

# Medium- and large-sized mammals in a steppic savanna area of the Brazilian Pampa: survey and conservation issues of a poorly known fauna

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(With 2 figures)

## Abstract

The wildlife of the Brazilian Pampa is threatened by large-scale habitat loss, due in particular to the expansion of soybean cultivation and the conversion of grasslands areas into extensive areas of silviculture. It is essential to study how the mammal fauna copes with the highly fragmented, human-influenced, non-protected landscape. Our study presents the results of a survey of the large- and medium-sized mammals of a typical human-influenced steppic savanna area of the Pampa biome. The survey was conducted exclusively with the use of camera traps over a period of 16 months. The relative frequencies of species in the area were evaluated. We recorded 18 species, some of them locally threatened (*Tamandua tetradactyla*, *Alouatta caraya*, *Leopardus colocolo*, *Leopardus geoffroyi*, *Leopardus wiedii*, *Puma yagouaroundi*, *Mazama gouazoubira* and *Cuniculus paca*). Several species were found to thrive in the area; however, many species were considered rare, and undoubtedly new species could be recorded if we continued the sampling. Our results contribute to the knowledge of faunal diversity in the Pampa biome and associated habitats, warn about threats and provide support for conservation measures.

**Keywords:** camera trapping, conservation, mammals, southern grasslands.

## Mamíferos de médio e grande porte em uma área de savana estépica do Pampa Brasileiro: levantamento e questões de conservação sobre uma fauna pouco conhecida

### Resumo

A fauna do Pampa brasileiro está sendo ameaçada pela grande perda de habitat que vem sofrendo, em especial, devido à expansão do cultivo da soja e da conversão de áreas de pastagens em extensas áreas de silvicultura. É essencial estudar como a fauna de mamíferos lida com a paisagem altamente fragmentada e não protegida, pela influência humana. Nosso estudo apresenta os resultados de um levantamento dos mamíferos de médio e grande porte em uma área típica do bioma Pampa com influência humana. O levantamento foi realizado exclusivamente com o uso de armadilhas fotográficas ao longo de um período de 16 meses. Foram avaliadas as frequências relativas das espécies na área. Foram registradas 18 espécies, algumas delas ameaçadas localmente (*Tamandua tetradactyla*, *Alouatta caraya*, *Leopardus colocolo*, *Leopardus geoffroyi*, *Leopardus wiedii*, *Puma yagouaroundi*, *Mazama gouazoubira* e *Cuniculus paca*). Várias espécies foram encontradas de forma abundante, no entanto, muitas espécies foram consideradas raras, sendo que novas espécies poderiam ser registradas se continuássemos a amostragem. Nossos resultados contribuem para o conhecimento da diversidade de mamíferos do bioma Pampa e habitats associados, alertam sobre ameaças e fornecem suporte para medidas de conservação.

**Palavras-chave:** armadilhagem fotográfica, conservação, mamíferos, campos sulinos.

### 1. Introduction

Biomes are regions that can be distinguished by their geography, climate, and associated flora and fauna (Campbell, 1996). In southern South America, there is a

biome known as the Pampa, which is a fitophysionomic formation characterized by grasslands with sparse shrub and tree formations (Berreta, 2001). The Pampa occupies an

area of approximately 700,000 km<sup>2</sup> in Argentina, Brazil and Uruguay (Bilenca and Miñarro, 2004). In southern Brazil, the Pampa biome is located between latitudes 28° 00' S and 34° 00' S and longitudes 49° 30' W and 58° 00' W (IBGE, 2004), and covers approximately 176,000 km<sup>2</sup>, corresponding to 2.1% of the area of the country (Collares, 2006). The Brazilian Pampa is home to a total of 83 native mammal species with potential occurrence, 12 of which are endemic to this biome, and 35 of which are mammals of medium and large size (Paglia et al., 2012). The Brazilian Pampa is the third largest biome in Brazil in terms of the percentage of endangered mammal species, approximately 13% (Costa et al., 2005), and over time, it has been profoundly modified by human activities, often leaving only small remnants of native fields (Porto, 2002). Recently, the Pampa has seen the expansion of soybean cultivation and the conversion of grasslands areas into extensive areas of silviculture (mainly *Pinus* spp. and *Eucalyptus* spp.), for the purpose of producing cellulose and wood (Verdum, 2006; Binkowski, 2009). Approximately 51% of the original grassland vegetation has been devastated as a result of human economic activities (Hasenack, 2006).

