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Activity patterns of Molina's hog-nosed skunk in two areas of the Pampas grassland (Argentina) under different anthropogenic pressure

D.F. Castillo [1,2,4], E.M. Luengos Vidal [1,2], N.C. Caruso [1,2], E.B. Casanave [1,2] and M. Lucherini [1,3]

[1] *GECM-Cát. Fisiología Animal, Departamento de Biología, Bioquímica y Farmacia, Universidad Nacional del Sur, Bahía Blanca, Argentina*
[2] *INBIOSUR-CONICET (Instituto de Investigaciones Biológicas y Biomédicas del Sur), Bahía Blanca, Argentina*
[3] *CONICET (Consejo Nacional de Investigaciones Científicas y Técnicas), Argentina*

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This study describes and compares the activity patterns of free-ranging Molina's hog-nosed skunks (*Conepatus chinga*) in a protected area (PA) and in a cropland area (CA) in the Pampas grassland of Argentina. Sixteen skunks (PA: three males, four females; CA: three males, six females) were captured and monitored using radio-telemetry techniques for 92–395 days each. In both areas, *C. chinga* was largely nocturnal and the start and cessation of activity was related to sunset and sunrise, respectively. Skunks spent more time active in the PA, where the level of anthropogenic activity was lower, and this difference was due to increased activity during the daylight hours. Finally, activity was greater for females than for males, and in the warm season when compared to the cold season. In the Pampas grasslands of Argentina, activity of Molina's hog-nosed skunks seems to be influenced by both food availability and predation risk related to human presence.

KEY WORDS: *Conepatus chinga*, Mephitidae, radio telemetry, carnivore.

INTRODUCTION

Daily activity patterns of terrestrial carnivores are affected by both endogenous biological factors and behavioral plasticity to environmental variations (Daan 1981), including activity of prey, competition and risk of predation (Zielinski et al. 1983; Lima & Dill 1990; Lode 1995; Lariviere & Messier 1997). Given increased threats to carnivores' survival posed by escalating human encroachment on landscapes worldwide (Woodroffe 2001), many carnivores exhibit behavioral plasticity in activity

[4] Corresponding author: Diego Fabián Castillo, GECM – Cat. Fisiología Animal, Departamento de Biología, Bioquímica y Farmacia, Universidad Nacional del Sur, San Juan 670, 8000 Bahía Blanca, Argentina (E-mail: diefcastillo@gmail.com).

patterns to decrease the potential for human-related mortality and to balance energy expenditure and gain (Drew & Bissonette 1997; Machutchon et al. 1998). Thus, in addition to theoretical interest, investigating activity patterns is important for the management and conservation of carnivore species.

Molina's hog-nosed skunk [*Conepatus chinga* (Molina 1782)] is a small-sized mephitid (Carnivora Mephitidae) with the black and white coloration pattern of pelage typical of many members of this family. In spite of its large distribution in the South American continent (Redford & Eisenberg 1992), there is little information about the genus *Conepatus*, particularly concerning ecological aspects (Kasper et al. 2012).

Our goals here were to compare the activity pattern of radio-tracked *C. chinga* in an agricultural area and a protected area of the Argentinean Pampas in order to investigate the influence of sex, day time period, seasons and food availability, and the effects of human disturbance on skunk activity patterns.

If human presence has an influence on the activity of Molina's hog-nosed skunks similar to that reported for other carnivores species (Grinder & Krausman 2001; McClennen et al. 2001), then we would expect activity patterns to differ between study areas; specifically, activity of skunks in disturbed areas should be reduced where agricultural activities are present. Additionally, we predicted that the greatest variation would be found in the hours of the day when human activities are most intense.

MATERIALS AND METHODS

Study site

The activity and movements of *C. chinga* were monitored in two areas of the Pampas grasslands with different levels of anthropogenic disturbance. The two areas are located less than 100 km away from each other in a temperate region of the central Argentina lowlands. Their natural vegetation, precipitations (ranging between 600 and 800 mm) and mean monthly temperatures (range: 8–23 °C) were very similar.

