

# Mammals of the Estação de Preservação e Desenvolvimento Ambiental de Peti (EPDA-Peti), São Gonçalo do Rio Abaixo, Minas Gerais, Brazil

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## Abstract

This study presents the results of an inventory of the mammal fauna of the Estação de Preservação e Desenvolvimento Ambiental de Peti (EPDA-Peti) a reserve in the transition between the Atlantic Forest and the Cerrado. Eight field campaigns (including trapping for small mammals and mist-netting for bats) were conducted between May 2002 and July 2004. Forty-six mammals belonging to eight orders were recorded. Fifteen species not recorded in previous inventories at the Station were identified; on the other hand, 14 mammals listed in previous studies were not recorded now. The most abundant small mammals at the EPDA-Peti were *Oligorizomys flavescens*, *Akodon cursor*, *Trinomys setosus* and *Bolomys lasiurus*. The small mammal community from the *campo rupestre* (high altitude, rocky grassland) habitat is distinct from that found in the forest. In spite of the reserve's small size, mammal species' richness is relatively high. Possible reasons for this are the diversity of habitats and the fact that EPDA-Peti is located in a transitional zone between the Atlantic Forest and the Cerrado.

**Key words** - Mammals, conservation, diversity, ecology, small mammals, Atlantic Forest, Cerrado

## Introduction

The mammal fauna of Brazil is extremely rich. Of the more than 524 species occurring in this country (Fonseca et al., 1996), nearly 46% (245 species,) have been recorded in the state of Minas Gerais, in the domains of the Atlantic Forest, Caatinga, Campos Rupestres (rocky shrubby and grasslands at high altitudes) and the Cerrado (Brazilian savanna) (Rylands, 1998). Thirty-nine of the mammal species present in Minas Gerais are threatened with extinction (Rylands, 1998), largely due to habitat loss, degradation and fragmentation, most notably in the Atlantic Forest and the Cerrado – domains considered as Global Biodiversity Hotspots, due to their elevate biological diversity and endemism and to the extent to which they have been destroyed (more than 75% of the original vegetation cover lost) (Myers et al., 2000). The richness of the state fauna results from the diversity of biomes – different climates, soils, altitudes and vegetation types – within its boundaries.

The known terrestrial fauna of vertebrates of the Atlantic Forest is estimated in *ca.* 2000 species, of which 600 are endemic (Fonseca et al. 2004), including approximately 270 species of mammals, of which 89 are endemic (Conservation International do Brasil et al., 2000). The Cerrado has fewer terrestrial vertebrates and less endemism when compared to forest habitats, but diversity is still high with more than 1300 species (93 endemics), of which 195 are mammals (18 endemics) (Fonseca et al. 2004). Transition zones between two biomes usually have faunas characteristic of both, and this is the case for the forest and open formations of the Estação de Preservação e Desenvolvimento Ambiental de Peti (environmental preservation and development station of Peti – EPDA-Peti) of the Minas Gerais energy company (CEMIG), located in the upper Rio Doce basin, in the transition zone between the Atlantic Forest in the east and the Cerrado to the west.

Numerous studies have monitored small mammal communities (rodents and marsupials) in protected areas in order to understand population and community dynamics in forest fragments in both the Atlantic Forest (Stallings, 1989; Bonvicino et al., 1997; Stevens & Husband, 1998; Pires et al., 2002 and Pardini, 2004) and the Cerrado (Alho, 1981; Fonseca & Redford, 1984; Bonvicino et al., 1997; Silveira et al., 1999 and

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**Table 1** – Location of sample points for small mammals and bats\* at EPDA-Peti.

Locality	Predominant vegetation	Latitude S	Longitude W	Altitude (m)
Mirante	<i>Campo rupestre</i>	19°53'22"	43°22'06"	824
Bonserá (transect A)	Gallery forest	19°53'19"	43°22'26"	721
Bonserá (praia)	Gallery forest	19°53'22"	43°22'26"	654
Transect D	Gallery forest	19°53'03"	43°22'26"	626
Cutia transect	Secondary forest	19°53'07"	43°22'21"	699
Bridge transect	Secondary forest	19°52'53"	43°22'09"	640
Dam	Gallery forest	19°53'34"	43°22'11"	737

\* Another two areas were sampled exclusively for bats: *Viveiro* (gallery forest) and *Barraginha* (secondary forest)

Bonvicino et al., 2002). In this study we: 1) identify the mammal fauna present in the EPDA-Peti (emphasizing particularly small mammals and bats); 2) compare our findings with previous inventories conducted in 1986-1988 for mammals in general and in 1995 for bats and 3) examine seasonal variation in diversity and the relative abundance of the main species of small mammals in the EPDA-Peti.

