Habitat use and diet of bush dogs, *Speothos venaticus*, in the Northern Pantanal, Mato Grosso, Brazil

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Abstract

From April 2001 to November 2003, direct (sightings) and indirect (feces, tracks, prey carcass/scent) evidence of bush dog (*Speothos venaticus*) presence were recorded in a private reserve in the Pantanal, Mato Grosso State, Brazil. Most observations were recorded either through direct sightings or tracks (36.67% each; total sample size=30). Although bush dogs are difficult to see, they seem to be frequent in the area, contradicting the reports in the available literature. Assuming a home-range size of 150 km² for a group of six bush dogs, we estimated that the northern and eastern regions of the Reserve contain 5.74 groups of bush dogs, each group with an average of 2.75 individuals (SD±1.07, variation 1–5 individuals, n=24). The distribution of records did not vary between the different habitats of the studied area (G=0.093, p=0.954), suggesting that bush dogs do not select preferential habitats in the Pantanal. The principal food item was *Dasypus novemcinctus* (94.1%; total sample size=17), indicating that nine-banded armadillos are the principal prey of bush dogs in the Pantanal. There were no records of fruit items in the collected feces, suggesting that bush dogs are hypercarnivorous or exclusively carnivorous.

Keywords: bush dog (*Speothos venaticus*); *Dasypus novemcinctus*; diet; habitat use; population estimates.

Introduction

The bush dog, *Speothos venaticus*, is one of the most poorly understood Neotropical canids. Most of the information about its ecology and natural history comes from opportunistic observations (Deutsch 1983, Defler 1986, Dalponte 1995, Silveira et al. 1998) and little comes from more systematic studies (Flower 1880, Beisiegel and Ades 2002, Beisiegel and Zuercher 2005).

Bush dogs are listed as CITES Vulnerable – Appendix I (IUCN 2003) and are considered threatened by Brazilian authorities (MMA 2003). Yet, it is difficult to prepare a design to protect the species due to the lack of basic information on its occurrence and also on effective capture methods.

Field studies throughout the range of the species are scant (Peres 1991, Strahl et al. 1992, Aquino and Puertas 1997, Silveira et al. 1998, Barnett et al. 2001, Zuercher et al. 2005). The radiotelemetry technique, especially of elusive species or those with nocturnal habits (Jacob and Rudran 2003), has contributed much to the knowledge of ecology and behavior of carnivores (e.g., Rodrigues 2002). Although no successful study using radiotelemetry has been made on wild bush dogs, it is important to try to apply this technique throughout the area of distribution of the species to elucidate its ecology and behavior. However, difficulties in finding and capturing bush dogs are certainly important limiting factors in using this technique. By determining the bush dog’s abundance, habitat use and diet preferences at Reserva Particular do Patrimônio Natural-Servico Social do Comércio (RPNN-SESC Pantanal) and developing appropriate capture sites and methods, we are contributing to an increase of basic information on the ecology and preferences in the wild of this elusive species.

Material and methods

Study site

The 106,000 ha RPPN-SESC Pantanal is a private reserve located in the Pantanal of Barão de Melgaço (16°17’ S; 56°57’ W), approximately 100 km from Cuiabá, the capital of Mato Grosso State, Brazil. The Reserve is seasonally flooded and contains a mosaic of vegetation types, including forest and former pasturelands. Cordeiro (2004) identified 13 habitat types, of which eight are forest formations; four are open formations (types of “Campão”) with hummocks of varying sizes bearing woody vegetation (Campo de Murunduns) and/or “cordilheiras” which consist of long, narrow strips of forest surrounded by grassland; and one is a shrub formation. The area has distinct rainy (October to March) and dry (April to September) seasons, and belongs to climate type Aw in the Köppen classification (dry winter and rainy summer, Nimer 1989). The mean annual rainfall varies between 1100 and 1200 mm (Antunes 1986). The mean temperature in January (middle of wet season) is 27–28°C and in July (middle of dry season) is 23–24°C (Antunes 1986). The terrain is essentially flat and composed of sandy and loamy soils (Allem and Valls 1987). Park guards constant-
ly monitor the area. No hunting or other human activities, such as agriculture, are performed there. Roads are used only by the park guards and researchers. Motor vehicles are used only during part of the dry season. During most of the year transportation is done only by horses or horse-drawn carts.