The first study site is a protected area (hereafter, PA; Ventania mountain system, southern Buenos Aires province: 38°00'S–62°00'W). Elevations range from 550 to 1240 m above sea level. This provincial park has a surface area of approximately 6700 ha and is composed of canyons and open plains. The climate is temperate with mean 500–800 mm annual precipitation (Frangi & Bottino 1995). The grassland within the park is dominated by short prairie grasses of the genera *Stipa*, *Piptochaetium*, *Briza* and *Festuca* but introduced tree/shrub patches are also frequent (Zalba & Villamil 2002).

The second site is the 'San Mateo' farm (hereafter, CA; a cropland area, southern Buenos Aires province: 38°37'S–60°53'W) with a surface area of 8100 ha and elevations ranging from 120 to 150 m. The climate is temperate with mean 500–1000 mm annual precipitation (Campo de Ferreras et al. 2004). Land was mostly used for extensive livestock breeding (cows and sheep) and intensive agriculture activities that include wheat, barley, soybean and sunflower crops (Bonaventura & Cagnoni 1995).

Estimation of anthropogenic activity levels

To measure human activity in both study areas, we used the following parameters: (1) percentage of total study area surface devoted to farming activities (seeding and harvesting crops). These activities, unlike livestock breeding, are performed continuously throughout the year and require the use of heavy machinery; (2) road density, (i.e. road extension in m per unit of area in ha); (3) daily average traffic (i.e. the average number of vehicles passing in either direction from a specific point in a 24-hr period). To calculate the daily average traffic, we randomly sampled 8 days in each meteorological season of the year: warm period (January to March, October to December) and cold period (April to September). We selected a point on the main road of each study area and counted all vehicles continuously for 24 hr. We compared this parameter between areas using Mann-Whitney U-test.

Capture and telemetry

Live trapping was carried out from October 2002 to February 2007. We spotlighted Molina's hog-nosed skunks (skunks, henceforward) from a vehicle and restrained them manually. Captured adult skunks were chemically immobilized (Castillo et al. 2012a) and fitted with a very high frequency (VHF) radiocollar weighing approximately 24 g that had both activity motion and a mortality sensor (Telemetry Solutions, Concord, CA). All trapping and handling procedures followed the recommendations of the American Society of Mammalogists (Animal Care & Use Commitee 1998).

Activity patterns

Skunks were radio tracked on foot using portable telemetry equipment and following two basic schedules: daily locations at different times throughout the 24-hr period and intensive tracking sessions of 24-hr. In both cases, activity was recorded every 10 min. Activity was assessed as either active or inactive based on a 2-min sampling of the signal from the motion sensor (Lariviere & Messier 1997). The percentage of time that an animal remained active was calculated and the record was considered active if it exceeded 50%. Thus, activity was recorded as a discrete binomial variable, assigning values of 0 for inactive and 1 for active data. Finally, activity was defined as the percentage of active fixes per hour (Neiswenter et al. 2010).

We looked for variation in activity between sexes, individuals, hours of day and seasons. Probability levels were computed using a complete randomization method based on Monte Carlo permutations (Good 2000). Monte Carlo simulations were generated by the Ecosim program® (version 6.0) (Gotelli & Entsminger 2001) and were used instead of the typical non-parametric Chi-square test (Murgia et al. 2007). EcoSim reshuffles the data among the categories and then determines how much variation is expected among the means of the different categories.

For daily activity analysis, we divided the day into four light phases: sunrise, daylight, sunset and night. Dawn and dusk encompassed 3 hr each, including 90 min before and after sunrise and sunset, respectively. Length of daylight and night periods changed according to the time of year.

RESULTS

Estimation of anthropogenic activity levels

In CA, 70.3% of the total area was devoted to farming activities, while in PA, due to protected area restrictions, there is not any surface dedicated to these activities. The road density was nearly 3 times higher in CA (9.75 m/ha) than in PA (3.59 m/ha). Finally, the daily average traffic in CA was (x ± standard deviation, SD) 20.75 ± 6 vehicles/day, while in PA it was 2 ± 2.4 (Table 1). In both areas, the average traffic was significantly higher during daylight hours compared to night (CA: $U = 0.001$, $n = 16$, $P < 0.001$; PA: $U = 27$, $n = 16$; $P < 0.001$).

Capture and telemetry

This study was performed using activity data from 16 skunks, six males (CA = 3; PA = 3) and 10 females (CA = 6; PA = 4), which were monitored for at least 3 months

Table 1.

Average number of vehicles two-way passing a specific point in a 24-hr period and in 12-hr periods (daylight and night) in two sites of the Pampas grassland of Argentina. PA, protected area; CA, cropland area.

