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## Density and Habitat Use by Giant Anteaters (*Myrmecophaga tridactyla*) and Southern Tamanduas (*Tamandua tetradactyla*) in the Pantanal Wetland, Brazil

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### Abstract

Giant anteaters and southern tamanduas are often sympatric throughout their range and are both found in the Pantanal wetland. Density, habitat use, selection, and habitat overlap between both species were estimated in the central region of the Brazilian Pantanal. A total of 2,174 km of transects were walked through three different landscapes and five different habitat types. Using strip transect methods, densities of giant anteaters in the study area were estimated at 0.15 individuals/km<sup>2</sup>, and 0.34 individuals/km<sup>2</sup> for southern tamanduas. Densities of both species were highest in forest landscapes. Southern tamanduas significantly selected the forest edge habitat. Scrub grasslands had the highest selection ratio for giant anteaters. Results from this study do not indicate that the two species partition habitat. Deforestation in the Pantanal is predicted to be detrimental to both species of anteaters.

**Keywords:** density, giant anteaters, southern tamanduas, niche overlap, habitat use, Pantanal, wetland

### Introduction

The giant anteater (*Myrmecophaga tridactyla* Linnaeus, 1758) occurs from southern Belize and Guatemala to northern Argentina, while the southern tamandua (*Tamandua tetradactyla* Linnaeus, 1758) is found from Venezuela to northern Argentina (Nowak, 1999). These species largely overlap throughout their distribution and share parts of their habitats. They occur in all biomes of Brazil (Fonseca *et al.*, 1996) and can be found in a wide variety of habitats, ranging from open fields to dense forests.

These mammals are myrmecophagous and termitophagous. In other words, they are specialized in feeding on ants and termites, which are gathered with the powerful claws of their forelimbs and the sticky, protractile tongue (Nowak, 1999). The southern tamandua is scansorial and can feed both on the ground and in trees. The giant anteater feeds mainly on the ground, but can also climb trees for feeding or for scratching, rubbing, and claw marking

(Shaw *et al.*, 1985; Rummel, 1988; Medri, 2002; Young *et al.*, 2003; Kreutz, 2007).

All members of the superorder Xenarthra, including giant anteaters and southern tamanduas, have lower body temperatures and lower basal metabolic rates than other mammals of similar body mass (McNab, 1985). The giant anteater can exceed 35 kg in weight, about seven times the body mass of the southern tamandua (approximately 5 kg; Rodrigues *et al.*, 2008). Giant anteaters and southern tamanduas display both nocturnal and diurnal activity as part of a thermoregulatory behavior to avoid exposure during the hottest or coldest hours of the day. Moreover, habitat use by these species is widely related to ambient temperature (Camilo-Alves and Mourão, 2006; Rodrigues *et al.*, 2008). Changes in timings of activity related to ambient temperature have also been reported for armadillos (Layne and Glover, 1985) and sloths (Chiarello, 2008).

Density is an important parameter to estimate population size and to monitor the status of a population. There is limited scientific literature on the population ecology of southern tamanduas and giant anteaters. Giant anteater and southern tamandua densities were estimated in Venezuela by Eisenberg *et al.* (1979). Data on the population density of giant anteaters in Brazil are available from the Pantanal region (Coutinho *et al.*, 1997), Serra da Canastra National Park, Minas Gerais state (Shaw *et al.*, 1985; Shaw *et al.*, 1987), Emas National Park, Goiás state (Miranda *et al.*, 2006) and Boa Vista, Roraima state (Kreutz, 2007). Furthermore, Silveira *et al.* (1999) compared the density of giant anteaters killed by a fire in Emas National Park to the density of live individuals some months after the fire. To our knowledge, there is no scientific information available on southern tamandua density in Brazil.

Our objective is to present density estimates of giant anteaters and southern tamanduas in three different landscapes of the central region of the Brazilian Pantanal and, in addition, present data on their biomass, habitat use and selection.