Although the northern portion of the Pampa biome, which is located in southern Brazil in the state of Rio Grande do Sul, potentially has a large number of endangered species of medium- and large-sized mammals (Fontana et al., 2003), basic information on the occurrence of this fauna is lacking, and few species surveys have been conducted in the southern portion of this state. The studies of medium- and large-sized mammals in the state of Rio Grande do Sul that have been conducted to date have involved mainly the forested areas of the northern (Wallauer and Albuquerque, 1986; Marques and Ramos, 2001; Santos et al., 2004; Kasper et al., 2007a; Marques, 2013) and central parts of the state (Kasper et al., 2007b; Santos et al., 2008). Most of these areas are characterized as forest formation areas (Atlantic forest and Araucaria moist forest). In the southern portion of the state, which is characterized by an open fitophysognomic formation (Vieira, 1983), the few survey studies of this fauna have been conducted in the region of the coastal plain (Gianuca, 1997, 1998; Oliveira et al., 2013). Therefore, there is still a large gap in the information available on the occurrence of medium- and large-sized mammals in the Brazilian Pampa. Thus, surveys and biological inventories in previously unexplored areas will contribute to further research and to the elaboration of strategies and new measures for the conservation of medium- and large-sized mammals in the Brazil's wildlife.

The purpose of this study was to contribute to the conservation of medium- and large-sized mammals in the Brazilian Pampa by identifying the species present in the studied steppic area, aiming to contribute to the knowledge of the mammalian fauna of this biome, updating information on species with conservation issues in an area under anthropic influence.

## 2. Material and Methods

### 2.1. Study area

This study was conducted in two gallery forest fragments located in a micro-basin of the Ibicuí River in southern Brazil, between the coordinates 29° 43' 27" S, 54° 50' 15" W and 29° 47' 29" S, 54° 45' 58" W (Espinosa, 2011). The total area of the micro-basin is approximately 3116.33 hectares, and the total study area (the sum of the two forest fragments) was 164 hectares (Figure 1). Fragment A, with an area of 116 hectares, and fragment B, with an area of 48 hectares, are both set in a matrix of native grassland used for agricultural and cattle-raising activities. The studied area is located in a steppic savanna physiographic region, based on the distribution of trees (UFSM, 2007).

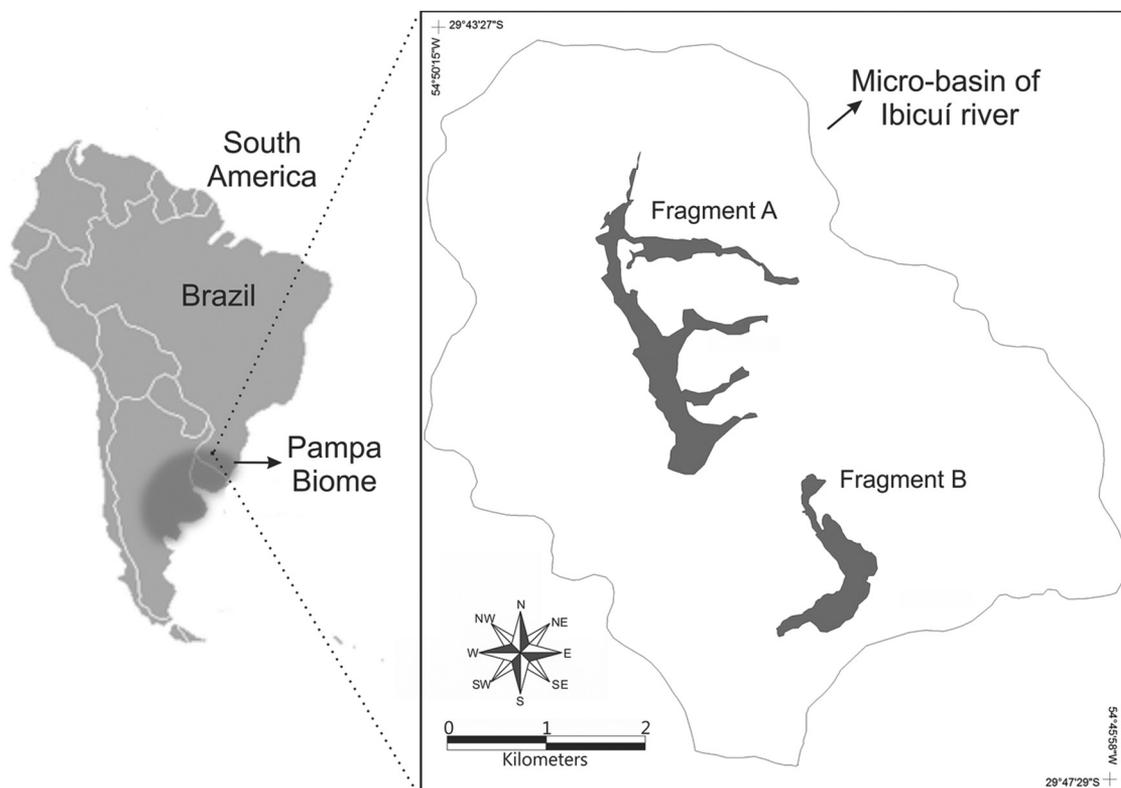
According to the classification system of the Brazilian National Institute of Geography and Statistics (IBGE, 2004), the Brazilian Pampa consists of a vegetated coastal belt and a savanna environment that dominates the entire western part of the biome (Leite and Klein, 1990). Dense forest formations are not common in the Pampa biome; grasslands dominate the landscape. The main forest formations are found at the northern limit of the biome, in the transition area to Atlantic rain forest. In other regions, plant formations with trees exist mainly as gallery forests, shrub forests and islands of trees within the grassland (Overbeck et al., 2006).

