



Medium and large-sized mammals in a remnant forest in the state of Rondônia, Brazil

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Resumen

La fauna mamífera brasileña está amenazada por varios factores, los principales de origen antropogénico, como la agricultura, la ganadería y la caza. Los mamíferos medianos y grandes se ven continuamente afectados por estos factores. En este contexto, realizamos un inventario y estimamos la abundancia de mamíferos medianos y grandes en un bosque remanente periurbano particular en la ciudad de Porto, Rondônia. Atraves de transectos lineales, señales indirectas y entrevistas, registramos 21 especies de mamíferos, de las cuáles hay cuatro en categoría de amenaza. Las reservas forestales privadas tienen el potencial de conservar especies en peligro de extinción, por lo que deben priorizarse las acciones que favorezcan la conexión de estas áreas en el medio rural.

Palabras clave: Selva amazónica, Fragmentación, Reserva privada.

Abstract

The Brazilian mammalian fauna is threatened by several factors, the main ones being anthropogenic origins, such as agriculture, cattle ranching, and hunting. Medium and large mammals are continually affected by these factors. In this context, we conducted an inventory and estimated the abundance of medium and large mammals in a particular peri-urban remnant forest in the city of Porto, Rondônia. Fieldwork was carried out involving 88 kilometers of census during the daytime, indirect signs research, and interviews. We recorded 21 species of mammals. Private forest reserves have the potential to conserve endangered species, and therefore, actions that favor the connection of these areas in the rural environment should be prioritized.

Key words: Amazon rainforest, Fragmentation, Private Reserve.

Brazilian biodiversity is threatened by anthropogenic factors (Wearn *et al.*, 2012), that have severe impacts on mammalian communities (Benítez-López *et al.*, 2017). The main threats are habitat loss and fragmentation as a result of crop and cattle activities (ICMBio, 2018). Habitat fragmentation, combined with hunting pressure, has become a major challenge for forest environment conservation, depending on the ability of the species to adapt to altered environments (Buchmann *et al.*, 2013). The maintenance of relatively intact and well-connected forest remnants is essential for faunal persistence in fragmented tropical forest landscapes (Michalski & Peres, 2007). However, fragments smaller than 0.1 km² are known to have an impoverished mammalian fauna and low chances of survival (Benchimol & Peres, 2015; Medeiro *et al.*, 2019), and hunting is one of the aggravating factors in the decline and disappearance of species in fragmented landscapes (Melo *et al.*, 2015).

Forests located on private rural properties have the potential to contribute to mammal biodiversity conservation (Negrões *et al.*, 2010; Cavalcante *et al.*, 2018), and are important habitats for the maintenance of endemic and endangered species (Gatti *et al.*, 2017). Thus, these spaces should be studied to understand how they may contribute to biodiversity maintenance and to the creation of measures to minimize the effects of fragmentation (Negrões *et al.*, 2010).

Our objective was to survey and calculate the relative abundance of medium and large mammals in a peri-urban forest fragment of the southwestern Brazilian Amazon. The study was conducted at the Kanindé Culture and Training Center (KCTC), located in a private remnant forest of 1.29 km² in the peri-urban area, 14 km from the city of Porto Velho, Rondônia, located in the Amazon biome at an altitude of 121 m above sea level (8°53'54" S; 63°54'18" W – WGS84) (Figure 1). During the study, the presence of hunters in the study area was verified through indirect observations such as the presence of traps, encounters with hunters, and shootings. The forest remnant is surrounded by a matrix of pasture and crops and is an open ombrophilous forest type, which is characterized by a discontinuous canopy with an understory of a high density of regenerating plants (Fernandes & Guimarães, 2002). According to the Köppen classification system, the climate is characterized as AM, distinguished by an average annual rainfall between 2 000 and 2 300 mm, having an average annual temperature between 24 °C and 27 °C (Mendonça & Danni-Oliveira, 2007).