Areas	Daily average traffic (vehicles/day)	Daylight (vehicles/daylight hours)	Night (vehicles/dark hours)
PA	2 ± 2.4	2 ± 2.4	0
CA	20.75 ± 6	18.4 ± 5.1	2.4 ± 1.6

(range: 92–395 days) (Appendix 1). An average (X ± SD) of 297.9 ± 29.4 activity records per animal (PA = 333.7 ± 45.6, CA = 270 ± 31.2 records, Appendix I) was obtained, giving a total of 4857 records (CA = 2476; PA = 2381, Appendix I).

Activity patterns

On average, skunks were more active at PA than at CA (PA = 53.7%; CA = 48.2%; χ^2 = 14.37; variance of simulated χ^2 = 3.06 ± 6.38; P = 0.003). Because we did not detect individual variation in activity patterns within each sex (PA: [females: χ^2 = 5.86; variance of simulated χ^2 = 6.90 ± 14.02; P = 0.54; males: χ^2 = 0.57; variance of simulated χ^2 = 4.86 ± 10.38; P = 0.98]; CA: [female: χ^2 = 4.14, variance of simulated χ^2 = 10.96 ± 21.15, P = 0.96; males: χ^2 = 2.06, variance of simulated χ^2 = 4.86 ± 9.84; P = 0.82]), for the following analyses, we pooled all individuals of the same sex in each area.

In both areas, females spent more time active than males (PA: [females: 58.3%; males: 47.9%; χ^2 = 24.83; variance of simulated χ^2 = 3.20 ± 6.91; $P < 0.001$]; CA: [females: 51.75%; males: 42.64%; χ^2 = 19.25; variance of simulated χ^2 = 2.96 ± 6.06; $P < 0.001$]).

Daily activity

In both sexes and both study areas, activity was not homogeneously distributed throughout the day (PA = [females: χ^2 = 681.16; variance of simulated χ^2 = 47.99 ± 95.35; $P < 0.001$; males: χ^2 = 901.17; variance of simulated χ^2 = 47.98 ± 96.87; $P < 0.0001$] CA = [females: χ^2 = 1267.4, variance of simulated χ^2 = 47.51 ± 98.65; P = 0.001; males: χ^2 = 1115.69, variance of simulated χ^2 = 48.12 ± 96.23; $P < 0.001$]). Skunks spent most of their time active at night while the minimum proportion of active fixes was recorded during the daylight (Table 2; Fig. 1). Both transition periods (sunrise and sunset) showed intermediate values (Table 2). In PA, activity peaked at 22:00 and 05:00 for males and at 21:00 and 00:00 for females (Fig. 1). The activity peaks appeared to occur later in CA than PA. Female activity had peaks between 21:00 and 00:00, while peaks were between 21:00 and 01:00 in males (Fig. 1). In both areas, females had both higher levels and more prolonged period of activity than males (Fig. 1).

There were no significant differences between study areas in the proportion of activity at sunrise (χ^2 = 0.01; variance of simulated χ^2 = 2.98 ± 5.88; $P < 0.99$), sunset (χ^2 = 0.35; variance of simulated χ^2 = 2.93 ± 5.39; $P < 0.96$) and at night (χ^2 = 1.38; variance of simulated χ^2 = 3.05 ± 6.64; $P < 0.71$). However, skunks from PA showed

Table 2.

Daily activity of *Conepatus chinga* in two sites of the Pampas grassland of Argentina. PA, protected area; CA, cropland area.

Area sex % of active fixes		Sunrise	Daylight	Sunset	Night
PA	Females	55.43	33.21	58.7	86.75
	Males	55.56	20.14	41.67	77.55
	Overall	55.48	27.42	50.78	82.54
CA	Females	60.94	10.75	54.3	85.38
	Males	44.44	5.39	51.88	84.21
	Overall	56.04	8.13	53.05	84.87