**Population size estimation**

Between April 2001 and November 2003, locations of bush dogs in RPPN-SESC Pantanal were recorded using three methods: a survey along fixed transects, opportunistic direct observation by our group of researchers, and reports from park guards and other researchers. The surveys were conducted along 14 fixed linear transects, each 4 km in length (Figure 1). Four were established inside forests and 10 in the savanna/forest mosaic. All of them followed dirt roads or trails. The higher number of transects in the savanna/forest mosaic is due to the extended length of the transects, which prevented them of being located exclusively in one vegetation type, and to the fact that this type of formation is the most abundant in the central portion of the reserve (covering approximately 40,000 ha). This part of the reserve was used for the establishment of transects since it is the area where the majority of trails and roads adequate for travel are situated. During the dry season (June to November 2001), all transects were systematically walked six separate times during the 6-month period, between 06:00 and 10:00 h, giving a total of 336 km walked. The day prior to the transect survey, the ground was cleared of all previous tracks and debris. While surveying each transect, we looked for evidence of bush dog presence (e.g., sighting, tracks, feces, fresh carcasses of prey and scent). Each location was marked with a Global Positioning System (GPS, Rino® 110, Garmin International Inc., Olathe, USA). When possible, the number of individuals in a group was determined.

Additionally, non-systematic data on locations of bush dog occurrences were collected by our group of researchers in the same areas, and observations by park guards and other research groups including the number of individuals observed, with their date, time, and location were also used in the analysis. We are confident that the identifications were accurate since the only animal that would cause possible confusion is the tayra (*Eira barbara*), but this species has a long tail and therefore eliminates any uncertainty. The tayra is not common in the reserve and we only observed an average of 0.8 ± 0.7 trail/km walked. The species is well known by the park guards and researchers who contributed to our study. All locations were geo-referenced.

Estimates of home-range size of bush dogs are speculative and tracking data do not exist for our study area. Thus, for the population size estimates, we assumed a home-range size of 50.01 km² for a pair of bush dogs or 150.03 km² for a group of six animals (Beisiegel 1999).

**Capture efforts**

From March to July 2003 (dry season) we concentrated our efforts into capturing bush dogs and fitting them with radio collars. A combination of foot/leg traps (Duke Trap, West Point MS) and live-box traps (1.1×0.4×0.5 m; Tomahawk Inc., Tomahawk, WI, USA) was used. All traps (leg and box) were established in areas of recent bush dog activity and were baited with live mice. The total effort consisted of 9 leg traps set for 29 days and 4 live-box traps set for 141 days.

![Figure 1](image.png)

**Figure 1** Thirty direct and indirect locations of the bush dog in RPPN-SESC Pantanal, MT, Brazil. The five park guard residences are indicated as follows: PSA—Posto Santo André; PSM—Posto Santa Maria; PNSC—Posto Nossa Senhora do Carmo; PSL—Posto São Luiz; and PES—Posto Espírito Santo. The minimum convex polygon was formed by bush dog’s locations. There was a total of 14 transects.
Habitat use

For our analysis of habitat use, we considered the RPPN-SESC Pantanal to have three vegetation formations (forest, savanna/forest mosaic and shrub formation) (Cordeiro 2004). All recorded locations of bush dogs were mapped with a GPS. Based on the most extreme locations, we determined a minimum convex polygon (MCP, Mohr 1947). Using a hypothetical uniform distribution of bush dogs in the different habitats, we determined the expected number of records of these animals in each habitat (forest, savanna/forest mosaic and shrub formation) within the polygon by multiplying the area of each of the vegetation formations by the total number of records, divided by the total area of the polygon. Then, we compared the proportions of the expected and observed locations in each type of habitat available (Jacob and Rudran 2003) within the polygon (MCP) using a Geographical Information System (ArcView GIS 3.2, Environmental Systems Research Institute, Inc., California, USA). The null hypothesis of non-selective habitat of bush dogs was tested with the G-test.

