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Article *in* Annales Zoologici Fennici · June 2012

Impact Factor: 0.86 · DOI: 10.5735/086.049.0306

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Ann. Zool. Fennici 49: 181–191 ISSN 0003-455X (print), ISSN 1797-2450 (online)
Helsinki 29 June 2012

First density estimation of two sympatric small cats, *Leopardus colocolo* and *Leopardus geoffroyi*, in a shrubland area of central Argentina

Nicolás Caruso[1,2,*], Claudia Manfredi[1], Estela M. Luengos Vidal[1],
Emma B. Casanaveo[1,2] & Mauro Lucherinio[1,2]

[1)] *GECM, Cat. Fisiología Animal, Depto. Biología, Bioquímica y Farmacia — UNS, San Juan 670, 8000 Bahía Blanca, Argentina (*corresponding author's e-mail: nccaruso@gmail.com)*
[2)] *Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Av. Rivadavia 1917, C1033AAJ, Capital Federal, Argentina*

Received 5 Aug. 2011, final version received 16 Jan. 2012, accepted 17 Jan. 2012

Caruso, N., Manfredi, C., Luengos Vidal, E. M., Casanave, E. B. & Lucherini, M. 2012: First density estimation of two sympatric small cats, *Leopardus colocolo* and *Leopardus geoffroyi*, in a shrubland area of central Argentina. — *Ann. Zool. Fennici* 49: 181–191.

Geoffroy's and Pampas cats are small felids with large distribution ranges in South America. A camera trap survey was conducted in the Espinal of central Argentina to estimate abundance based on capture–recapture data. For density estimations we used both non-spatial methods and spatially explicit capture–recapture models (SECR). For Geoffroy's cat we also obtained density estimates from 8 radio-tracked individuals. Based on the data on 10 Geoffroy's cats and 7 Pampas cats, non-spatial methods produced density ranges of 16.21–21.94 indiv./100 km^2 and 11.34–17.58 indiv./100 km^2, respectively. The density estimated using SECR models was 45 animals/100 km^2 for Geoffroy's cat, whereas we were unable to produce a reliable estimate for the Pampas cat. The SECR estimate for Geoffroy's cat is more similar to that obtained from telemetry data (58.82 cats/100 km^2). In agreement with the hypothesis of its greater adaptability, Geoffroy's cat was more abundant than the Pampas cat.

Introduction

Geoffroy's cat, *Leopardus geoffroyi*, and the Pampas cat, *Leopardus colocolo*, are two small felids with wide, largely overlapping distributions in South America (Macdonald & Loveridge 2010). They occur in a wide range of habitats, including grasslands, savannahs, woodlands and scrublands (Ximenez 1975, Olrog & Lucero 1980, Redford & Eisenberg 1992). In spite of the fact that both Geoffroy's and Pampas cats were recently upgraded to IUCN's Near Threatened category (*see L. geoffroyi* and *L. colocolo* at www.iucnredlist.org), the knowledge about their populations is still largely incomplete (Nowell 2002, Brodie 2009). This information is particularly necessary for central Argentina, where human activities have extensively destroyed or modified natural habitats (Aurambout *et al*. 2005) and wildcat populations have been apparently relegated to marginal areas (Pereira *et al*. 2002, Castillo *et al*. 2008). This intense transformation of natural ecosystems has already caused the local extinction/reduction of many vertebrates (Chebez 1994, Gabelli *et al*. 2004), but its effect on small cat populations is little understood, and there is very little information on population abundance in modified habitats (Pereira *et al*. 2010).

