



New records of carnivore mammals at the Araucárias National Park and surrounding areas in Southern Brazil

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Abstract: The Araucárias National Park (ANP) is one of the largest remaining areas of the Araucaria Forest, a threatened ecosystem in Brazil. The ANP protects biodiversity, including threatened species of carnivore mammals. In addition to the fauna listed in the ANP Management Plan, we recorded five carnivore species: *Galictis cuja* and *Conepatus chinga* (new records); *Leopardus wiedii*, *Herpailurus yagouaroundi* and *Eira barbara* (interviews confirmation). *Conepatus chinga* is usually associated with open environments but occurred in dense forested areas. The results highlight the importance of ANP and its surrounding areas for protection of vulnerable species and the need of long-term research.

Key-Words: Araucaria Forest; Atlantic Forest; Carnivora; Conservation unit.

Resumo: Novos registros de mamíferos carnívoros no Parque Nacional das Araucárias e entorno no Sul do Brasil. O Parque Nacional das Araucárias (PNA) é um dos maiores remanescentes de Floresta com Araucária, um dos ecossistemas mais ameaçados do Brasil. O PNA protege a biodiversidade, como espécies ameaçadas de mamíferos carnívoros. Complementando a lista de fauna do Plano de Manejo do PNA, registramos cinco espécies de carnívoros: *Galictis cuja* e *Conepatus chinga* (novos registros); *Leopardus wiedii*, *Herpailurus yagouaroundi* e *Eira barbara* (confirmação de antigas entrevistas). *Conepatus chinga*, geralmente associado a ambientes abertos, ocorreu em áreas densamente florestadas. Os resultados destacam a importância do PNA e seu entorno para espécies vulneráveis e a necessidade de pesquisas de longo prazo.

Palavras-Chave: Carnívora; Floresta Atlântica; Floresta com Araucária; Unidade de conservação.

Protected Areas (PAs) play an important role in safeguarding biodiversity, genetic resources, and ecological processes (Simões, 2008). In the Brazilian National System of PAs (SNUC; Brasil, 2000), National Parks are responsible for the preservation of natural ecosystems of high ecological relevance. Thus, PAs are essential for species conservation in high biodiverse but fragmented ecosystems, like those of the Atlantic Forest biome (Myers *et al.*, 2000). According to the SNUC (Brasil, 2000), every PA, including its buffer zone and surrounding areas, must have a Management Plan to delineate its use. The PA's fauna must be inventoried, added to their Management Plan, and updated during its revision (Galanter *et al.*, 2002). Brazil is one of the most megadiverse countries in the world (Mittermeier *et al.*, 1997). Its territory includes two biomes considered *hotspots* for biodiversity and priorities for conservation: the Cerrado and the Atlantic Forest (Myers *et al.*, 2000). One of the most threatened ecosystems of the Atlantic Forest is the Araucaria Forest, with less than 13% of its original cover remaining and more than one third of its territory in the Santa Catarina State (Ribeiro *et al.*, 2009). The Araucárias National Park (ANP) was created in 2005 (MMA/

ICMBio/APREMAVI, 2010) and comprises one of the last and largest remaining Araucaria Forest in Santa Catarina State (Tiepo, 2010). Its Management Plan describes the occurrence of 26 species of medium and large sized mammals (Gruener, 2010), including seven endangered species (Brasil/MMA, 2014). Of those 26 species, 11 are carnivores (Gruener, 2010), including four endangered species (Brasil/MMA, 2014). The number of carnivores recorded in the ANP is representative considering the 16 species of this order documented for Santa Catarina State according to Cherem *et al.* (2004; not including *Galictis vittata* mentioned by these authors due to its new distribution data) and ICMBio (2013).

Species of the Carnivora order include important top predators (Estes *et al.*, 2011). Usually, carnivores present diverse ecological requirements and have large home ranges and territories (Emmons & Feer, 1997; Eisenberg & Redford, 1999; Nowak, 2005). Most carnivores are target species of conservation strategies, but information gaps about their microscale occurrence is an obstacle to understand their distribution and to develop regional conservation programs (see ICMBio, 2013). The confirmation of a species occurrence in a PA is important



not only for its conservation, but also to demonstrate to governmental agencies, wildlife managers and deliberative councils that the PA is ensuring the representativeness of local species (Brasil, 2000). Information about microscale occurrences improves knowledge about endangered or poorly studied species. These occurrences also contribute data on the biology and habitat use of these species within and around PAs. The objectives of this study were (i) to report new records of carnivore mammals occurring in the ANP and its surrounding areas and (ii) to confirm previous records registered during interviews of local residents included in the ANP's Management Plan.