## Materials and Methods

### Study Area

The Estação de Preservação e Desenvolvimento Ambiental de (environmental preservation and development station of) Peti – EPDA-Peti, is in the municipalities of São Gonçalo do Rio Abaixo and Santa Bárbara (19°53'57''S and 43°22'07''W). Established in 1983, the reserve is an approximately 605 ha area intersected by the Rio Santa Bárbara and numerous small streams. The station is in a transition zone between seasonal tropical forest (inland Atlantic Forest) and the Cerrado (tropical bush savanna of Central Brazil), in the upper Rio Doce basin, with altitudes ranging from 630 m to 806 m. The climate, according to the Köppen classification, is subtropical moderately humid, with an average annual temperature of 21.7°C.

The vegetation is mostly secondary forest in different stages of regeneration. Other types of vegetation include gallery forest, *cerrado*, *campo rupestre*, and, the landscaped and urbanized areas around the Station headquarters and outbuildings where there are cultivated gardens and numerous exotic plants.

### Sampling

Trapping began in May 2002 and ended in July 2004. Eight field trips were conducted – May, August and December 2002; April, August and November-December 2003 and April and July 2004. Transects were placed in seven areas of the station: Mirante, Bonserá (trail A and beach), Trail D, Cotia Trail, Bridge and Dam Trail (Table 1). A capture-mark-recapture method was used for the small mammals (Mares et al., 1986; Lacher et al. 1989; Mares & Ernest, 1995; Paglia et al. 1995 and Grelle, 1996). Fifteen to 20 trapping points were set up on each transect, each approximately 20 m apart and consisting of two

small mammal traps placed on the ground. The traps were set for six consecutive days and were checked every morning. The total sampling effort was 6,316 trap-nights. We did not sample the intermediate vegetation layer (understorey) because it is too open (very few vines and lianas). The animals were weighed, measured, marked with a numbered metallic ear-tag and then released. The areas sampled were in two of the vegetation formations – the *campo rupestre* (Mirante transect) and the forest (the other transects).

Bats were captured with mist nets in the same areas where terrestrial mammals were sampled. Nets were also set up close to a greenhouse near the station chapel. Five nets were set up in each area and were opened from 17:00 to 02:00. Once captured, bats were taken to the laboratory and identified, weighed, measured, tagged on the forearm with numbered metal tags and later released. Bats we were unable to identify were sacrificed, as well as a voucher specimen of each species caught. They were fixed and preserved in liquid or taxidermized for identification.

Besides these systematic collections, all other species of medium to large mammals were recorded at EPDA-Peti through either sightings or vocalizations or through signs such as scats and tracks. The species were identified using the taxonomic information and species lists of Wilson & Reeder (1993), Fonseca et al. (1996), Hershkovitz (1998), Eisenberg & Redford (1999), Rylands et al., (2000) and Van Roosmalen et al. (2002). Voucher specimens were deposited in the Mammal Collection at the Taxonomic Collections of the Universidade Federal de Minas Gerais (UFMG).

## Results

The eight collecting campaigns for the small terrestrial mammals resulted in 359 captures of 241 individuals, belonging to 18 species, in five orders: Carnivora, Lagomorpha, Primates, Didelphimorphia and Rodentia. Animals captured included the Geoffroy's marmoset (*Callithrix geoffroyi*) and the coati (*Nasua nasua*), normally not captured in small mammal traps. Moreover, a total of 197 bats belonging to 16 species in three families were captured and another 12 mammal species were recorded based on visual sightings and/or other signs. Two species of bats in the genus *Myotis* have yet to be identified.