In their recent essay on felid conservation, Macdonald and Loveridge (2010) underlined the necessity of studying cats within the framework of intraguild competition, because it has been shown that interspecific relationships may strongly affect carnivore population status (Burrows 1995). Ecological interactions and mechanisms promoting coexistence of sympatric species have been the focus of research for a long time (e.g., MacArthur & Levins 1967, Emmons 1987, Grassman *et al*. 2005). Differences between sympatric species in the use of trophic, temporal and spatial niches have been frequently used to describe community structure and explain the coexistence of similar species. Geoffroy's and Pampas cats have similar mating systems, overlap extensively in morphospace (Morales & Giannini 2010), have extensively overlapping distribution ranges (Macdonald & Loveridge 2010) and apparently similar diets (Manfredi 2006, Walker *et al*. 2007, Bisceglia *et al*. 2008), although their sympatric populations have not been studied. Recently, de Oliveira *et al*. (2010) suggested that Geoffroy's cat may dominate the small cat guilds in temperate, comparatively open habitats. This alleged dominance would be related to the great ecological plasticity of Geoffroy's cats, supported by the relatively ample variations in diet (Manfredi *et al*. 2004, Canepuccia *et al*. 2007, Bisceglia *et al*. 2008) and home range size (Johnson & Franklin 1991, Manfredi *et al*. 2006, Pereira *et al*. 2006, Castillo *et al*. 2008), as well as its ability to coexist with livestock ranching (Pereira *et al*. 2010).

Camera trapping has been successfully used to estimate densities of different animal species based on capture–mark–recapture models (Otis *et al*. 1978, White *et al*. 1982), in which a recapture is the appearance of the same individual in subsequent photographic records (Karanth 1995, Karanth & Nichols 1998). This methodology is particularly useful to study population densities of nocturnal and elusive species such as felids (e.g., Cuellar *et al*. 2006, Di Bitetti *et al*. 2006, Dillon & Kelly 2007, Reppucci *et al*. 2011). However, the application of this method to estimate density has raised several questions (Maffei & Noss 2007). The most problematic is the definition of the appropriate distance used as a buffer around camera-trap locations to determine the effective survey area. This factor is the most important source of variation in the density estimates produced by camera-trap surveys (O'Connell *et al*. 2011).

We used camera trapping to obtain estimates of capture probabilities and densities for sympatric populations of Geoffroy's and Pampas cats in a xeric scrubland area from the Argentine Espinal ecoregion. The Espinal is a natural habitat characterized by a forest of xerophitic species. It covers 325 360 km^2 and surrounds the Pampas region to the north, west and southwest. As the Espinal comprises a relatively large proportion of Geoffroy's and Pampas cat distribution ranges (8.9% and 5.9%, respectively) (de Oliveira 1994, Lucherini *et al*. 2005, Brown *et al*. 2006), and because of the lack of information on sympatric Neotropical cat populations, information about these species abundances in these ecosystems is of great relevance for the design of conservation strategies. Based on the information on these species in other communities (de Oliveira *et al*. 2010), we predicted that Geoffroy's cats would be more abundant than Pampas cats.

Material and methods

Study area

Fieldwork was carried out on private farms (Fabián Plischuk and Alberto S. Salvá, 38°42´S–62°56´W) adjacent to the Laguna Chasicó Provincial Park (LCPP), southwestern Buenos Aires Province, Argentina (Fig. 1). The study area was located in the transition zone between the Pampas grasslands and Argentine Monte (called Argentine Espinal), a dry shrubland with natural vegetation formed by a low xerophytic forest of caldén (*Prosopis caldenia*), algarrobo (*Prosopis alba* and *P. nigra*), espinillos (*Acacia caven*), chañar (*Geoffroea decorticans*) and tala (*Celtis tala*), as well as *Elyonurus muticus* grasslands adapted to salty soils (Cabrera & Willink 1980). Approximately 50% of the