### Materials and Methods

#### Study Area

This study took place between October 2002 and November 2004 in the center of the Pantanal at the Embrapa Pantanal Nhumirim ranch and its surrounding ranches (18°59'S, 56°39'W). The study area covers over 200 km<sup>2</sup> and includes three different

landscapes characteristic of the region: 1) floodplains, dominated by seasonally flooded grasslands; 2) forests, characterized by strips and patches of semi-deciduous forest; and 3) cerrado, covered by scrub forest and open scrub grasslands. The study area overlaps six ranches that are traditionally managed and therefore mainly comprise native vegetation. There are no roads in the area, and overall anthropogenic impact on the landscape is considered low. Further details of the study area are provided in Desbiez (2007) and Soriano *et al.* (1997).

#### Density estimates

Twenty-one transects ranging from 3.5 to 5 km and marked at 50 m intervals were randomly placed within the study area with no previous knowledge of animal distribution: seven in the forest landscape, six in the cerrado landscape, and eight in the floodplain. Transects were walked alone by the same observer (AD), except for the ones in the floodplains, 200 km of which were walked alone by another trained observer. Transects were generally walked twice a month and regularly cleaned to remove overgrowth. The latter ensured detection of animals on the line and helped avoiding noise while walking. Transect censuses began at sunrise; no nocturnal surveys were conducted. In both the forest and cerrado landscapes, transects were walked out at a pace of approximately 1–2 km per hour, followed by a minimum one hour wait in a location 500 m from the end of the transect, and then walked back. In the floodplain, transects were walked out at 2–4 km per hour. At the end of the trail, the observer stopped data collection, walked to a parallel transect distant 1 km, and walked back along it collecting data. Date, time of the day, species, perpendicular distance from the transect, habitat type, and activity were registered for each sighting. A total of 2,174 km of transects were walked (847.8 km in the forest landscape; 906.5 km in the cerrado landscape; and 420 km in the floodplain landscape).

Giant anteaters were sighted 23 times and southern tamanduas 21 times from the trail. This number of sightings was too low to estimate density using the DISTANCE software (Thomas *et al.*, 2006) because a minimum of 60 sightings is required to obtain reliable results (Buckland *et al.*, 2001). Strip transect methods were therefore used to analyze data. Strip transect counts presume a complete census of all animals within a fixed distance from the transect (Cochran, 1977). Fixed transect widths of 10 m and 12 m were used for southern tamanduas and giant anteaters, respectively, as it was estimated that both species were seen within those distances in all

surveyed habitat types. Twelve sightings of giant anteater and 7 of southern tamandua were discarded because they occurred beyond the fixed width. Densities were determined for each species in the three landscapes (floodplains, forests, and Cerrado) using the fixed transect width to calculate the surveyed area.

#### Biomass

Biomass was estimated by multiplying the average individual weight by the respective species density (Eisenberg, 1980). Average individual weight was obtained during a recent study on giant anteaters (35 kg) near the Embrapa Pantanal Nhumirim ranch (Medri and Mourão, 2005a) and from the literature for southern tamandua (5 kg) (Schaller, 1983; Robinson and Redford, 1986).

#### Habitat use and availability

Transects were marked every 50 m, and these sections were then categorized in five different habitat categories: 1) open grasslands, 2) scrub grasslands, 3) scrub forest, 4) semi-deciduous forest, and 5) forest edge. Encounter rates were determined on each of them. The frequency of sightings was standardized by taking into account the number of times each section was sampled. Habitat use was then determined by grouping the encounter rate of each species per habitat category. Habitat availability was estimated from the total proportion of 50 m habitat segments in the 21 transects.