Diet study

From April 2001 to November 2003, feces samples of bush dog were opportunistically collected in roads and transects within the RPPN-SESC Pantanal. The feces were identified as belonging to bush dogs by their characteristic odor and the tracks associated with them. Food items were separated by dissolving individual scats in water and filtering with a 1.1-mm sieve. The resulting material was then dried and separated, with the help of a stereomicroscope when necessary. The material was identified to the lowest possible taxonomic level. The relative frequency of total food item counts was calculated (number of occurrences of each item in the scats relative to the total number of occurrences of all food items). Mean weight of vertebrate prey was estimated to the species level, were collectively estimated at 250 g (Zuercher et al. 2005). Scats were analyzed in the Laboratory of Zoology in the University of Mato Grosso State (UNEMAT-Nova Xavantina).

Results and discussion

Population size estimation

A total of 30 locations of bush dogs were recorded in RPPN-SESC Pantanal, using the three combined techniques (tracks, feces, and direct observation) (Table 1). Using a combination of the number of individuals in a group directly sighted and the number of individuals, researchers could discern through footprints, we estimated that the average pack-size was 2.75 bush dogs (SD±1.07; range: 1–5 ind.; n=24).

<table>
<thead>
<tr>
<th>Type of evidence</th>
<th>No. of times</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feces</td>
<td>5</td>
<td>16.67</td>
</tr>
<tr>
<td>Direct observation</td>
<td>11</td>
<td>36.67</td>
</tr>
<tr>
<td>Footprints</td>
<td>11</td>
<td>36.67</td>
</tr>
<tr>
<td>Footprints/feces</td>
<td>2</td>
<td>6.67</td>
</tr>
<tr>
<td>Recently killed prey</td>
<td>1</td>
<td>3.33</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Most of the direct observations occurred during early to late morning (06:00 to 11:05 h) or evening (15:20 to 21:00 h) in forested areas or open grasslands with isolated areas of shrub/forest and/or hills. As pointed out by Araujo Neto et al. (1986), this vegetation is a low, flat landscape covered by grasses including a more elevated area of variable size ("island") covered by shrubs and trees and usually forming a regular pattern. In Brazil, this vegetation is called Campo de Murundus. Two separate sightings occurred near Posto São Luiz (PSL), in 2002 (Figure 1). One was a group of two individuals (RPPN-SESC Park Guards personal observation) and the second a group of three individuals (E.S. Lima and R.S.P. Jorge, personal observation). In the latter, two individuals were lying in the center of a local highway and the third was walking around sniffing. When the three detected the researchers’ presence, they immediately fled to the high grass (40 cm in height). Additionally, two separate sightings occurred near Posto Santo André (PSA) in 2002 and 2003 (Figure 1). The first involved two individuals traveling in a line and sniffing a trail of agouti that had been observed at that location a few seconds before (L.A.C. Melo personal observation). The second was a group of three bush dogs pursuing an agouti (J. Oliveira personal observation).

Using 150 km² as the estimated home range of six bush dogs (Beisiegel 1999), we calculated that in the 394.35 km² polygon formed by the bush dog's locations (Figure 1), 15.77 individuals exist, or, considering our pack-size estimation of 2.75 individuals, 5.74 groups of bush dogs. However, it is possible that this estimate is low as other researchers have estimated home ranges of the bush dog to be only 4.56–4.72 km² (Silveira et al. 1998), 3.8–10.0 km² (Beisiegel and Zuercher 2005) or 20 km² (Van Humbeck and Pérez 1998).

The grassy vegetation of the Pantanal is dense and without prior preparation of a particular area it would be difficult to find bush dog signs. Based on the number of records during the 30 months of investigations, we suggest that bush dogs live hidden under dense vegetation (underbrush) and spend most of the day inside dens of armadillos (Cingulata, Dasyopodidae). Based on a similar experience of limited encounters with bush dogs in eastern Paraguay, Zuercher et al. (2005) suggested that the species is rare or at least rarely encountered in that region. In addition, although distracted and noisy while hunting, bush dogs quickly hide in dens of recently killed.
prey (e.g., armadillos) or in dense grassy vegetation or undergrowth of forested areas, whenever they detect the presence of people (E.S. Lima personal observation). Although all of our records were made on roads or tracks, they indicated that animals were crossing rather than walking along them. These observations indicate that the species is errant and avoids walking along roads or tracks, differing in this respect from the majority of other canids as well as felids.