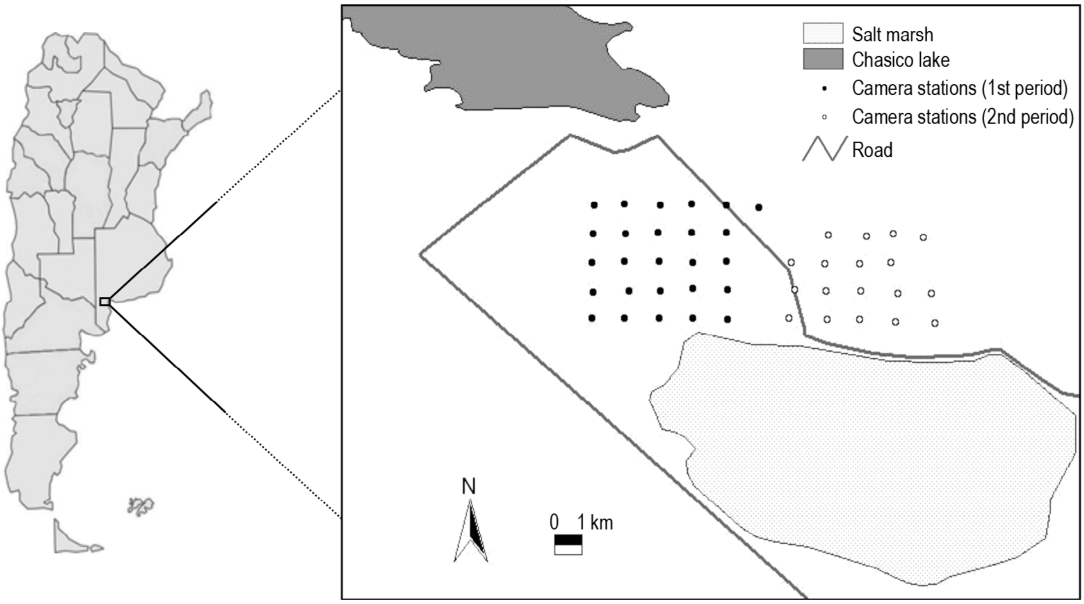

Fig. 1. Study area location in Argentina (left) and camera-trap locations within the study area (right).

shrubland in the region of the Argentine Espinal where our study area is located was logged during the last 30 years. Although the impact of human modification has not been quantified in our study area, natural habitats have been partially replaced by croplands and cattle pastures, and large portions of the original shrubland has also been logged.

Camera trapping

We conducted camera trapping from January 2008 to March 2008, corresponding to the non-breeding season for Geoffroy's cat. To maximize the size of the study area, we divided both the study area and the total study period in two contiguous sections (each one corresponds to a 'survey') (Fig. 1) that were sampled sequentially. We used a combination of both film and digital camera traps (CamTrakker®, StealthCam®, Cudde Back®, TrapaCamera®, Trail Master® and Bushnell®) that were strategically placed in a grid of 44 stations covering a fairly regular minimum convex-polygon area of 24.2 km^2 (Fig. 1). At each station, we deployed two cameras operating independently and facing each other, to obtain pictures of both flanks of the animals to identify them in subsequent captures. The cameras run continuously and we set them up to work with a model-specific minimum delay between pictures. All stations were positioned in places where we had previously registered indirect evidence of wildcats, or along trails. Because many of our stations were located in open habitats, we used odorous baits (Bobcat Urine and Bobcat Gland Lure) at all stations in order to increase photo-capture probability and the chances of getting pictures enabling individual identification. Each survey was conducted for 27 days and all cameras operated 24 hours per day, except for cases of malfunction or damage caused by cattle, climate or other causes. We checked cameras every 5 days to replace batteries, film or memory card and to ensure their proper functioning. If a camera failed, we replaced it to avoid stations with only one working camera. Sampling effort was calculated as the product of the total number of stations and the number of effective days of sampling (omitting those days when the cameras did not work) (Di Bitetti *et al.* 2006) and totalled 2808 camera-trap days. The distance among adjacent camera stations was approximately 800 m and was selected using radiocollared Geoffroy's cat data obtained previously in the same area (Benzaquín 2008). This distance was large enough to accommodate the home range of an adult Geoffroy's cat and to ensure that no adult animal had a zero capture probability within the sampled area. Since there is no information about the home-range size for Pampas cats in Argentina, we assumed that 800 m was an adequate distance to respect model assumptions. We based this assumption on the fact that the body sizes of these cat species are very similar (Nowell & Jackson 1996).