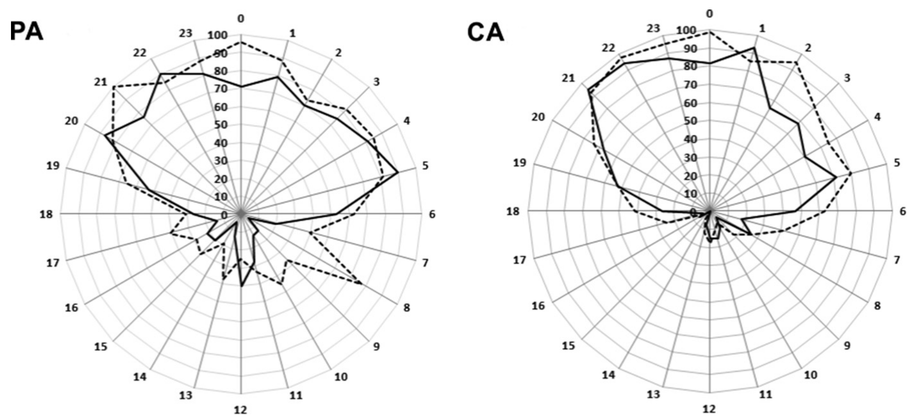

Fig. 1. — Daily activity patterns of *Conepatus chinga* in two sites of the Pampas grassland of Argentina. Hours of the day are indicated along the circumference, the internal lines show the percentages of activity. Males, solid line; females, broken line; PA, protected area; CA, cropland area.

more activity during the daylight hours (χ^2 = 110.4; variance of simulated χ^2 = 3.02 ± 5.82; $P < 0.001$).

Seasonal activity

In both areas, the overall percentage of activity of skunks in the warm season was higher than in the cold season (PA = [χ^2 = 91.64; variance of simulated χ^2 = 48.06 ± 100.69; P = 0.001]; CA = [χ^2 = 82.57, variance of simulated χ^2 = 50.24 ± 120.75; P = 0.006; Table 3). This difference held true when sexes were analyzed separately (PA = [females: χ^2 = 180.58; variance of simulated χ^2 = 47.63 ± 93.82; P = 0.001; males: χ^2 = 173; variance of simulated

Table 3.

Seasonal activity of *Conepatus chinga* in two sites of the Pampas grassland of Argentina. PA, protected area; CA, cropland area.

Area	Sex	% of active fixes	
		Cold season	Warm season
PA	Females	57.79	58.04
	Males	42.76	56.07
	Overall	49.62	57.37
CA	Females	44.84	55.69
	Males	41.38	43.39
	Overall	43.02	51.69
Overall		46.5	54.48

χ^2 = 49.12 ± 106.55; *P* = 0.001]; CA = [females: χ^2 = 112.88; variance of simulated χ^2 = 51.90 ± 132.16; *P* = 0.001; males: χ^2 = 134.32; variance of simulated χ^2 = 55.43 ± 160.98; *P* = 0.001], Table 3).

DISCUSSION

We found that in both study areas, Molina's hog-nosed skunks were clearly nocturnal and the start and cessation of their activities were related to sunset and sunrise, respectively. This pattern is in agreement with previous studies on this species (Donadio et al. 2001; Kasper et al. 2012) and other mephitids (Johnson et al. 1988; Lariviere & Messier 1997; Rosatte & Larivière 2003).

Carnivore activity in general is synchronized with predation risk and the activity of their prey (e.g. Lovari et al. 1994; Lode 1995), and daily peaks are expected to occur when foraging is most rewarding (Kruuk 1989). The diet of the Molina's hog-nosed skunk in Pampas grassland mainly consists of beetles (Castillo et al. 2012b). Ground beetles have been reported to be highly vulnerable to skunk predation during the night (Kirk 1974). *C. chinga* also ate a large number of scorpions, a typical nocturnal invertebrate of this region (Nabte et al. 2008). Thus, probably, the largely nocturnal activity exhibited by skunks serves to increase the probability of encountering prey.

In both areas, skunks were more active during the warm months than in the cold season. Because the abundance of the main food, coleopterans, is greater in the warm season in both areas (Castillo 2011), an increase in activity might be expected in the cold season. However, in previous work in the same study areas, we described that because of the patchy distribution of food, in the cold season skunks travelled longer distances (presumably to find new food patches) than in the warm season, but these displacements were made in relatively short periods of time (Castillo et al. 2011b). We speculate that skunks reduced their activity during the cold months mostly in order to reduce exposure to low temperatures. Nevertheless, another possible explanation is that the mating season in the warm period led to an increase in the level of activity.