The Araucárias National Park (26°45'53"S, 51°58'03"W; Datum WGS84) is mainly composed of coniferous forest, characteristic of the Araucaria Forest (Atlantic Forest biome; MMA/ICMBio/APREMAVI, 2010). The ANP is located in the western part of the Santa Catarina State, within the municipalities of Ponte Serrada and Passos Maia, surrounded by 13 rural districts (Figure 1). It has 12,841 ha of secondary forest patches in different stages of regeneration; this area includes patches of pristine and exploited primary forest, standing forest with native (yerba mate *Ilex paraguariensis*) and exotic species vegetation (*Pinus* spp. and *Eucalyptus* spp.), and areas of agriculture and pasture. There are detrimental activities in the ANP region including poaching, animal traffic, unsustainable collection of araucaria seeds, agriculture expansion, presence of domestic and

exotic animals, road kill, and infrastructure for electricity networks and hydroelectric power (MMA/ICMBio/APREMAVI, 2010).

From 2008 to 2016, three research projects were carried out to survey the fauna within the ANP, its 500 m buffer zone, and surrounding areas (up to 10 km away from the ANP's limits) (SISBIO/ICMBio licenses 15513-2, 40214-1, 25133 and 41776). These projects contributed data via sampling efforts and provided new records of carnivore mammals neither documented in the ANP's management plan nor confirmed by reliable methods (*i.e.*, only recorded through interviews with local residents; see Gruener, 2010). Interviews may be considered an unreliable method due to a major susceptibility of errors in the identification of species by non-specialists, inaccuracy of time (disregarding possible local extinction) and/or imprecision of space (wide geographical range). Mammals of ANP and surrounding areas were surveyed from 2008 to 2014 by researchers via camera traps and direct and indirect (*e.g.*, tracks) observations. In addition, since 2012, ANP has been consistently monitored by its management team and other wildlife researchers. Their reliable records (*e.g.*, pictures and direct observation) were considered in the present study. Twenty analog and 20 digital camera traps operated at least 3 km distance apart in crossing paths of medium and large bodied mammals within different habitats, functioning 24 hours/day with three minutes intervals between shots. The camera traps totaled an effort of