Each photographed individual Geoffroy's and Pampas cat was identified by its unique spot pattern (Cuellar *et al*. 2006, Maffei & Noss 2007). Because of the paucity of photographs of both flanks, we developed our analysis using only the photos of one flank for both species (Wang & Macdonald 2009).

Abundance estimation

To estimate population abundance of the two cat species, we combined the data from both surveys in order to construct a unique survey diagram. To do this, we considered the first day of both surveys to be the first day of the final diagram; the second days of both surveys to be the second day of the final diagram; and so on (e.g., Karanth & Nichols 1998, Di Bitetti *et al*. 2006, Soisalo & Cavalcanti 2006). We pooled three successive trap days into one trapping occasion (e.g., days one to three = first trapping occasion, four to six = second trapping occasion, and so on) to increase the capture probability over the 0.10 threshold per trapping occasion (e.g., Otis *et al*. 1978, Trolle & Kéry 2003). Then for each individual we constructed a capture history that consisted of a string of 9 trapping occasions. We used the programs MARK® and CAPTURE® to estimate the abundance (number of individuals) of cats in the study area (Rexstad & Burnham 1991, White & Burnham 1999). These software allows for different models that differ in their assumed sources of variation in capture probability (Williams *et al*. 2002). We used Akaike's Information Criterion corrected for small sample sizes (AIC_c) to identify the most parsimonious model that fits the data set in question and then generated capture statistics for all adequately fitted models (Burnham & Anderson 2002); or the model selection criterion incorporated in CAPTURE that uses a godness-of-fit test and simulation to recommend the best model (where 1 indicated the most parsimonious model) (Otis *et al*. 1978). These models assume that the population is closed, thus emigration or immigration does not take place during the survey and all the individuals present in the study area have a capture probability greater than 0 (Conroy & Carroll 2009). Our sampling design did not allow us to use a closure test to confirm this hypothesis (Pereira *et al*. 2010). Because we could not prove the lack of dispersal of animals the assumption of a demographically-closed population should be considered with caution. However, we can assume no change in the population due to births and deaths because we performed our surveys during a relatively short period. Both programs approximated the standard error (SE) for an estimate of abundance. However, at small samples sizes it is difficult to compute the 95% confidence interval (95%CI), which is not always symmetric and often has a coverage of less than 95% (Lynam *et al*. 2009). Thus we estimated 95% confidence limits (95%CL) following the recommendations of White *et al*. (1982), rounding up to the nearest integer to get the upper 95%CL and rounding down to nearest integer to get the lower 95%CL. If the lower 95%CL was smaller than the number of individuals caught, we used the number of individuals caught as the lower 95%CL (White *et al*. 1982).

The best features allowing unequivocal identification of individuals of Geoffroy's cat were the same as those used by Pereira *et al*. (2010). If the photograph's angle did not allow us to use those features for individual identification, the patterns of the lower part of the shoulders and legs were used. For Pampas cats the best identifying characters were the lines in the lower part of the legs and those in the central part of the flanks. The spots of the cranial region were used if, due to the angle of the picture, there were no other body parts available for identification. Tail length, number of bands, and banding pattern are often helpful characters in both species. We were unable to identify sex of the individuals from the photographs.

Density estimation

To estimate the density of animals, we followed the methodology described by Karanth *et al*. (1998). This *ad hoc* method estimates an effective trapping area by adding an outer buffer to the camera trap stations. There is no agreement about how to construct the external buffer (O'Connell *et al*. 2011), so we decided to follow Balme *et al*. (2009) and compared 5 methods: (1) the mean maximum distance covered by individuals photographed on more than one occasion (MMDM); (2) its half value (HMMDM); (3) the HMMDM calculated from adult Geoffroy's cat (eight individuals) and Pampas cat (one individual) radiotelemetry data collected in the same region during the 3-month camera-trap survey period; (4) the mean annual home-range (HR, computed by the 95% minimum convex polygon) radius; and (5) the mean HR radius for the 3-months survey period of radiotagged Geoffroy's and Pampas cats. We calculated the effective trapping area by adding each of the outer buffer types to the trap polygon and finally estimated density as the quotient of the abundance and the effective trapping area.