### 2.2. Methods

The sampling of medium- and large-sized mammals was conducted over a period of 16 months, from May 2009 to October 2010, except during the months of February and March 2010, when the sampling was interrupted due to heavy rain that made the use of the survey equipment impossible. We used a camera trapping method exclusively. Camera trapping has been proven as a highly efficient method at recording Neotropical mammals (Trolle and Emmons, 2004; Sanderson and Trolle, 2005; Kasper et al., 2007a; Srbek-Araujo and Chiarello, 2008; Carvalho et al., 2013).

A total of 112 points, 51 in fragment A and 61 in fragment B, were sampled. Each month, a total of 10 camera traps (each one representing a sampling point) were used for 15 uninterrupted days. The minimum distance between the sampling points was 150 meters. After each 15-day sampling period, the traps were reviewed and relocated. The traps were placed along trails in water bodies or in places that exhibited traces of the presence of medium- and large-sized mammals (feces, fur or footprints). The sampling was carried out within these areas of woody vegetation because these sites are used as refuges for medium- and large-sized species.

The relative frequencies of the species in the region were calculated as  $i/N$ , where  $i$  = the number of species records and  $N$  = the total number of species records (Crooks, 2002). We treated each record as an independent sample. The relative frequencies were expressed as percentages.



**Figure 1.** The study area, located in a micro-basin of the Ibicuí River, in Rio Grande do Sul State in southern Brazil.

### 3. Results

We obtained a total of 341 photographic records of 17 medium- and large-sized mammal species belonging to seven orders and 11 families: Artiodactyla (Cervidae), Carnivora (Canidae, Procyonidae, Mephitidae and Felidae), Cingulata (Dasypodidae), Didelphimorphia (Didelphidae), Lagomorpha (Leporidae), Pilosa (Myrmecophagidae) and Rodentia (Caviidae and Cuniculidae) (Paglia et al., 2012). In addition, we directly observed the species *Alouatta caraya* (Humboldt, 1812) (Primates, Atelidae), adding the total 18 medium- and large-sized mammal species registered for the area, belonging to eight orders and 12 families. The order Carnivora was the most representative, with four families and eight species registered, followed by the order Cingulata, with one family and three species, and the order Rodentia, with two families and two species (Table 1).

The species *Mazama gouazoubira* (G. Fischer [von Waldheim], 1814) presented the highest occurrence frequency in the study area, with 21.11% of the total records. The second most frequently occurring species was *Cerdocyon thous* (Linnaeus, 1766) (19.35%), followed by *Dasypus novemcinctus* Linnaeus, 1758 (13.78%), *Lycalopex gymnocercus* (G. Fischer, 1814) (11.14%), *Leopardus wiedii* (Schinz, 1821) (7.92%), *Conepatus chinga* (Molina, 1782) (6.16%), *Euphractus sexcinctus* (Linnaeus, 1758) (4.69%), *Dasypus hybridus* (Desmarest, 1804) (4.40%), *Cuniculus paca* (Linnaeus 1766) (2.64%),

*Procyon cancrivorus* (G.[Baron] Cuvier, 1798) (2.35%), *Tamandua tetradactyla* (Linnaeus, 1758) (1.76%), *Puma yagouaroundi* (É. Geoffroy Saint-Hilaire, 1803) (1.47%), *Hydrochaerus hydrochaeris* (Linnaeus, 1766) (0.88%), *Leopardus geoffroyi* (d'Orbigny & Gervais, 1844) (0.88%), *Leopardus colocolo* (Molina, 1782) (0.59%), *Lepus europaeus* Pallas, 1778 (0.59%) and *Didelphis albiventris* Lund, 1840 (0.29%) (Figure 2).