Including the medium and large mammals, a total of 46

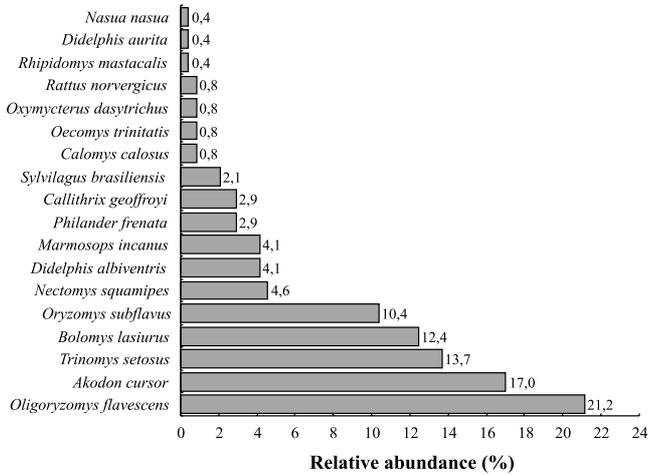


Figure 1 - Relative abundance of the small mammals captured in EPDA-Peti.

species was recorded for the EPDA-Peti (see Appendix 1), ten of them for the first time for this location – the bats *Myotis* sp. 1, *Myotis* sp. 2, *Peropteryx macrotis*, and *Plathyrrhinus recifinus*; the rodents *Blarinomys breviceps*, *Bolomys lasiurus*, *Oryzomys subflavus* and *Oligoryzomys flavescens*; the woolly opossum *Caluromys philander*, and the tamandua, *Tamandua tetradactyla*.

Three of the mammals recorded during this study are in the threatened-species list of Minas Gerais (Machado et al., 1998), the tamandua (*T. tetradactyla*), the southern masked titi monkey (*Callicebus nigrifrons*) and the bat *Plathyrrhinus recifinus*, the last also in the Brazilian official list of threatened species (Machado et al. 2005). The Geoffroy’s marmoset (*C. geoffroyi*) is listed as vulnerable in the 2004 IUCN Red List (IUCN 2004). Four additional threatened species recorded in previous inventories (Fonseca et al., 1989; Tavares & Cesari, 1996) were not recorded during the present work (*Chiroderma doriae* – Chiroptera; *Kannabateomys amblyonyx* – Rodentia; *Chrysocyon brachyurus* and *Puma concolor* – Carnivora). We also did not record the marsupial *Gracilinanus agilis* and the rodent *Wilfredomys pictipes*, collected in previous studies. All bats were recorded in the 1987 (Fonseca et al., 1989) inventory were recorded in the current study but the 1995 study (Tavares & Cesari, 1996) listed five bats we failed to catch (*Chiroderma doriae*, *Phyllostomus hastatus*, *Anoura geoffroyi*, *Nyctinomops laticaudatus* and *Molossus molossus*).

The most frequently captured small mammals at EPDA-Peti were *Oligoryzomys flavescens*, *Akodon cursor*, *Trinomys setosus* and *Bolomys lasiurus* (Fig. 1). The *campo rupestre* was dominated by *O. flavescens* and *B. lasiurus*, which jointly accounted for almost 65% of all first time captures within this habitat (Fig. 2A). In the forest, the dominant species were *A. cursor* and *T. setosus*, which accounted for more than 46% of the first captures in that habitat (Fig. 2B). There is no correlation between the seasonal fluctuations in numbers of *Oligoryzomys flavescens* and *Bolomys lasiurus* in the *campo rupestre* ( $R = 0.07$ ;  $p = 0.8$  and Fig. 3A) and of *Akodon cursor* and *Trinomys setosus* in the forest ( $R = -0.66$ ,  $p = 0.07$  e Figure 3B).