Although the number of records of bush dogs in the RPPN-SESC Pantanal was limited if compared with other sympatric carnivores, it was quite high compared with reports of other researchers in other regions, as well as that of our own experience. The species is referred to in the literature as rare, but seems to be frequent in the northern and eastern sections of the Reserve, probably due to high availability of food, abundance of prey and a suitable habitat with little anthropogenic disturbance. While no scientific studies or surveys have been conducted, the bush dog is generally seen as a species with a broad distribution yet low density of occurrence (Strahl et al. 1992, Silveira et al. 1998, Silva and Soares 1999, Barnett et al. 2001). The destruction of the natural environment for crop growing and cattle production contributes to the reduction in the number of bush dogs and their prey, constituting a progressive threat to both.

Capture attempts
All trapping efforts were unsuccessful in capturing bush dogs. On the other hand, five other species, seven individuals in total, were captured: one black hawk (Buteogallus urubittinga), three ocelots (Leopardus pardalis), one common gray four-eyed opossum (Philander opossum), one mouse-jumper (Trichomys pachyurus), and an agouti. These latter three species are of interest as they are potential bush dog prey.

The lack of success in capturing the bush dogs may be the result of the species behavioral patterns. As mentioned previously, bush dogs are skittish and seem to avoid entering into live-box traps. Our lack of success in capturing bush dogs reinforces the concept that the difficulty of locating and studying the species in the field can be attributed to a pattern of extensive movement in a very large home range area, when pups reach maturity, and to their secretive habits (Beisiegel and Ades 2002). Beisiegel (1999), attempting to capture bush dogs, used a combination of methods (live-box traps, ambush, several kinds of baits and camera traps), resulting in an effort of almost 6000 h in the field, but did not succeed in catching or observing any. DeMatteo et al. (2004) used vocalizations recorded from bush dogs in captivity and deposition of captive bush dog’s urine to try to attract wild specimens. This method elicited vocal responses from wild bush dogs. However, attempts to capture specimens using this method in the eastern region of Mato Grosso state were unsuccessful (E.S. Lima personal observation). An efficient method for capturing bush dogs still needs to be established.

Habitat use
Bush dogs occur in a variety of habitats, including Interior Atlantic Forest, Tropical Rainforest, Wet Savanna, Cerrado, Chaco and Steppe (Zuercher et al. 2005). Previous records confirm the presence of bush dogs in typical savanna formation dominated by grass (Defler 1986, Barnett et al. 2001), closed-canopy forest (Strahl et al. 1992), and lowland tropical rainforest (Langguth 1975), forested region in ecotonal area (Silva and Soares 1999), Atlantic rain forest (Beisiegel and Ades 2002, 2004),cerrado habitats in Brazil (Deutsch 1983, Dalponte 1995, Silveira et al. 1998), and Paraguay (Zuercher and Villalba 2002) and in all subtypes of the cerrado biome, from grassy to gallery forests (E.S. Lima personal observation).

Out of our 30 bush dog records, the majority (16) occurred in the forested area, i.e., the habitat of major proportion in the polygon (MCP) determined through the locations. The savanna/forest mosaic was also well represented (13); however, only one record occurred in the shrub formation. Yet, the distribution of observed and expected records in the different habitats of the studied area did not differ significantly (G=0.093, p=0.954; Table 2), suggesting that bush dogs do not select habitats in the RPPN-SESC Pantanal.

