84 - *0.13*	2.26 + *0.07*	2.13 *0.07*	1.79 + *0.08*	2.43 + *0.06*	2.56 - *0.06*	
M. meles ΔQAIC 1.24	0.96 *0.14*	2.87 + *0.05*	2.74 + *0.06*	2.15 - *0.08*	2.75 + *0.06*	0 *0.22*	1.89 + *0.09*	1.77 + *0.09*	1.19 - *0.12*	1.83 + *0.09*
S. scrofa ΔQAIC 1.43	0.69 *0.16*	2.62 - *0.06*	2.45 + *0.07*	2.5 - *0.06*	2.49 + *0.06*	0 *0.22*	1.95 - 0.08	1.73 + *0.09*	1.77 - *0.09*	1.8 + *0.09*
H. cristata ΔAIC	0.99 *0.15*	1.1 + *0.14*	0 + *0.24*	2.09 - *0.09*	2.85 - *0.06*	2.47 *0.07*	2.69 + *0.06*	1.42 + *0.12*		
R. rattus ΔQAIC 1.88		0 + *0.64*								
S. vulgaris ΔAIC						0.16 *0.25*	2.01 + *0.10*	2.07 - *0.10*	0 - *0.27*	0.96 + *0.17*
L. europaeus ΔQAIC 2.05	0 *0.33*	2 + *0.12*	1.5 - *0.15*	1.74 - *0.14*	1.75 + *0.14*					

Tab. 5 - Model selection for the multi-species occupancy model from camera trapping of mammals in the Lepini Mountains at community level (average occupancy), based on the Widely Applicable Information Criterion (WAIC). Codes for environmental covariates for abundance: “ag”: agricultural areas, “ar”: artificial surface, “o”: open areas, “w”: woods; “+” or “-” indicate if the covariate impacts positively or negatively the occupancy. / Selezione dei modelli *multi-species occupancy* dai dati del fototrappolaggio nei Monti Lepini al livello di comunità (*occupancy* media), basata sul *Widely Applicable Information Criterion* (WAIC). Abbreviazioni per le covariate ambientali applicate alla numerosità delle specie: “ag”: aree agricole, “ar”: superfici antropiche, “o”: ambienti aperti, “w”: boschi, “+” o “-” indicano se la covariata ha un effetto positivo o negativo sull’*occupancy*.

MSOM model	**ΔWAIC**	**Covariate**
ψ(ag) *p*(t)	0	+
ψ(w) *p*(t)	2.04	+
ψ(ag) *p*(.)	4.44	+
ψ(.) *p*(t)	4.61	
ψ(o) *p*(t)	4.94	-
ψ(w) *p*(.)	6.03	+
ψ(o) *p*(.)	6.4	-
ψ(an) *p*(t)	6.88	+
ψ(an) *p*(.)	9.41	+
ψ(.) *p*(.)	9.57	

Open habitats negatively impact on the presence of *S. vulgaris* more than wooded areas impact on this species positively, consistently with its sensitivity to forest fragmentation (Koprowoski, 2005). The species is re-colonizing its former range and expanding its range in Central Italy (Battisti *et al*., 2013). Apparently, the species went extinct in the Lepini Mountains since the early 1950s (Amori *et al*., 2002), but isolated records have been reported in the late 1970s (various personal communications to CA), in the 1980s (Amori *et al*., 2002) and in the 1990s (Esposito, 2013). Then, since 2008 (Esposito, 2013) an increasing number of records have been reported. In the last decades grazing activities decreased in the study area (pers. obs.), with consequent natural reforestation and reduction of forest fragmentation (Buccomino, 2005). This could explain the recent re-colonization of the Lepini Mountains area by this fragmentation-sensitive species, not unlikely starting from local residual very small population.

Conversely, logging has dramatically increased in the Lepini Mountains in the last decade. This likely represents a direct threat for the elusive *C. lupus*, positively associated with woods and negatively impacted by artificial areas (Ciucci & Boitani, 2003), and *F. silvestris*, which is strictly associated with woods (Genovesi, 2003). This is suggesting an environmental management outcome from our study. A second management outcome results from the general avoidance of open areas by the species detected by camera traps, as confirmed also at community level. This raises a question over the appropriateness of the actions planned for the Special Protection Areas ("Monti Lepini" SPA covers 469.25 km^2, more than half of the territory), including the artificial maintenance of open areas such as pastures even in the absence of current grazing (Agenzia Regionale Parchi, 2012). Such actions are specifically tailored for bird conservation, but while conservation of small pastures could increase overall habitat diversity, it should be considered that artificial maintenance of large pastures could not foster non-avian species, such as *C. lupus*, *F. silvestris* and *S. vulgaris*. A further and longer camera trap study, which will consider habitat management (including logging), as well as other sources of environmental change, could likely help in understanding if and how these factors impact on the presence of mammals.

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