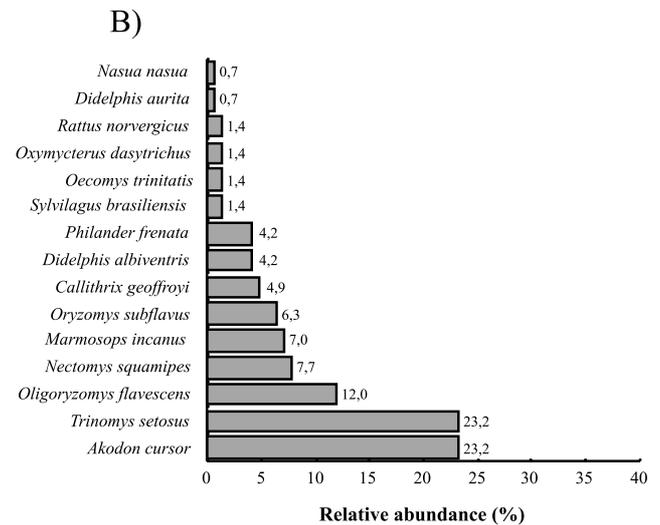
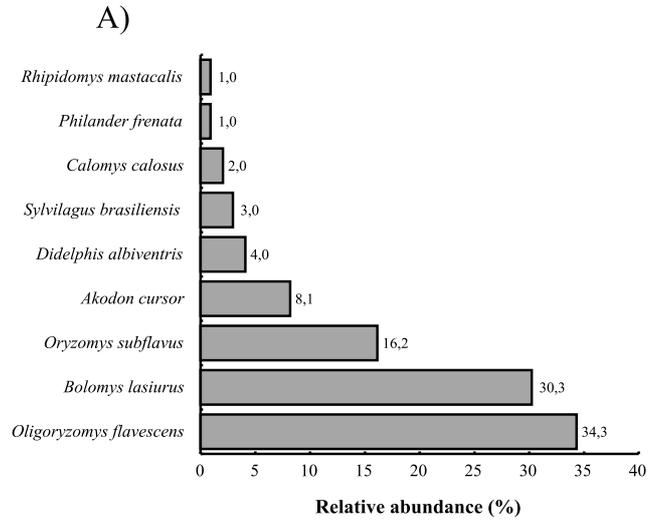
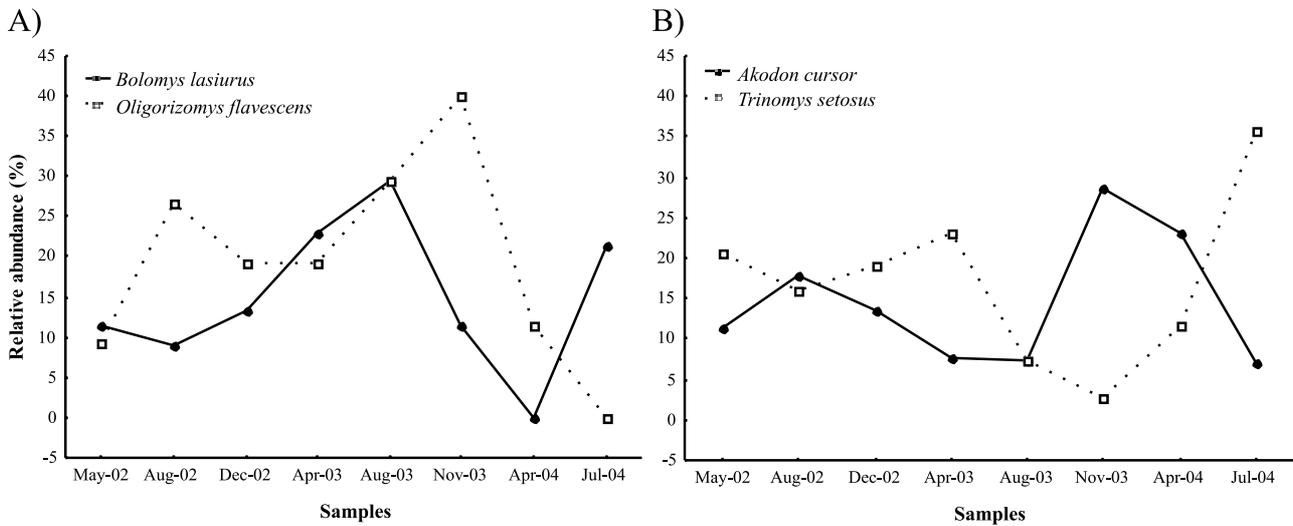


Figure 2 - Relative abundance of the small mammals captured in the *campo rupestre* (A) and forest (B) habitats in EPDA-Peti.