Bush dogs were once considered a lineage of South American canids specialized for dwelling in forested habitats (Langguth 1975). Additionally, Zuercher et al. (2005) recorded more bush dog signs in high forest than in the medium and low forest, suggesting that the species has a preference for this type of habitat. However, Zuercher et al. (2005) admitted that the larger number of observed bush dog signs in high forest may have occurred as a consequence of sparse vegetation on the floor, making it easier to observe the animals. Our results reinforce this observation, considering that all records were of bush dogs crossing roads and transects. In previous studies, the majority of encounters with bush dogs have occurred in forested areas (Langguth 1975, Strahl et al. 1992). Yet, sightings have also been made in cerrado areas (Silveira et al. 1998, Zuercher and Villalba 2002). A smaller number of bush dog records in open areas could be the result

Table 2: Available area of each habitat type, number of bush dogs’ records (feces, direct observation, footprints, footprints/feces and prey fresh/scents) observed within each habitat type, and number of records expected in each habitat type, calculation based on a proportionally uniform distribution of bush dogs in the different habitats of the RPPN-SESC Pantanal.

<table>
<thead>
<tr>
<th>Habitat type</th>
<th>Available area (km²)</th>
<th>No. of observed records</th>
<th>No. of expected records</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>203.4</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>Wet savanna/forest mosaic</td>
<td>192</td>
<td>13</td>
<td>14.2</td>
</tr>
<tr>
<td>Shrub</td>
<td>11.4</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Total</td>
<td>406.8</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>
of bush dogs having short legs, making it difficult to observe them in dense grassy vegetation.

During the course of their evolution, bush dogs seem to have developed characteristics for hunting prey in burrows, independently of the vegetation type. They have short legs and tail, small ears and eyes, an elongated body shape, and forefeet that are larger than hind feet, and have stronger claws. All these characteristics enable bush dogs to enter dens, dig and remove soil to reach and kill prey inside burrows (e.g., nine-banded armadillo), and pull the prey back to the outside for the pack to consume it without intra-group disputes (E.S. Lima personal observation).

Diet

Out of 17 bush dog samples, we recorded eight different food items. The principal food item was *Dasypus novemcinctus*, which represented 94.1% of the occurrence in number of scats and 95.4% of the total biomass consumed (Table 3), suggesting that in the Pantanal nine-banded armadillos are the principal bush dog prey. Nine-banded armadillos are not good diggers when compared with other genera of armadillos (e.g., *Euphractus*, *Priodontes*, *Cabassous*). Generally, they dwell in dens hollowed by other armadillo species. This facilitates the bush dog's strategy of predation, since nine-banded armadillos are not capable of escaping because of their inability to dig quickly. In open areas of the Pantanal, *D. novemcinctus* is common: we found in the transects on the reserve an average of 2.7±1.3 trails/km walked. In terms of biomass, Zuercher et al. (2005) registered paca (*Agouti paca*) and agouti as the most important items of the bush dog's diet in forested areas. Agoutis are extremely abundant in the RPPN-SESC Pantanal (12.6±4.0 trails/km walked). The difference in the average number of tracks/trails of nine-banded armadillos (2.7) and agouti (12.6) found in the Reserve suggest that bush dogs have a preference for *D. novemcinctus*. Curiously, only one occurrence of agouti remains was registered in our feces samples of bush dogs. This may be due to difficulties in bush dogs capturing agoutis in our study area. Generally, agoutis, when fleeing, seek refuge in hollows at the base of trees (E.S. Lima personal observation). Bush dogs are probably less capable of hunting agoutis in such situations because they have larger bodies and find it difficult to enter such hiding places. Thus, in an area where both nine-banded armadillos and agoutis are abundant, bush dogs probably have higher success predating the former.