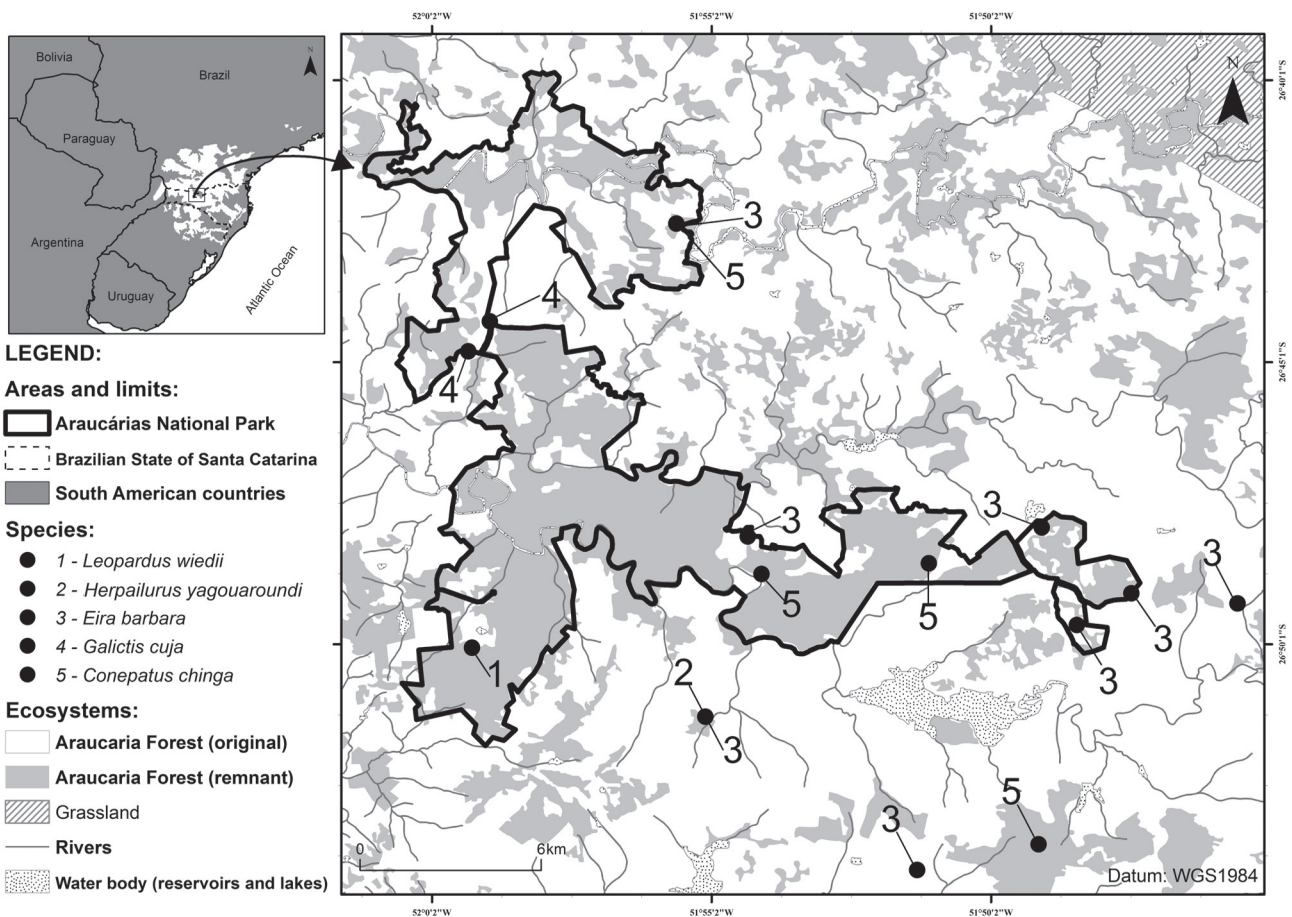


Figure 1: New records of carnivore mammals from 2008 to 2016 in the Araucárias National Park and surroundings. Datum WGS84.



Table 1: New records and confirmation of the presence of carnivorous mammals between 2008 and 2016 in the Araucárias National Park (ANP), southern Brazil. Local: ANP = Araucárias National Park, SU = surrounding. Habitat: AF = Araucaria Forest in middle to advanced stage of regeneration, AFF = Araucaria Forest in medium to advanced stage of regeneration with field area, P = small glade with regeneration pasture. Method: CT = camera trap, T = track, DO = direct observation, I = interview, ND = not detected.

Family and Species	Coordinates	Local	Habitat	Method (this study)	Method (management plan*)
Felidae					
<i>Leopardus wiedii</i>	26°50'04.7"S, 51°59'18.9"W	ANP	AF	CT	I
<i>Herpailurus yagouaroundi</i>	26°51'18.2"S, 51°55'8.5"W	SU	AF	CT	I
Mustelidae					
<i>Eira barbara</i>	26°49'40.5"S, 51°48'30.0"W	ANP	AFF	CT	I
	26°47'56.8"S, 51°49'07.7"W	ANP	AFF	CT	I
	26°42'33.6"S, 51°55'39.7"W	ANP	AF	CT	I
	26°49'06.8"S, 51°47'31.5"W	ANP	AFF	CT	I
	26°48'06.4"S, 51°54'23.1"W	ANP	AF	CT	I
	26°48'34.9"S, 51°51'08.8"W	ANP	AFF	CT	I
	26°51'18.2"S, 51°55'08.5"W	SU	AF	CT	I
	26°49'17.5"S, 51°45'37.5"W	SU	AF	CT	I
	26°49'17.5"S, 51°45'37.5"W	SU	AF	CT	I
	26°51'18.2"S, 51°55'08.5"W	SU	AF	CT	I
	26°49'17.5"S, 51°45'37.5"W	SU	AF	CT	I
	26°54'01.2"S, 51°51'21.3"W	SU	AF	CT	I
	<i>Galictis cuja</i>	26°44'17.6"S, 51°58'59.9"W	ANP	P	DO
26°44'49.5"S, 51°59'22.9"W		ANP	P	DO	ND
Mephitidae					
<i>Conepatus chinga</i>	26°48'46.4"S, 51°54'08.4"W	ANP	AF	T	ND
	26°42'33.6"S, 51°55'39.7"W	ANP	AF	CT	ND
	26°53'33.8"S, 51°49'10.9"W	SU	AF	T	ND