The small mammal species richness was higher in the first year campaigns, totaling 12 species in December of 2002. Subsequently, there was a noticeable reduction in the number of species in the traps, which dropped to six species in the last campaign, in July 2004 (Fig. 4).

## Discussion

Combining our results with the inventories already conducted in 1986-1988 (Fonseca et al., 1989; Herrmann, 1991) and 1995 (Tavares & Cesari, 1996), a total of 60 mammals have been recorded in the EPDA-Peti. The inventory reported here documented 46 species, a high number for an area of only 600 ha and considering the small sampling effort of only eight campaigns. The number of small terrestrial mammals recorded



**Figure 3** - Seasonal variation in the relative abundance of the dominant small mammals in the *campo rupestre* (A) and forest (B) in EPDA-Peti.

(19 species) is similar to the species-richness documented for other larger areas such as the Caparaó and the Chapada dos Veadeiros National Parks, with 21 species each (Bonvicino et al., 2002).

This relatively high species richness can be explained, at least in part, by the fact that the station is in a transition zone between the Cerrado and the Atlantic Forest, housing, therefore, species typical of each, such as *Caluromys philander*, *Didelphis aurita*, *Trinomys setosus*, and *Callithrix geoffroyi*, associated to the Atlantic Forest and *Didelphis albiventris*, *Bolomys lasiurus*, and *Calomys callosus*, associated to open habitats. Another contributing factor may be that the forests in the EPDA-Peti are a mosaic of different stages of succession, which increases spatial heterogeneity, resulting in a greater diversity of habitats and, therefore, more species.

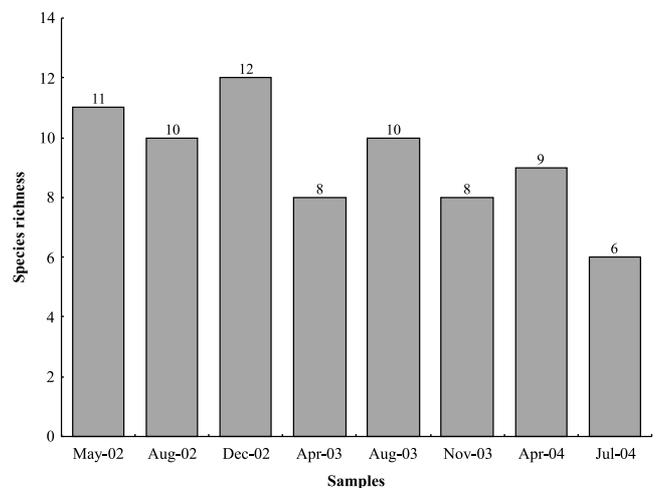
The first records of several species at the EPDA-Peti may indicate that the bat diversity in the station is still underestimated. Bergallo et al. (2003) claim that about 1,000 captures are needed for a bat community to be well sampled. We got less than 200 captures, which, together with the ones from Tavares & Cesari (1996), add up to less than 430 individuals. Therefore, it is possible that additional bat species still wait to be recorded in the EPDA-Peti.

Although our sampling effort for small mammals was smaller than in previous inventories, we sampled a greater diversity of habitats in our study. In the previous inventory (Fonseca et al., 1989; Hermann, 1991), monthly samples were carried out in two forest habitats in different successional stages during two years, achieving a total sampling effort of 26,880 trap-nights, four times larger than ours. With this effort, the authors recorded a total of 13 small mammal species, of which five were marsupials and eight rodents (Herman, 1991) – only five species less than those recorded by us. Considering only rodents and marsupials, we recorded 15 species in the EPDA-Peti. The comparison between these studies suggests that, for small mammal inventories, the

diversification in sampling typologies and areas is more important than the sampling effort.

Diversification in sampling methods may also have contributed. *Blarinomys breviceps*, for example, a fossorial species rarely recorded (Silva et al., 2002) was collected in a pitfall trap set out for herpetological sampling (Paglia et al., in press). *Caluromys philander*, an arboreal marsupial, generally caught on platforms or traps set on vegetation at an intermediate height or at the canopy, was manually caught in a tree.