Additionally, we run spatially explicit capture–recapture models (SECR; Efford *et al*. 2009) that avoided the necessity for calculating an *ad hoc* effective trapping area and estimated density directly from the capture–recapture data using a maximum likelihood approach. To do this, we used the program DENSITY® (Efford *et al*. 2004) that was specifically designed to fit these models. DENSITY® allows for choosing among different detection models and modelling variations in the capture probability. We used a half normal distribution to describe how an animal probability of being detected declines as its home range centre gets further from a camera and the maximum likelihood method to estimate the three parameters of the spatial models (g_0, D and σ; Efford *et al*. 2009).

Finally, we estimated the density of Geoffroy's cats using the telemetry data (Benzaquin 2008) to have an independent estimate that could be used when comparing the techniques based on the camera-trapping data. To achieve this, first we calculated the average home-range of the 8 radiotracked individuals (100% minimum convex polygon), corrected by the average proportion of overlap by neighbouring individuals (Harris *et al*. 1990, Luengos Vidal 2003, Castillo *et al*. 2011); and second, we computed the total area occupied by radiotracked animals and divided it by the number of radiotracked individuals that occupied this area (Dunstone *et al*. 2002, Castillo *et al*. 2011). We decided not to perform these analyses for Pampas cats because the data from only one individual would not provide a reliable estimation.

Results

We obtained 19 captures (8 different animals recognized) and 9 recaptures of Geoffroy's cat, and 10 captures (7 different animals) and 3 recaptures of the Pampas cat.

The capture–recapture history of the individually-identified Geoffroy' cats was best explained by the null model (M_0) and by the model that incorporated capture variation before and after being captured (behaviour effect, M_b; Table 1). We used the latter to calculate abundance as it is more biologically realistic and robust to violations of the assumption of homogeneous capture probabilities (Boulanger & Krebs 1996, Karanth & Nichols 1998). The low number of identified individuals of the Pampas cat prohibited an effective use of the program MARK, therefore, we used CAPTURE (Gerber *et al*. 2010), which selected the model that incorporates behaviour and heterogeneity effect as the most parsimonious (criterion = 1), and behaviour effect as the second one (criterion = 0.94). We used the latter to calculate abundances because of the inability of CAPTURE to compute the other estimator with our data.

The capture probability was 0.277 (recapture probability = 0.148) for Geoffroy's cat and 0.389 (recapture probability = 0.067) for the Pampas cat. The estimated population sizes were 10 (SE = 1.277) Geoffroy's cats and 7 (SE = 0.334) Pampas cats.

The values of annual HR radius were always more similar to MDMM than to HMDMM. The HMDMM calculated from the quarterly telemetry data was, in both cases, greater than the same distance calculated from the trapping data (Tables 2 and 3).

For the Pampas cat, all the recaptures were at the same station, so we could not calculate the MMDM. Because of this we decided to use the same MMDM value obtained for Geoffroy's cat to estimate the effective trapping area of the Pampas cat. Irrespective of the procedure, density estimates were constantly greater for Geoffroy's cat than for the Pampas cat. Density by non-spatial methods ranged from 11.34 to 17.58 animals per 100 km^2 and from 16.21 to 21.94 animals per 100 km^2, for the Pampas cat and Geoffroy's cat, respectively (Tables 2 and 3). The densities of Geoffroy's cat estimated by the SECR models were almost two times greater than those produced by the non-spatial methods, whereas the densities obtained for the Pampas cat were unrealistically high (Tables 2 and 3).

The densities of Geoffroy's cat calculated from the telemetry data were 58.82 indiv./100 km^2 (95%CL = 32.26–333.33), and 50.22 indiv./100 km^2, for the first and second procedure, respectively (*see* Material and methods).