* MMA/ICMBio/APREMAVI 2010.

2,871 camera trap-nights: 25-45 days in the summer and winter seasons of each year from 2008 to 2011 and 26 days in summer 2013 and winter 2014. To increase the reliability of the identifications, experts also evaluated photos and video recorded in the present study.

A total of 19 records of five carnivore species were made (Table 1). Some species were either previously recorded only during interviews of local residents, such as *Leopardus wiedii* (Schinz, 1821) (margay; n = 1), *Herpailurus yagouaroundi* (É Geoffroy Saint-Hilaire, 1803) (jaguarundi; n = 1) and *Eira barbara* (Linnaeus, 1758) (tayra; n = 12), or they were new records, such as *Galictis cuja* (Molina, 1782) (lesser grison; n = 2) and *Conepatus chinga* (Molina, 1782) (hog-nosed skunk; n = 3). Records were made within ANP (n = 10) and its 5 km surrounding areas (n = 9) through camera traps (n = 15), animal tracks (n = 2), and direct observations (n = 2; Table 1). Most records occurred within well-conserved Araucaria Forest (AF; n = 13; *L. wiedii*, *H. yagouaroundi*, *E. barbara* and *C. chinga*), while others were within areas of Araucaria Forest in medium to advanced stages of regeneration merged with field areas (AFF; n = 4; only *E. barbara*) and open areas, i.e., old pasture (P; n = 2; only *G. cuja*; Table 1).

Our results increased the species list of Carnivore mammals protected by the ANP by 18%, including the confirmation of two nationally threatened species: *Leopardus wiedii* and *Herpailurus yagouaroundi* (both Vulnerable; Brasil/MMA, 2014). Previously, the ANP Management Plan (Gruener, 2010) listed more carnivore species (n = 11) than a carnivore mammal survey conducted in several locations within the Chapecó river

basin, which is in the ANP surrounding areas (n = 9; Mazzoli, 2007). This present study offers unprecedented records of carnivore species and confirms records for the ANP and its surrounding areas, which is important for Santa Catarina State and its PAs system.

Leopardus wiedii is a felid vulnerable to extinction in Brazil (Brasil/MMA, 2014). It inhabits most of the Brazilian territory and is predominantly associated with forested environments (Oliveira, 2008; Tortato *et al.*, 2013). In the ANP, it had only been recorded through interviews as presented in the Management Plan (Gruener, 2010). In the present study, it was registered within a substantial Araucaria Forest area. A literature review shows records of *Leopardus wiedii* in a PA in western Santa Catarina State (see Hendges *et al.*, 2015) and in six PAs in the coastal region (Cherem *et al.*, 2011; FATMA/APREMAVI, 2016; Goulart *et al.*, 2009; Gruener, 2009; Tortato, 2009; Tortato *et al.*, 2013; Tortato *et al.*, 2014; Table 2). *Herpailurus yagouaroundi* (see recent revised taxonomy in Kitchener *et al.*, 2017) is another felid vulnerable to extinction in Brazil (Brasil/MMA, 2014) and it is associated with forest and open environments (see studies in Almeida *et al.*, 2013 and Oliveira, 1998). In Santa Catarina State, this species was recorded in eight PAs (Cherem *et al.*, 2011; FATMA/APREMAVI, 2016; FATMA/CAIPORA, 2007; Gruener, 2009; Hendges *et al.*, 2015; Santos *et al.*, 2004; Tortato, 2009; Tortato *et al.*, 2014; Wallauer *et al.*, 2000) and in the same municipality where a protected area occurs (Cherem, 2005; Table 2). *Herpailurus yagouaroundi* was included in the ANP Management Plan due to reports during interviews (Gruener, 2010), and it was confirmed in the present study in an area close