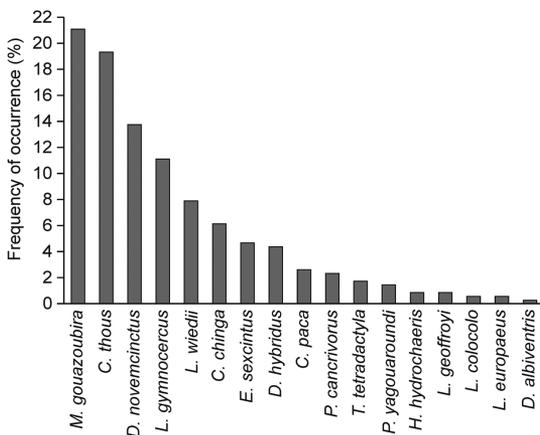
### 4. Discussion

We registered a total of 18 species of mammals of medium and large size, and among them, eight (45%) are threatened with extinction in the state of Rio Grande do Sul (Fontana et al., 2003), two are listed as “endangered”, and six are listed as “vulnerable”. In this context, the importance of the studied area and of the natural fragments present in this region to the conservation of these mammals in this biome is clear.

We found four species to be exceptionally common in the area: *M. gouazoubira*, *C. thous*, *D. novemcinctus* and *L. gymnocercus*. Another four species were apparently relatively common: *L. wiedii*, *C. chinga*, *E. sexcinctus* and *D. hybridus*. On the other hand, a number of species seem to occur at relatively low frequencies: *C. paca*, *P. cancrivorus*, *T. tetradactyla*, *P. yagouaroundi*, *H. hydrochaeris*, *L. geoffroyi*, *L. colocolo*, *L. europaeus* and *D. albiventris*.

**Table 1.** Medium- and large-sized mammal species registered in a steppic savanna physiographic region of the Brazilian Pampa, located in a micro-basin of the Ibicuí River in southern Brazil. The conservation status of each species is given according to Fontana et al. (2003): Vulnerable (VU), Endangered (EN) and not threatened (-).

Family/Species	Common name	Conservation status
Didelphidae		
<i>Didelphis albiventris</i>	White-eared Opossum	-
Dasypodidae		
<i>Dasypus novemcinctus</i>	Nine-banded Armadillo	-
<i>Dasypus hybridus</i>	Southern Long-Nosed Armadillo	-
<i>Euphractus sexcinctus</i>	Six-Banded Armadillo	-
Myrmecophagidae		
<i>Tamandua tetradactyla</i>	Southern Tamandua	VU
Atelidae		
<i>Alouatta caraya</i>	Black-and-gold Howler Monkey	VU
Canidae		
<i>Cerdocyon thous</i>	Crab-eating Fox	-
<i>Lycalopex gymnocercus</i>	Pampas Fox	-
Felidae		
<i>Leopardus colocolo</i>	Pampas Cat	EN
<i>Leopardus geoffroyi</i>	Geoffroy's Cat	VU
<i>Leopardus wiedii</i>	Margay	VU
<i>Puma yagouaroundi</i>	Jaguarundi	VU
Mephitidae		
<i>Conepatus chinga</i>	Molina's Hog-nosed Skunk	-
Procyonidae		
<i>Procyon cancrivorus</i>	Crab-eating Raccoon	-
Cervidae		
<i>Mazama gouazoubira</i>	Gray Brocket	VU
Cuniculidae		
<i>Cuniculus paca</i>	Spotted Paca	EN
Caviidae		
<i>Hydrochaeris hydrochaeris</i>	Capybara	-
Leporidae		
<i>Lepus europaeus</i>	European Hare	-



**Figure 2.** Relative frequency of medium- and large-sized mammal species in a steppic savanna physiographic region of the Brazilian Pampa, located in a micro-basin of the Ibicuí River in southern Brazil.