Discussion

This is the first estimation of the densities of the sympatric Geoffroy's and Pampas cat populations. The results indicate that Geoffroy's cat is more abundant in the Argentine Espinal than the Pampas cat. Our results confirm the usefulness of the photographic sampling technique for estimating population abundances of individually recognisable species of small cats that have traditionally been difficult to study because of cryptic behaviour and low population densities (Cuellar *et al*. 2006, Di Bitetti *et al*. 2006, Dillon & Kelly 2007, Reppucci *et al*. 2011).

Only two previous studies reported data on Geoffroy's cat population numbers using camera trapping but none of them reported detection probabilities (Table 4). Geoffroy's cat density in our study area was similar to those reported by Cuellar *et al*. (2006) for a range of habitats from the Bolivian Chaco but considerably smaller than those estimated by Pereira *et al*. (2010) in the Argentine Monte of La Pampa Province (Table 4). Pereira *et al*. (2010) proposed that the much higher densities in their study when compared with those given by Cuellar *et al*. (2006) were related to: (1) good habitat conditions in their study area; (2) the presence of a large number of transient individuals; (3) the lack of interspecific competition with ocelots; and (4) the fact that Cuellar *et al*. (2006) estimates were obtained close to the northern limit of Geoffroy's cat distribution. Our study was carried out in an area only 250 km apart and in an ecologically related region to that of Pereira *et al*. (2010). Thus, the comparison with our results indicates that habitat quality, intraguild competition and location of the study area with respect to the species' distribution limits were unlikely to play

Table 1. Candidate models given by Akaike's Information Criterion (AIC) model selection procedure used to best-fit capture–recapture histories of Geoffroy's cat from 44 camera trap stations during January–March 2008. The models were created from capture histories evaluated by modelling the detection process (after Otis *et al.* 1978); *K* is the number of parameters per model; AIC$_c$ is the AIC with small sample bias adjustment (Burnham & Anderson 2002); ΔAIC$_c$ is the difference between a model's AIC$_c$ and the most parsimonious model; Wi is the percentage of model weight attributed to each model and the Model likelihood indicate the strength of evidence of each model relative to other candidate models.

Model	*K*	AIC$_c$	ΔAIC$_c$	Wi	Model likelihood	Model deviance
Null	2	62.8629	0	0.53888	1	42.882
Behaviour	3	63.9151	1.0522	0.31843	0.5909	41.7931
Heterogeneity	4	66.1066	3.2437	0.10645	0.1975	41.7931
Heterogeneity + behaviour	5	68.3505	5.4874	0.03467	0.0643	41.7931
Time	10	75.582	12.7191	0.00093	0.0017	36.9543
Behaviour + time	11	76.6821	13.8192	0.00054	0.001	35.4546
Heterogeneity + time	12	80.0268	17.1639	0.0001	0.0002	36.132

Table 2. Abundance and density estimates for Geoffroy's cat using five types of buffers and their associated effective survey areas, and a maximum-likelihood spatially-explicit model (SECR; Efford *et al.* 2004) using data from of 44 camera-trap stations during January–March 2008. MMDM is mean maximum distance moved by individuals photographed on more than one occasion; HMDMM is the half value of the MDMM; HMDMM is the half of the mean maximum distance moved calculated from of three months radiotelemetry data; Quarterly HR radius refers to the home range radius calculated from three months radiotelemetry data; Annual HR radius is the home range calculated from annual radiotelemetry data and SECR refers to density estimation using spatially explicit capture-recapture models. *n* is the number of individual used to obtain the estimation.