#### Habitat selection

Manly's standardized habitat selection index for constant resources (Manly *et al.*, 2002) was used to compare habitat selection in the different landscapes. The index is based on the selection ratio  $w_i$ , which is the proportional use divided by the proportional availability of each resource:

$$O_{jk} = \frac{\sum^n p_{ij} p_{ik}}{\sqrt{\sum p_{ij}^2 \sum p_{ik}^2}}$$

Where:  $O_i$  = Proportion of the sample of used resource units in category  $i$  (encounter rate);  $\pi_i$  = Proportion of available resource units in category  $i$  (available habitat). A  $w_i$  value larger than 1 indicates a positive selection for the resource, while a value lower than 1 indicates avoidance of the resource. A value around 1 indicates that the resource is used proportionally to its availability and no resource selection occurs. The

preference/avoidance for each resource and species was calculated from the selection ratio  $w_i$  and tested for each species in each habitat using a chi-square test adjusted by Bonferroni. Calculations were made with the extension “adehabitat” of the statistical package R (Ihaka and Gentleman, 1996; Calenge, 2006).

### Habitat overlap

Pianka’s index was used to calculate habitat overlap between the two species (Gotelli and Entsminger, 2004). Pianka’s index was calculated using the equation:

$$W_i = O_i / \pi_i$$

where  $O_{jk}$  = Pianka’s index of niche overlap between species  $j$  and species  $k$ ;  $p_{ij}$  = Proportion resource  $i$  of the total resources used by species  $j$ ;  $p_{ij}$  = Proportion resource  $i$  of the total resources used by species  $k$ ;  $n$  = Total number of resources. Pianka’s index ranges from 0 (no resources in common) to 1 (complete overlap). To determine the probability that the observed niche overlap is greater or lower than would be expected by random, we performed 5,000 Monte Carlo randomizations of different frequencies of resource use to simulate possible overlaps among the two species. All calculations and simulations were carried out with the software EcoSim version 7.72 (Gotelli and Entsminger, 2004).

### Results

The density of giant anteaters in the study area was 0.15 individuals/km<sup>2</sup>, and 0.34 individuals/km<sup>2</sup> for southern tamanduas (Table 1). Most of the observations occurred between October and December for both 2002 and 2003. During those months, 73% of the giant anteater and 57% of southern tamandua counts were made. One third (33.3%) of the observed southern tamanduas were foraging, resting or moving around in trees. Densities of both species were highest in forest landscapes (Table 1). Animals were usually sighted alone, but occasionally a female

was observed carrying a pup on her back. Both species were encountered in the three surveyed landscapes and all habitat types (Tables 1 and 2). Due to their larger size, total biomass of giant anteaters was higher in all landscapes even though their densities were lower. Southern tamanduas significantly selected the forest edge habitat ( $w_i > 1$  and  $P < \text{Bonferroni level } 0.0125$ ) (Table 3). Scrub grasslands had the highest selection ratio  $w_i$  values (Table 4) for giant anteaters, however, results did not show that they significantly selected a particular habitat ( $P > \text{Bonferroni level } 0.0125$  when  $w_i > 1$ ). For both species, forest edges had high  $w_i$  values (Tables 3 and 4). Results from this study do not indicate that the two species partition habitat. Observed mean niche overlap was 0.730 after 5,000 Monte Carlo simulations. This value was higher than the expected mean niche overlap of 0.462.

### Discussion

Previously published density estimates for giant anteaters have been obtained by different methods, and results are therefore not easily compared. The only available information about giant anteater density in the Pantanal was obtained by aerial surveys and estimates were calculated at 0.035 individuals/km<sup>2</sup> (Coutinho *et al.*, 1997). Population density of giant anteaters at Serra da Canastra was estimated at 1–2 individuals/km<sup>2</sup> based on a time/area count method (Shaw *et al.*, 1985). In the same study, giant anteater densities of 0.17–1.31 individuals/km<sup>2</sup> were recorded using road counts. Densities of 1.3 giant anteaters/km<sup>2</sup> were registered by capture-recapture methods at the same site (Shaw *et al.*, 1987). The highest density of giant anteaters was found at Serra da Canastra National Park and is probably due to habitat conditions and high food availability (termite mounds and ant nests), as well as the absence of large predators such as jaguars (*Pantera onca*) (Shaw *et al.*, 1985). At Emas National Park, giant anteater density was estimated at 0.2 individuals/km<sup>2</sup> using aerial strip transects, and 0.4 individuals/km<sup>2</sup> using terrestrial line transects (Miranda *et al.*, 2006). In the same park, the density of giant