Vegetation remains occurred in 88% of feces (Table 3), consisting basically of grass and leaves. Although the proportion of samples where vegetation remains were found was high, the volume in each sample was very small. These were probably accidentally ingested while bush dogs consumed their prey. Termite and non-identified insects were also found in the feces. Similarly to vegetation remains, they were probably ingested accidentally. In this case, either while bush dogs consumed their prey or because they were in the prey's digestive tract. Small mammals, agoutis and birds occurred in small quantities. Remains of fruits, which are commonly found in other South American canid scats (e.g., Facure 1996 in *Cerdocyon thous*, Dalponte 1997 in *Pseudealopex vetulus*, Azevedo and Gastal 1997 in *Chrysocyon brachyurus*), were not encountered. This suggests that, in terms of diet, bush dogs fit better in the group of the authentic carnivorous animals, closer to the felids, than to the group of generalist canids. The only record of fruit consumption by bush dogs was documented by Zuercher et al. (2005), but the authors suggested that it could be either an opportunistic or an incidental event. Our results reinforce the indication that bush dogs are hypercarnivorous or exclusively carnivorous. This was also suggested by Zuercher et al. (2005) based on the modified carnassial teeth and on the results of the dietary analyses in Paraguay. Considering that *D. novemcinctus* is the principal bush dog prey in the Pantanal, the bush dog may be regarded as an ecological intermediate between larger felids and smaller carnivores (Zuercher et al. 2005).

The only study on the diet of wild bush dogs through the analysis of feces occurred in Paraguay and was restricted to 11 samples (Zuercher et al. 2005). Biben (1982) states that bush dogs do not use feces for scent-marking. This reduces the possibility of finding scats on roads or tracks, especially assuming that the species is errant, and the shortage of studies of the diet of bush dogs may be related to that fact. Wasser et al. (2004) trained dogs to detect scats of grizzly and black bears in the Yellowhead Ecosystem in Canada. Training domes-

Table 3 Percentage of occurrence, frequency and biomass in 17 bush dogs’ (*Speothos venaticus*) feces samples collected in the RPPN-SESC Pantanal.

<table>
<thead>
<tr>
<th>Items</th>
<th>Oc.</th>
<th>% Oc.</th>
<th>Rf</th>
<th>TB</th>
<th>% RB</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Dasypus novemcinctus</em> dermal plates, bones and nails</td>
<td>16</td>
<td>94.1</td>
<td>41.0</td>
<td>65.6</td>
<td>95.4</td>
</tr>
<tr>
<td>Plant remains, grass</td>
<td>15</td>
<td>88.2</td>
<td>38.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-identified insects</td>
<td>1</td>
<td>5.9</td>
<td>2.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hair, incisor teeth and fragments of bone of small mammals</td>
<td>2</td>
<td>11.8</td>
<td>5.1</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Hair and bones of <em>Dasyprocta azarae</em></td>
<td>1</td>
<td>5.9</td>
<td>2.6</td>
<td>2.7</td>
<td>3.9</td>
</tr>
<tr>
<td>Feathers</td>
<td>1</td>
<td>5.9</td>
<td>2.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Syntermes</em> sp.</td>
<td>1</td>
<td>5.9</td>
<td>2.6</td>
<td>2.7</td>
<td>3.9</td>
</tr>
<tr>
<td>Non-identified hair</td>
<td>2</td>
<td>11.8</td>
<td>5.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Oc, occurrence in number of scats; Rf, relative frequency of all food items recorded; TB, total biomass of each vertebrate prey item ingested (kg); RB, relative biomass for each vertebrate item ingested.
tic dogs to detect bush dog feces would probably be an excellent method to find scats in the field and perhaps even the pack inside the den, because bush dogs normally defecate in its surroundings (E.S. Lima personal observation). Because of this, the search for feces should be concentrated in the proximities of potential bush dog dens, not on roads or tracks.

**Conclusions**

The RPPN-SESC Pantanal should be considered an important area for future studies of the bush dog. Based on the data collected in this study, it seems to be frequent in the northern and eastern sections of the Reserve. The use of foot/leg traps may provide positive results in capturing bush dogs, but an effective method for capturing the species still needs to be established. According to our analysis, bush dogs used all available habitat types of the RPPN-SESC Pantanal in equal proportion. Nine-banded armadillos (Dasypus novemcinctus) were the principal food item in the diet of bush dogs in the RPPN-SESC Pantanal in percentage of occurrence as well as in terms of relative ingested biomass. Other items seemed to have little importance in the composition of their diet, suggesting the species to be authentically carnivorous, predating mainly on medium-sized prey. Efforts by researchers and governments are essential for conservation and management of wildlife, especially of this poorly known species.

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