Table 2: Occurrence of carnivores in the Araucárias National Park (ANP) and surroundings, and in other protected areas or its municipality of Santa Catarina State, southeastern Brazil. The species are represented by *L. w.* = *Leopardus wiedii*, *H. y.* = *Herpailurus yagouaroundi*, *E. b.* = *Eira barbara*, *G. c.* = *Galictis cuja*, *C. c.* = *Conepatus chinga*.

Species/Protected Areas or its municipality	<i>L. w.</i>	<i>H. y.</i>	<i>E. b.</i>	<i>G. c.</i>	<i>C. c.</i>
Serra do Itajaí National Park (Gruener, 2009)	X	X	X	X	
São Joaquim National Park municipality (Cherem <i>et al.</i> , 2004)					X
Aparados da Serra National Park (Santos <i>et al.</i> , 2004)		X	X		X
Três Barras National Forest municipality (Cherem & Peres, 1996)				X	
Três Barras National Forest (Wallauer <i>et al.</i> , 2000)		X	X		
Araucárias State Park (FATMA/APREMAVI, 2016; FATMA/CAIPORA, 2007)	X	X	X	X*	X**
Serra do Tabuleiro State Park (Cherem <i>et al.</i> , 2011; Goulart <i>et al.</i> , 2009)	X	X	X	X	X
Fritz Plaumann State Park (Hendges <i>et al.</i> , 2015)	X	X	X		
Rio Canoas State Park municipality (Cherem, 2005)		X	X	X*	X
State Biological Reserve of Aguai (Tortato, 2009)	X	X	X	X	X
State Biological Reserve of Sassafrás (Tortato & Althoff, 2007; Tortato <i>et al.</i> , 2014)	X	X	X	X	
Ecological Reserve of Caraguatá (Goulart <i>et al.</i> , 2009; Tortato <i>et al.</i> , 2013)	X				

* Original record for *Galictis* sp.

** Only recorded in the protected areas' municipality.

to this previous report, but within the 5 km buffer zone of the ANP. The individual had a gray/dark phenotype coloration, common in southern Brazil and in moist/dense forests (Silva *et al.*, 2016). *Eira barbara* is a mustelid widely distributed (Rodrigues *et al.*, 2013) and currently not threatened in Brazil (see Brasil/MMA, 2014). In Santa Catarina State, this species is present in eight PAs (Cherem *et al.*, 2011; FATMA/Caipora, 2007; Goulart *et al.*, 2009; Gruener, 2009; Hendges *et al.*, 2015; Santos *et al.*, 2004; Tortato & Althoff, 2007; Tortato, 2009; Tortato *et al.*, 2014; Wallauer *et al.*, 2000) and in the same municipality where a protected area occurs (Cherem, 2005; Table 2). Although this species had been previously recorded through interviews in one region of the ANP, the present study lists 12 records in other parts of this PA and its surrounding areas. *Eira barbara* is highly associated with areas of dense vegetation (Eisenberg & Redford, 1999; Emmons & Feer, 1997), and its occurrence in the buffer zone of ANP may be explained by its tolerance to disturbed habitats (Indrusiak & Eizirik, 2003; Presley, 2000). *Galictis cuja* is a mustelid that it is not threatened in Brazil (see Brasil/MMA, 2014). Its distribution runs northeast, central-west, southeast and south of Brazil (Kasper *et al.*, 2013b) within the interior and edges of both pristine or less disturbed forests (see Kasper *et al.*, 2013b) and open habitats (fields and savannas; Rodrigues *et al.*, 2002). It is considered one of the least studied Neotropical carnivores (Morato *et al.*, 2004; Oliveira, 2006, 2009) due to its unusual behavior leading to rare sightings and its population fluctuations (Kasper *et al.*, 2013b). This species is rarely detected during wildlife surveys (Kasper *et al.*, 2013b), which may result in regional sub samples. Moreover, such distribution records can also be influenced by temporary disappearance of the species or inefficiency in detection methods (Kasper *et al.*, 2013b). In Santa Catarina State, *G. cuja* is recorded in four PAs (Cherem *et al.*, 2011; Gruener, 2009; Tortato, 2009; Tortato *et al.*, 2014). Due to the records of *Galictis* sp., it is possibly registered in another PA (FATMA/Caipora, 2007) and in two municipalities where protected areas occur (Cherem, 2005; Cherem & Peres