The most commonly observed species in the study area (*M. gouazoubira*, *C. thous*, *D. novemcinctus* and *L. gymnocercus*) exhibited the highest occurrence frequencies, most likely because the camera traps might have recorded the same individuals, although we treated each “capture” as an independent sample. In addition, it is known that many mammals, such as species of the genera *Mazama* (Erxleben, 1777) have the habit of preferring to move on pre-existing trails (Tomas and Miranda, 2003), and as these trails were the focus of our sample, such mammals could have been overanalyzed.

The relatively common species, such as *C. chinga*, inhabit mainly open areas and were found even in densely urbanized areas, indicating the high degree of adaptation of these species to modified environments (Oliveira et al., 2013). The species *E. sexcinctus* and *D. hybridus* were also found in disturbed and open areas (Eisenberg and Redford, 1999), and this environment seems to be favorable for these species. The most common feline

species in the area was the margay *L. weidii*. The margay is more forest-dependent, reaching its greatest abundance in lowland rainforests (Oliveira et al., 2008). According to Kasper et al. (2007a), most felines have the habit of moving over trails and moving long distances. They tend to be commonly recorded in camera traps, although their density is always considerably lower than the densities of others species referred here as being relatively common in the area. The presence of the margay reflects the importance of natural fragments of the Pampa landscape, because they shelter more forest-dependent species such as this.

Among the species listed, those that were present at low frequencies were noted. The occurrence of carnivores, such as *P. yagouaroundi* and *L. geoffroyi*, whose populations have declined in the state due to the loss of natural habitats (Indrusiak and Eizirik, 2003), demonstrates the regional importance of the study area. In addition, the low occurrence frequency of *T. tetradactyla* may reflect the low carrying capacity of the area for the species. Despite its use of the arboreal stratum, the species is commonly photographed on the ground in other locations and ecosystems (Oliveira et al., 2007). The low percentage of recordings of *L. colocolo* compared to the other species suggests that they are not common in the study area. It should also be noted that *L. colocolo* is considered a rare species: it is found over a wide geographic range, is a habitat specialist, and occurs at low population densities. The pampas regions of Argentina and Uruguay, like our study area, have been heavily settled and grazed, which is suspected to have had a negative impact on pampas cat populations (Garman, 1997; IUCN, 2013).

The species *C. paca*, *P. cancrivorus*, *H. hydrochaeris* and *L. europaeus* were also observed at low frequencies. *Cuniculus paca* is locally listed as an endangered species (Fontana et al., 2003). Some surveys report disturbing signs of decline of the species population due to extensive hunting and habitat loss (Queirolo et al., 2008; Huanca-Hurachi et al., 2011). The species *P. cancrivorus* is naturally rare in some areas of its range and does not seem as adaptable to human activity, although it is considered stable throughout South America (Glatston, 1994). The rodent *H. hydrochaeris* occurs only in habitats close to water, including areas along rivers and streams (Eisenberg and Redford, 1999), and is generally more often found in anthropized places (Dias and Mikich, 2006; Negrão and Valladares-Pádua, 2006; Kasper et al., 2007a; Pires and Cademartori, 2012). This rodent is very common in the region, but few individuals were recorded in our survey, because there is a dam located adjacent to our study area, where the individuals are concentrated. The only exotic species found in the region was *L. europaeus*, which is considered an invasive species that occupies open areas and pastures and is considered an agricultural pest in several countries in South America (Jaksic et al., 2002; Reis et al., 2011; Oliveira et al., 2013). The low frequency of occurrence of the species is due to our sample being focused on forested areas, while this species prefers to inhabit fields.

The richness and composition of medium- and large-sized mammals found in this area of the Pampa, with a predominance of generalist species and less frequent recordings of rare and specialist species, suggest that the area is in a medium state of conservation. Despite the human influence, we can affirm that natural forest remnants present within the Pampa may play an important role in the conservation of medium- and large-sized mammals, most likely because these natural forest fragments can provide food resources and shelter for such species. However, these two remnants by themselves may not be able to maintain the mammalian fauna in the region, which requires evaluations on the scale of the full landscape.

Considering that the entire region of the Pampa biome in southern Brazil has been little studied, new species will undoubtedly be recorded. Our results contribute to the knowledge of faunal diversity in the Pampa biome and its associated habitats, warn about threats and provide support for conservation measures. We have proven that many important mammal species survive in the area. However, there is a great need for concern: many species in the region are considered to be rare, and the fragmentation and substitution of natural fields is no doubt the major factor contributing to the rarity of these species, although hunting may also have played a role for certain species. Although a longer-term investigation is needed, these preliminary observations are highly valuable, given that the Pampa biome in Brazil, and in particular the human-influenced areas making up the majority of the region, is so little known.

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