In both study areas, females had a higher percentage of overall activity than males, especially during the day. In the absence of experimental work, we can hypothesize that sexual differences in metabolic demands related to reproductive costs and caring for young could explain this behavioral difference (LARIVIERE & MESSIER 1997; ZALEWSKI 2001).

Because of their conspicuous black and white aposematic coloration and their powerful anal glands, skunks are rarely preyed upon (LARIVIERE & MESSIER 1997). However, denning behaviour may help skunks avoid predation by black-crested buzzard-eagles (*Geranoaetus melanoleucus*), Pampas foxes (*Pseudalopex gymnocercus*) and dogs (CASTILLO et al. 2011a). Although skunks are not frequently persecuted directly by people, in rural areas they can be injured or killed by dog attacks and hit by cars (KASPER et al. 2009). As expected, we found that skunks spent more time active in the protected area, where human disturbance was more limited. Additionally, the highest percentage of overall activity of the PA skunks was due primarily to their greater activity during daylight hours, while sunrise, sunset and night activity were similar between the two areas. Although usually a great proportion of the daytime activities of radio-tracked skunks occurred inside or in close proximity of the dens (CASTILLO et al. 2011a; see also KASPER et al. 2012), it was not uncommon to observe PA skunks moving during the day. This behavior was never observed at CA, where human activity was intense during daylight time hours. Only a specifically designed experiment would confirm the direct cause-effect relationship between anthropogenic disturbance and skunk activity. Additionally, it cannot be completely excluded that other factors, such as food availability and climate variations between study years, may have affected the differences in activities we recorded between areas. However, we observed no major variations for either weather conditions across the study period or invertebrate abundances between study sites (CASTILLO 2011), Thus, our results suggest that Molina's hog-nosed skunks adopt the same behavioral switch (reduce daytime activities in response to increased human disturbance) that has been described for a number of carnivores (e.g. LUCHERINI et al. 1995; GRINDER & KRAUSMAN 2001; TIGAS et al. 2002; BECKMANN & BERGER 2003). We speculate that a greater perceived (and probably real) risk of predation is the ultimate cause of the differences in activity patterns that we observed.

The results obtained in this study contribute to improve our limited information on the behavior and natural history of *C. chinga*. Documentation of behavioral changes such as that reported here increases our understanding of human-carnivore interactions and the extent to which carnivores can adapt to human presence.

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REFERENCES

Animal Care & Use Committee 1998. Guidelines for the capture, handling, and care of mammals as approved by the American Society of Mammalogists. *Journal of Mammalogy* 79: 1416–1431.

Beckmann J.P. & Berger J. 2003. Rapid ecological and behavioural changes in carnivores: the responses of black bears (*Ursus americanus*) to altered food. *Journal of Zoology* 261: 207–212.

Bonaventura S.M. & Cagnoni M.C. 1995. La vegetación de los bordes de los caminos en agroecosistemas. *Physis* 50: 63–71.

Campo de Ferreras A.M., Capelli de Steffens A.M. & Diez P.G. 2004. El clima del Suroeste Bonaerense. *Bahía Blanca*: *Departamento de Geografía y Turismo, Universidad Nacional del Sur*.

Castillo D.F. 2011. Ecología espacial, temporal y trófica del zorrino (*Conepatus chinga*) en un área natural y un área de uso agrícola. *Ph.D. Disertation, Universidad Nacional del Sur*.

Castillo D.F., Lucherini M. & Casanave E.B. 2011a. Denning ecology of Molina's hog-nosed skunk in a farmland area in the Pampas grassland of Argentina. *Ecological Research* 26: 845–850.

Castillo D.F., Lucherini M., Luengos Vidal E.M., Manfredi C. & Casanave E.B. 2011b. Spatial organization of Molina's hog-nosed skunk (*Conepatus chinga*) in two landscapes of the Pampas grassland of Argentina. *Canadian Journal of Zoology* 89: 229–238. doi:10.1139/Z10-110.

Castillo D.F., Luengos Vidal E.L., Casanave E.B. & Lucherini M. 2012a. Field immobilization of Molina's hog-nosed skunk (*Conepatus chinga*) using ketamine and xylazine. *Journal of Wildlife Diseases* 48: 173–175.

Castillo D.F., Luengos Vidal E.L., Casanave E.B. & Lucherini M. 2012b. Habitat selection of Molina's hog-nosed skunks in relation to prey abundance in the Pampas grassland of Argentina. *Journal of Mammalogy* 93: 716–721. doi:10.1644/11-MAMM-A-300.2.