1996; Table 2). Despite the fact that the ANP is located in the *G. cuja* distribution area (see Kasper *et al.*, 2013b), this species was not listed in the ANP Management Plan (Gruener, 2010). Current sighting records occurred in areas distant from the sampling points of ANP Management Plan. *Galictis cuja* and *G. vittata* (greater grison) are similar species, and recently, scientists have been researching their possible distribution overlap (Bornholdt *et al.*, 2013; Poo-Muñoz *et al.*, 2014). *Galictis vittata*'s distribution in Brazil is known to be mainly restricted to the northern region (Oliveira, 2009). However, a recent study indicated its occurrence in the southern region of Paraguay, in coexistence with *G. cuja* (Bornholdt *et al.*, 2013) and next to the ANP latitude, showing the proximity of *G. vittata* to southern Brazil. Nevertheless, the records made in the ANP refer to *G. cuja* as confirmed by a specialist in both species. *Conepatus chinga* is a mephitid not threatened in Brazil (Brasil/MMA, 2014) and occurs in open vegetation environments within southern regions, such as the Pampa biome and Campos Gerais of Atlantic Forest biome (Kasper *et al.*, 2013a). In Santa Catarina State, *C. chinga* was recorded in three PAs (Cherem *et al.*, 2011; FATMA/Caipora, 2007; Santos *et al.*, 2004; Tortato, 2009) and in three municipalities where protected areas occur (Cherem, 2005; Cherem & Peres 1996; Cherem *et al.*, 2004; Table 2). The present study provides the first three records of the species at the ANP and its surrounding areas. Although previous records of *C. chinga* in Santa Catarina State were done mainly in the central region (Cherem, 2005; Cherem *et al.*, 2004, 2007; Kasper *et al.*, 2012), the species has already been reported in the western part of the State (Bazilio *et al.*, 2015; FATMA/Caipora, 2007). However, Passos Maia and Ponte Serrada municipalities, where the ANP is located, were not considered part of geographic distribution of *C. chinga*, according to previous species review (Kasper *et al.*, 2013a). Despite the fact that the ANP is surrounded by a matrix of forested patches and open areas (original or due to deforestation; see Tiepo, 2010), the three sightings occurred in forested areas, where the species is not expected (Kasper *et al.*, 2013a). Records



like these are considered occasional occurrence or expansion of the species' distribution due forest fragmentation (Kasper *et al.*, 2013a). Other records for this species in forest areas include the Atlantic Forest in Paraná State (Cáceres, 2004) and Serra da Bodoquena (Atlantic Forest and Cerrado biomes) in Mato Grosso do Sul State (Cáceres *et al.*, 2007; recorded from interview). For the present study, the records of *C. chinga* may represent an expansion of the Campos Gerais population, located few kilometers north (12 to 22 km; see Figure 1).

Thus, the records obtained in this study include two carnivore mammal species detected for first time (*G. cuja* and *C. chinga*) at ANP and that should be protected in its surrounding areas. We also confirmed the presence of three carnivore mammals in the ANP and its surrounding areas, previously registered only through interviews in the ANP Management Plan, two of which are vulnerable to extinction: *L. wiedii* (within the ANP area) and *H. yagouaroundi* (in ANP's surroundings). With the exception of *C. chinga* records, all specimens were recorded in habitats consistent with those described in the literature (see studies in Cheida *et al.*, 2011). The records of *C. chinga* in forest areas, draws the attention for more investigation into biological aspects or other causes related to this scenario. This study also draws attention to the importance of a PA's surrounding areas to Vulnerable and/or lesser-known species. Finally, this study demonstrates the importance of long-term research on mammals in the Araucaria Forest region in order to better understand the local community of carnivore species, their territorial needs, and possible anthropogenic threats.

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