	MMDM	HMDMM	Quarterly HMDMM	Quarterly HR radius	Annual HR radius	SECR
Buffer value, m	1430 (*n* = 5)	715 (*n* = 5)	1112.6 (*n* = 3)	946 (*n* = 3)	873 (*n* = 8)	
Effective trapping area, km^2	61.71	41.35	52.58	47.61	45.60	
Abundance estimate (95%CL)	10.0 (10.0–27.5)					
Density, indiv./100 km^2 (95%CL)	16.21 (16.21–44.56)	24.18 (24.18–66.50)	19.02 (19.02–52.31)	21.02 (21.02–57.77)	21.94 (21.94–60.31)	45.00 (22.95–88.28)

Table 3. Abundance and density estimates for Pampas cat using five types of buffers and their associated effective survey areas, and a maximum-likelihood spatially-explicit model (SECR; Efford *et al.* 2004) using data from of 44 camera-trap stations during January–March 2008. MMDM is mean maximum distance moved by individuals photographed on more than one occasion; HMDMM is the half value of the MDMM; HMDMM is the half of the mean maximum distance moved calculated from of three months radiotelemetry data; Quarterly HR radius refers to the home range radius calculated from three months radiotelemetry data; Annual HR radius is the home range calculated from annual radiotelemetry data and SECR refers to density estimation using spatially explicit capture-recapture models. *n* is the number of individual used to obtain the estimation.

	MMDM	HMDMM	Quarterly HMDMM	Quarterly HR radius	Annual HR radius	SECR
Buffer value, m	1430 (*n* = 5)	715 (*n* = 5)	747.4 (*n* = 1)	642.7 (*n* = 1)	656.3 (*n* = 1)	
Effective trapping area, km^2	61.71	41.35	42.19	39.48	39.82	
Abundance estimate (95%CL)	7.0 (7.0–8.7)					
Density, indiv./100 km^2 (95%CL)	11.34 (11.34–14.10)	16.93 (16.93–20.62)	16.59 (16.59–20.62)	17.73 (17.73–22.04)	17.58 (17.58–21.85)	10257.26 (3705.18–28395.73)

a major role in explaining the extremely high Geoffroy's cat densities observed in the Argentine Monte and support the suggestion by Pereira *et al.* (2010) that their estimates should be treated cautiously because they may have been inflated by the presence of many transient cats.

Information on Pampas cat densities is extremely scarce. In our study area, the Pampas cat density appeared to be fairly larger than that in the Brazilian grassland (Silveira *et al.* 2005), and much smaller than that in the high Andes of northwestern Argentina (Gardner *et al.* 2010, Reppucci *et al.* 2011). Because both the Espinal and Brazilian grasslands are likely to be more productive ecoregions than the high Andes, we agree with Reppucci *et al.* (2011) that their result was likely affected by the exceptionally good quality and relatively small size of the study area.

The greater population density of Geoffroy's cat with respect to that of the Pampas cat in our study is in agreement with our prediction and supports the hypothesis that Geoffroy's cat tends to be the most common small felid species in the temperate regions of the Southern Cone of South America (de Oliveira *et al.* 2010). Overlap between sympatric populations of similar species in the use of trophic, temporal and spatial niches has frequently been seen as an indicator of competition. It is possible that in our study area, competition between Pampas and Geoffroy's cats is avoided by spatial/habitat segregation, as suggested by the fact that the Pampas cat pictures were mostly taken in the areas where salty soils support open grassland vegetation.

Differences in the way of determining the effective survey area are the most important source of variation in the density estimates produced by camera-trap surveys (O'Connell *et al.* 2011). To estimate density, most authors used buffers equivalent to half the mean maximum distance covered (HMMDM) by camera-trapped animals. However, it has been suggested that HMMDM produces a sub-estimation of the actual effective trapping area (e.g., Trolle & Kery 2005, Di Bitetti *et al.* 2006, Dillon & Kelly 2008). Our estimate using the SECR models was most consistent with the Geoffroy's cat density values obtained by applying HMMDM. Additionally, in both cases, the annual HR radius was more similar to that of HMMDM than to that produced by other buffer methods. This indicates that HMMDM could give the least-biased esti-

Table 4. Comparison of the density estimates (animals per 100 km^2) and capture probabilities for Geoffroy's cat and Pampas cat obtained by different authors with different methods (*see* Tables 2 and 3).