The dominance of two or three species of small mammals in two habitats sampled in the EPDA-Peti, with some intermediary species and a small number of rare species, is a pattern described by the lognormal curve, usually found where limited resources are monopolized by a small fraction of the community (Fleming,



**Figure 4** - Numbers of species of small terrestrial mammals recorded in each collecting campaign at EPDA-Peti.

1975; Magurran, 1988; Krebs, 1999). This lognormal distribution is common and was described for other small mammal communities in the Atlantic Forest (Stevens & Husband, 1988; Stallings, 1989; Fonseca, 1997, Paglia et al., 1995) and Cerrado (Marinho-Filho et al, 1994; Mares & Ernest, 1995; Carmignotto, 1999).

In studies in the Cerrado, the species generally reported as dominant in the small mammal community are *Bolomys lasiurus* (Dietz, 1983; Alho & Pereira, 1985; Rodriguez et al, 2002), generally associated to habitats with herbaceous cover (Vieira, 2002), and *Oryzomys megacephalus* (Nitikman & Mares, 1987; Carmignotto, 2004), usually associated to *cerradão* (closed woodland) and forest vegetations. In studies in the Atlantic Forest, on the other hand, the species usually dominant are the marsupials *Micoureus demerarae* and/or *Didelphis aurita* (Fonseca & Kierulff, 1989; Paglia et al., 1995; Stevens & Husband, 1998; Lessa et al., 1999; Pires et al. 2002) and the rodents *Akodon cursor* and *Oligoryzomys* spp. (Stallings, 1989; Lessa et al., 1999; Pires et al., 2002). In the previous inventory at EPDA-Peti the dominant species were the rodent *Akodon cursor* and the marsupial *Marmosops incanus*, respectively with 29,9% and 21,5% of the first captures.

In this study, in the *campo rupestre*, the most abundant species, *Oligoryzomys flavescens* and *Bolomys lasiurus*, co-exist probably because the niche overlap between them is small. Vieira (2002) pointed out that *B. lasiurus* is generalist in its diet, showing a great variety of food items with relatively high arthropod proportion. That author also pointed out that another specie in the community (*Oligoryzomys elirus*) shows high microhabitat diversification and a predominant diet of seeds and leaves. Differences in habitat exploitation by these two species can explain their co-existence in the *campo rupestre* and the absence of correlation between their seasonal fluctuations in relative abundance.

In the forest habitats, the two most abundant species, *Akodon cursor* and *Trinomys setosus*, are also habitat generalists and have a certain diet distinction, *A. cursor* being insectivorous/omnivorous and *T. setosus* frugivorous/omnivorous (Fonseca et al, 1996). In addition, they are relatively distant phylogenetically, (belonging in Muridae and Echimididae, respectively) and morphologically distinct (*A. cursor* weights about 40 g and *T. setosus* 180 g). All these factors help to explain the co-existence of these two species in high abundance. Besides, although not statistically significant, these two dominant species show a slight inverse relation in their abundance fluctuation along the sampling.

It would be convenient to carry out genetic and demographic studies to contribute to the conservation status assessments of the two threatened mammals, *Plathyrrhinus recifinus* and *Tamandua tetradactyla*. Moreover, we recommend regular inventories to monitor the mammal fauna at EPDA-Peti to provide for insights regarding long-term patterns associated to the successional forest development and even to climate fluctuation and change.

On the other hand, it is important that research on mammals continue in the station, in order to verify if the 14 species recorded in the area in previous studies and not reported in this study still occur in the EPDA-Peti. Four of them are officially listed as threatened species.

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## Appendix

Mammal species recorded at the Estação de Preservação e Desenvolvimento Ambiental de Peti, São Gonçalo do Rio Abaixo, MG, between May 2002 and July 2004 (this study) and in prior studies (Fonseca et al., 1989; Tavares & Cesari, 1996). nr – not recorded; VU – vulnerable; EN – endangered; CR – critically Endangered.