**TABLE 1.** Density (individuals/km<sup>2</sup>), number of animals sighted in each landscape, and biomass (kg/km<sup>2</sup>) of giant anteaters and southern tamanduas in the central region of the Pantanal.

	Giant anteater		Southern tamandua	
	Density individuals/km <sup>2</sup> (Number sighted)	Biomass (kg/km <sup>2</sup> )	Density individuals/km <sup>2</sup> (Number sighted)	Biomass (kg/km <sup>2</sup> )
Study area	0.15 (N=8)	5.35	0.34 (N=15)	1.70
Forest landscape	0.20 (N=4)	7.00	0.41 (N=7)	2.05
Cerrado landscape	0.14 (N=3)	4.90	0.39 (N=7)	1.95
Floodplain landscape	0.10 (N=1)	3.50	0.12 (N=1)	0.60

anteaters killed by a forest fire was estimated by distance sampling at 0.63 individuals/km<sup>2</sup> (Silveira *et al.*, 1999). However, giant anteater density increased to 0.85 individuals/km<sup>2</sup> after the fire, probably due to migration of individuals to the area (Silveira *et al.*, 1999). Giant anteater density in llanos and semi-deciduous forests in Venezuela was 0.18 individuals/km<sup>2</sup>, and biomass was 4.9 kg/km<sup>2</sup> (Eisenberg *et al.*, 1979).

In this study, the estimated giant anteater density was 0.15 individuals/km<sup>2</sup>, and biomass was 5.35 kg/km<sup>2</sup>. This species probably naturally occurs at lower densities in the Pantanal than in the other studied areas. Although line transects have been widely used to estimate animal densities throughout the Neotropics (Emmons, 1984; Mendes Pontes *et al.*, 2007), they may not be the most efficient method to estimate densities of giant anteaters because their encounter rates are so low.

**TABLE 2.** Encounter rates (sightings/100 km) of giant anteaters and southern tamanduas in different habitats from the central region of the Pantanal between October 2002 and November 2004.

Habitat	Giant anteater	Southern tamandua
Open grasslands	0.50	0.37
Scrub grasslands	0.99	0.33
Scrub forest	0.27	0.27
Forest	0.25	0.99
Forest edges	0.57	2.86

**TABLE 3.** Habitat selection of southern tamanduas in the central region of the Pantanal between October 2002 and November 2004, where  $w_i$  is the selection ratio, SE  $w_i$  is the standard error of  $w_i$  and P chi-square probability with Bonferroni level 0.0125. A habitat is considered selected when:  $w_i > 1$  and  $P < \text{Bonferroni level } 0.0125$ .

Habitat	Habitat use	Habitat available	$w_i$	SE $w_i$	p
Open grasslands	0.08	0.570	0.135	0.095	0.000
Scrub grasslands	0.07	0.110	0.622	0.467	0.419
Scrub forest	0.06	0.120	0.474	0.393	0.180
Forest	0.21	0.130	1.579	0.633	0.360
Forest edges	0.59	0.070	<b>8.461</b>	1.430	<b>0.000</b>

**TABLE 4.** Habitat selection of giant anteaters in the central region of the Pantanal between October 2002 and November 2004, where  $w_i$  is the selection ratio, SE  $w_i$  is the standard error of  $w_i$  and P chi-square probability with Bonferroni level 0.0125. A habitat is considered selected when:  $w_i > 1$  and  $P < \text{Bonferroni level } 0.0125$ .