Daan S. 1981. Adaptive daily strategies in behavior, pp. 275–298. In: Aschoff J., Ed. Handbook of behavioral neurobiology. *New York*: *Plenum Press*.

Donadio E., Di Martino S., Aubone M. & Novaro A.J. 2001. Activity patterns, home-range, and habitat selection of the common hog-nosed skunk, *Conepatus chinga* (Mammmalia, Mustelidae), in northwestern Patagonia. *Mammalia* 65: 49–54. doi:10.1515/mamm.2001.65.1.49.

Drew G.S. & Bissonette J.A. 1997. Winter activity patterns of American martens (*Martes americana*): rejection of the hypothesis of thermal-costminimization. *Canadian Journal of Zoology* 75: 812–816. doi:10.1139/z97-103.

Frangi J.L. & Bottino O.J. 1995. Comunidades vegetales de la Sierra de la Ventana, Provincia de Buenos Aires, Argentina. *Revista de la Facultad de Agronomía de La Plata* 71: 93–133.

Good P. (Ed.) 2000. Permutation tests: a practical guide to resampling methods for testing hypotheses. *New York*: *Springer-Verlag*.

Gotelli N.J. & Entsminger G.L. 2001. EcoSim: Null models software for ecology. Version 6.0. Acquired Intelligence Inc. and Kesey-Bear. (Available at http://homepages.together.net/~gentsmin/ecosim.htm).

Grinder M.I. & Krausman P.R. 2001. Home range, habitat use, and nocturnal activity of coyotes in an urban environment. *The Journal of Wildlife Management* 65: 887–898. doi:10.2307/3803038.

Johnson W.E., Fuller T.K., Arribiliaga G., Franklin W.E. & Johnson K.A. 1988. Seasonal changes in activity patterns of the Patagonian hog-nosed skunk (*Conepatus humboldtii)* in Torres del Paine National Park, Chile. *Revista Chilena de Historia Natural* 61: 17–22.

Kasper C.B., Da Fontoura-Rodriguez M.L., Cavalcanti G.N., De Freitas T.R.O., Rodrigues F.H.G., Gomez De Oliveira T. & Ezirik E. 2009. Recent advances in the knowledge of Molina's hog-nosed skunk *Conepatus chinga* and striped hog-nosed skunk *C. semistriatus* in South America. *Small Carnivore Conservation* 41: 25–28.

Kasper C.B., Soares J.B.G. & De Freitas T.R.O. 2012. Differential patterns of home-range, net displacement and resting sites use of *Conepatus chinga* in southern Brazil. *Mammalian Biology - Zeitschrift für Säugetierkunde* 77: 358–362. doi:10.1016/j.mambio.2012.03.006.

KIRK V.M. 1974. Biology of a ground beetle, *Harpalus erraticus*. *Annals of the Entomological Society of America* 67: 24–28.

KRUUK H. 1989. The social badger. *Oxford*: *Oxford University Press*.

LARIVIERE S. & MESSIER F. 1997. Seasonal and daily activity patterns of striped skunks (*Mephitis mephitis*) in the Canadian prairies. *Journal of Zoology* 243: 255–262. doi:10.1111/j.1469-7998.1997.tb02780.x.

LIMA S. & DILL L. 1990. Behavioral decisions made under the risk of predation: a review and prospectus. *Canadian Journal of Zoology* 68: 619–640. doi:10.1139/z90-092.

LODE T. 1995. Activity pattern of polecats *Mustela putorius* L. in relation to food habits and prey activity. *Ethology* 100: 295–308. doi:10.1111/j.1439-0310.1995.tb00334.x.

LOVARI S., VALIER P. & RICCI LUCCHI M. 1994. Ranging behaviour and acctivity of red foxes (*Vulpes vulpes:* Mammalia) in relation to enviromental variables in a mediterranean mixed pinewood. *Journal of Zoolology* 232: 323–339.

LUCHERINI M., LOVARI S. & CREMA G. 1995. Habitat use and ranging behaviour of the red fox (*Vulpes vulpes*) in a Mediterranean rural area: Is shelter availability a key factor? *Journal of Zoology* 237: 577–591. doi:10.1111/j.1469-7998.1995.tb05016.x.