TÁXON	INVENTORY		CONSERVATION STATUS		
	2002-2004	1987, 1995	IBAMA 2003	IUCN 2004	MG state Red List
<b>Chiroptera</b>					
<i>Chrotopterus auritus</i>	x	x			
<i>Carollia perspicillata</i>	x	x			
<i>Glossophaga soricina</i>	x	x			
<i>Anoura caudifer</i>	x	x			
<i>Chiroderma doriae</i>	nr	x		VU	VU
<i>Phyllostomus hastatus</i>	nr	x			
<i>Anoura geoffroyi</i>	nr	x			
<i>Nyctinomops laticaudatus</i>	nr	x			
<i>Molossus molossus</i>	nr	x			
<i>Artibeus lituratus</i>	x	x			
<i>Artibeus cf. fimbriatus</i>	x	x			
<i>Sturnira lilium</i>	x	x			
<i>Peropteryx macrotis</i>	x	nr			
<i>Plathyrrhinus lineatus</i>	x	x			
<i>Plathyrrhinus recifinus</i>	x	nr	VU	VU	VU
<i>Pygoderma bilabiatum</i>	x	x			
<i>Vampyressa pusilla</i>	x	x			
<i>Desmodus rotundus</i>	x	x			
<i>Myotis cf. nigricans</i>	x	x			
<i>Myotis</i> sp.1	x	nr			
<i>Myotis</i> sp.2	x	nr			
<b>Rodentia</b>					
<i>Akodon cursor</i>	x	x			

TÁXON	INVENTORY		CONSERVATION STATUS		
	2002-2004	1987, 1995	IBAMA 2003	IUCN 2004	MG state Red List
<i>Bolomys lasiurus</i>	x	nr			
<i>Blarinomys breviceps</i>	x	nr			
<i>Calomys callosus</i>	x	x			
<i>Nectomys squamipes</i>	x	x			
<i>Oecomys trinitatis</i> <sup>1</sup>	x	x			
<i>Oligoryzomys flavescens</i>	x	nr			
<i>Oryzomys subflavus</i>	x	nr			
<i>Oxymycterus dasytrichus</i>	x	x			
<i>Rhipidomys mastacalis</i>	x	x			
<i>Trinomys setosus</i> <sup>2</sup>	x	x			
<i>Rattus norvergicus</i>	x	x			
<i>Kannabateomys amblyonyx</i>	nr	x			VU
<i>Wilfredomys pictipes</i>	nr	x			
<i>Sciurus aestuans</i>	x	x			
<i>Hydrochaeris hydrochaeris</i>	x	x			
<i>Agouti paca</i>	x	x			
<i>Dasyprocta agouti</i>	x	x			
Continued...					
<b>Didelphimorphia</b>					
<i>Marmosops incanus</i>	x	x			
<i>Didelphis albiventris</i>	x	x			
<i>Didelphis aurita</i>	x	x			
<i>Caluromys philander</i>	x	nr			
<i>Philander frenata</i>	x	x			
<i>Gracilinanus agilis</i> <sup>3</sup>	nr	x			
<b>Carnivora</b>					
<i>Nasua nasua</i>	x	x			
<i>Procyon cancrivorus</i>	x	x			
<i>Eira barbara</i>	x	x			
<i>Galictis cuja</i>	nr	x			
<i>Cerdocyon thous</i>	x	x			
<i>Chrysocyon brachyurus</i>	nr	x	VU		VU
<i>Puma concolor</i>	nr	x	VU		CR
<i>Herpailurus yagouaroundi</i>	nr	x			
<b>Primates</b>					
<i>Callithrix geoffroyi</i>	x	x		VU	
<i>Callicebus nigrifrons</i>	x	x			VU
<i>Cebus nigrinus</i>	nr	x			
<b>Lagomorpha</b>					
<i>Silvilagus brasiliensis</i>	x	x			
<b>Artiodactyla</b>					
<i>Mazama sp.</i>	x	x			
<b>Xenartha</b>					
<i>Dasypus sp.</i>	nr	x			
<i>Tamandua tetradactyla</i>	x	nr			EN

<sup>1</sup> Referred to the genus *Oryzomys* in previous surveys (Fonseca et al., 1989)<sup>2</sup> Referred to the genus *Proechimys* in previous surveys (Fonseca et al., 1989)<sup>3</sup> Referred to the genus *Marmosa* in previous surveys (Fonseca et al., 1989)