Habitat	Habitat use	Habitat available	$w_i$	SE $w_i$	p
Open grasslands	0.19	0.570	0.337	0.192	0.001
Scrub grasslands	0.38	0.110	3.493	1.231	0.043
Scrub forest	0.11	0.120	0.884	0.714	0.871
Forest	0.10	0.130	0.739	0.631	0.679
Forest edges	0.22	0.070	3.165	1.651	0.190

Southern tamandua density in Venezuela was 3.0 individuals/km<sup>2</sup>, and biomass was 12 kg/km<sup>2</sup> (Eisenberg *et al.*, 1979). No previous scientific information is available on southern tamandua density in Brazil. In the present study, the estimated density for this species was 0.34 individuals/km<sup>2</sup> and biomass was 1.70 kg/km<sup>2</sup>. The higher density of southern tamanduas than of giant anteaters (0.34 *versus* 0.15 individuals/km<sup>2</sup>) agrees with Mohr's (1940) prediction that in interspecific comparisons, numerical density generally declines with increasing body mass.

The activity of giant anteaters and southern tamanduas can be diurnal, crepuscular or nocturnal. Variation not only occurs between regions and seasons, but also among different individuals in a population (Montgomery, 1985; Rodrigues *et al.*, 2008). Previous studies have shown that giant anteaters modify their activity periods according to ambient temperature (Medri and Mourão, 2005a; Camilo-Alves and Mourão, 2006). Like giant anteaters, southern tamanduas have lower metabolic rates than would be expected for their body mass (McNab, 1984; 1985). It is therefore probable that they also modify activity patterns according to ambient temperature. In this study, censuses started at sunrise and ended in the early afternoon. Perhaps, nocturnal and crepuscular censuses would have increased encounter rates. Most of the giant anteater and southern tamandua sightings occurred between October and December, suggesting that activity patterns may vary at different times of the year. For example, Camilo-Alves and

Mourão (2006) reported seasonal changes in activity patterns of giant anteaters at the same study site as surveyed here. It is not clear whether this difference was due to temperature, changes in resource availability, breeding behavior or other factors.

Habitat use by giant anteaters varies among regions where the species occurs. It is also influenced by ambient temperature or even individual preferences (Medri and Mourão, 2005a; Camilo-Alves and Mourão, 2006; Rosa, 2007; Rodrigues *et al.*, 2008). In this study, giant anteaters did not significantly select a habitat type, but the highest encounter rates for this species occurred in open habitats (open grasslands, scrub grasslands and forest edge) rather than in covered ones. Some possible explanations for this finding are that: 1) giant anteaters generally are more active in open habitats and use forest habitats for resting (Medri and Mourão, 2005a; Mourão and Medri, 2007); 2) it is easier to see an active than a resting giant anteater because the latter covers its body with its dark and bushy tail for camouflage and to preserve body heat (Shaw and Carter, 1980; McNab, 1984; Medri and Mourão, 2005b). Southern tamanduas also selected forest edges but were more frequently observed in forested habitats (forest and forest edges). This species is scansorial and can use habitats with dense vegetation to feed and rest. In addition, due to its small size the southern tamandua is probably more vulnerable to predator attacks, and living in a forest habitat will provide them with more opportunities to flee from predators by climbing up trees.

Results of habitat overlap for giant anteaters and southern tamanduas could be misleading. This analysis did not take into account that the study species use different strata of their habitat. While giant anteaters are mainly terrestrial, the scansorial southern tamandua can feed on ants and termites nesting in trees. Habitat overlap values would therefore be much lower if strata were included, and the animals may in fact be partitioning habitat.

In the Pantanal, current intensifications and changes in land use practices often lead to deforestation and loss of forested habitats. Forest habitats are very important for both species of anteaters. The southern tamanduas were found to select forested habitats, which are also important for the thermoregulation of giant anteaters (Camilo-Alves and Mourão, 2006). Results from this study predict that deforestation in the Pantanal will be particularly detrimental to southern tamanduas, but may also impact giant anteaters.

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