MACHUTCHON A.G., HIMMER S., DAVIS H. & GALLAGHER M. 1998. Temporal and spatial activity patterns among coastal bear populations. *Ursus* 10: 539–546.

MCCLENNEN N., WIGGLESWORTH R.R., ANDERSON S.H. & WACHOB D.G. 2001. The effect of suburban and agricultural development on the activity patterns of coyotes (*Canis latrans*). *The American Midland Naturalist* 146: 27–36. doi:10.1674/0003-0031(2001)146[0027:TEOSAA]2.0.CO;2.

MURGIA C., MURGIA A., LUISELLI L. & ANGELICI F.M. 2007. Movements and activity patterns of Radiotracked Sardinian wildcats, *Felis silvestris libyca* Forster, 1780. *Revue d'Ecologie (La Terre et la Vie)* 62: 381–386.

NABTE M.J., PARDIÑAS U.J.F. & SABA S.L. 2008. The diet of the Burrowing Owl, *Athene cunicularia*, in the arid lands of northeastern Patagonia, Argentina. *Journal of Arid Environments* 72: 1526–1530. doi:10.1016/j.jaridenv.2008.02.009.

NEISWENTER S.A., DOWLER R.C. & YOUNG J.H. 2010. Activity patterns of two sympatric species of skunks (*Mephitis mephitis* and *Spilogale gracilis*) in Texas. *The Southwestern Naturalist* 55: 16–21. doi:10.1894/PS-51.1.

REDFORD K.H. & EISENBERG J.F. 1992. Mammals of the neotropics: the Southern Cone. *Chicago*: *The University of Chicago Press*.

ROSATTE R. & LARIVIÈRE S. 2003. Skunks (Genera *Mephitis*, *Spilogale*, and *Conepatus*), pp. 692–707. In: Feldhamer G. et al., Eds. Wild mammals of North America: Biology, management, and conservation (2nd Ed). *Baltimore*: *John Hopkins University Press*.

TIGAS L.A., VAN VUREN D.H. & SAUVAJOT R.M. 2002. Behavioral responses of bobcats and coyotes to habitat fragmentation and corridors in an urban environment. *Biological Conservation* 108: 299–306. doi:10.1016/S0006-3207(02)00120-9.

WOODROFFE R. 2001. Strategies for carnivore conservation: lessons from contemporary extinctions, pp. 61–92. In: Gittleman J.L. et al., Eds. Carnivore conservation. *Cambridge*: *Cambridge University Press*.

ZALBA S.M. & VILLAMIL C.B. 2002. Woody plant invasion in relictual grasslands. *Biological Invasions* 4: 55–72. doi:10.1023/A:1020532609792.

ZALEWSKI A. 2001. Seasonal and sexual variation in diel activity rhythms of pine marten *Martes martes* in the Bialowieza National Park (Poland). *Acta Theriologica* 46: 295–304.

ZIELINSKI W.J., SPENCER W.D. & BARRETT R.H. 1983. Relationship between food habits and activity patterns of Pine Martens. *Journal of Mammalogy* 64: 387–396. doi:10.2307/1380351.

Appendix I.

Data of activity for 16 radio-tracked *Conepatus chinga* at two sites of the Argentine Pampas grassland. PA, protected area; CA, cropland area. M, male; F, female.

Area	ID	Radio-tracking period	Total number of activity fixes	% of active fixes referred to the total of data
PA	M1	Aug 2002–Sep 2003	225	45.78
	M3	Jan 2005–Oct 2005	553	48.28
	M4	Feb 2005–Aug 2005	259	49.03
	F1	Jan 2004 –May 2004	364	61.81
	F2	Sep 2004 –Dec 2004	361	54.29
	F3	Oct 2004–Oct 2005	376	53.99
	F4	Mar 2005–Oct 2005	198	67.17
CA	M5	Nov 2003–May2004	520	41.54
	M6	Dec 2006–May 2007	293	41.98
	M7	Jan 2007–May 2007	139	48.2
	F6	Jan 2006–May 2006	296	56.08
	F7	Feb 2006–May 2006	298	49.66
	F8	Feb 2006–Aug2006	280	49.29
	F9	Jun 2006–Aug 2006	152	53.95
	F10	Jun 2006–Jan 2007	278	50
	F11	Jan 2007–May 2007	174	52.87