Species/source	Method	Density estimates	Habitat	Capture probab.
Geoffroy's cat				
Cuellar *et al.* 2006	HMMDM	9–42	Bolivian Chaco	n/a
Pereira *et al.* 2010	HR radius	140–240	Argentine Monte	n/a
— ″ —	MMDM	100–160		
— ″ —	HMMDM	190–290		
This work	MMDM	16–45	Argentine Espinal	0.277
— ″ —	HMDMM	28–65		
— ″ —	Quarterly HMDMM	19–52		
— ″ —	Quarterly HR radius	21–58		
— ″ —	Annual HR radius	22–60		
— ″ —	SECR	23–88		
Pampas cat				
Silveira *et al.* 2005	N/A	2–10	Brazilian grassland	n/a
Gardner *et al.* 2010	SECR	74–79	High Andes of NW Argentina	0.02
This work	MMDM	11–14	Argentine Espinal	0.02
— ″ —	HMDMM	17–21		
— ″ —	Quarterly HMDMM	17–21		
— ″ —	Quarterly HR radius	18–22		
— ″ —	Annual HR radius	18–22		
— ″ —	SECR	3705–28395		

mations of the HR radius, the variable of interest when estimating the effective sampling area. The result that the use of HMMDM from photographic recaptures does not seem to produce overestimates of population density is in agreement with the conclusions of Balme *et al*. (2009) and Núñez-Pérez (2011), who compared camera trapping to telemetry data.

Densities calculated from our telemetry data were greater than those obtained using non-spatial capture–recapture models and similar to the estimation by the SECR models. Our data based on telemetry are indicative of the inability of the non-spatial *ad hoc* method to give an unbiased density estimation. They also support the importance of applying more effective techniques, such as the SECR models, which avoid the need for indirect calculation of effective trapping area (Gardner *et al*. 2010). On the other hand, the SECR models produced an unrealistically high estimation of the Pampas cat density. This was most likely a consequence of the small number of captures (Efford *et al*. 2009b) and also their geographical location. Our Pampas cat captures were registered by only a few cameras that were close to each other and located in a particular habitat (sandy open areas) that was underrepresented in our survey array. Based on our results, the SECR models appear to be very sensitive to spatial variation in recapture.

The capture probabilities of both Geoffroy's and Pampas cats were grater than those found for other Neotropical small cats ($p = 0.16$ and $p = 0.03$ for ocelots: Trolle & Kery 2003 and Maffei *et al*. 2007, respectively; $p = 0.02$ for Pampas cats in the high Andes: Gardner *et al*. 2010). Interestingly, capture probability was greater for the less abundant species. This confirms that population abundance studies should always account for and report this parameter to produce correct density estimations and enable meaningful comparisons across species or areas (Reppucci *et al*. 2011).

Finally, our results suggest that where the mosaic of xeric forest and grasslands typical of the Argentine Espinal is relatively well preserved, this ecoregion may sustain relatively dense populations of both Geoffroy's and Pampas cats and thus contribute to the global conservation of these species. This is especially important because the populations of these felids have suffered marked declines in the contiguous Pampas grassland (Pereira *et al*. 2002, Castillo *et al*. 2008).

Unfortunately, the conservation value of the Argentine Espinal for these felids and other components of the community of native vertebrates would be greatly reduced if the rate of habitat loss and modification it has suffered in the last decades is sustained.

Acknowledgments

We sincerely thank the members of GECM (particularly P. Costilla, J. Reppucci, C. Tellaeche), M. Benzaquin, P. Cuello, and all the volunteers who contributed to data collection. A. Salva, M.J. Salva, J. Meller, and P. Meleer from 'Los Alamos' ranch provided important logistic support. We are grateful to L. Denapole and P. Perovic, who made their camera traps available, and L. Grassman for revising the English form. N.C. was supported by a student scholarship by Comisión para la Investigación Científica de la Provincia de Buenos Aires (CIC), C.M. and E.L.V. by a postgraduate scholarship from UNS and Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET). Our project received financial support from SGCyT, UNS (PGI 24/B123), Earthwatch Institute, and Panthera/Wildlife Conservation Society Kaplan Awards Program. We acknowledge all the governmental institutions that endorsed and authorized our project.

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