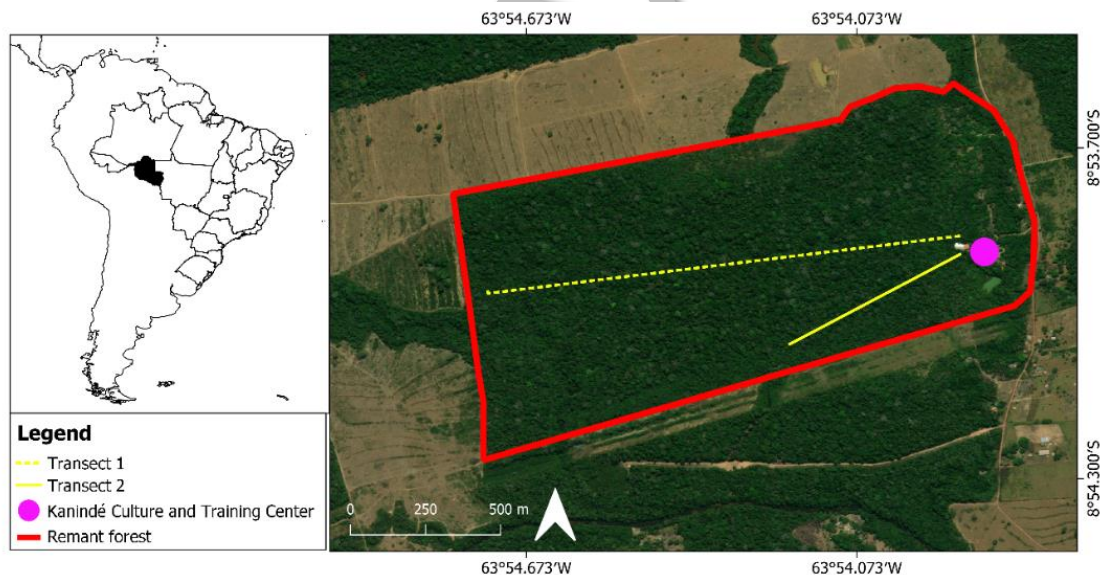


FIGURE 1. Location of Kanindé Culture and Training Center.

The survey of medium and large-sized mammals was carried out from October 2017 to October 2018, totaling 24 days of sampling. There was no difference in the sighting rate as a function of seasonality. The census was conducted twice a month, and each trail was walked on different days. We used direct and indirect records. Direct records included sightings derived from the linear transect method (Burnham *et al.*, 1980), a transect one (T1) with 1 600 m and transect two (T2) with 600 m. The transects were covered on foot at a standard speed of 1.5 km/h from 6:00h to 12:00h. For each sighting, the following data were recorded: species and number of individuals. The indirect records included all records documented outside the census period; these included tracks, feces, interviews with other researchers and KCTC visitors, and sightings by the team outside of the census.

We calculated the abundance of direct records using the following formula: Relative abundance = $n/(D \times 10)$, where n is the number of sightings recorded on the route and D equals the distance covered in ten kilometers (Chiarello, 1999). To assess sampling effort, rarefaction and species extrapolation curves were constructed with a 95% confidence interval of 100 repetitions using the bootstrap resampling method. Diversity, rarefaction curves, and extrapolated species richness values were calculated using the iNEXT package (Hsieh *et al.*, 2020) in R 3.5.3 (R Development Core Team, 2021).

The field guides of Emmons (1997) and Eisenberg & Redford (1999) were used for species identification. For taxonomic classification, we followed the method described by Byrne *et al.* (2016), Rylands *et al.* (2016) and Abreu *et al.* (2021). The conservation status of each species was obtained from the Chico Mendes Institute for Biodiversity Conservation (MMA, 2022) and the International Union for the Conservation of Nature Version 2021-1 (IUCN, 2021). In a total of 88 kilometers of census, we recorded 21 species of mammals, of those three in the threat category according to IUCN (Table 1).

TABLE 1. Record of the number of (NS), number of individuals (N), and abundance (AB) of medium and large-sized mammals from the Kanindé Culture and Training Center. Methods used in the research: T = tracks; SO = sighting opportunity; ST = sighting in the transect. Threat status: VU= vulnerable and EN= endangered.

Taxon	Common name	Record	NS(N)/ AB	IUCN	ICMBio
Didelphimorphia					
<i>Didelphis marsupialis</i>	Common opossum	SO	-	-	
Cingulata					
<i>Dasyopus novemcinctus</i>	Nine-banded armadillo	T/ST	1(1)/0.001	-	-
<i>Dasyopus beniensis</i>	Greater long-nosed armadillo	T	-	-	-
<i>Cabassous unicinctus</i>	Southern naked-tailed armadillo	SO	-	-	-
Primates					
<i>Alouatta puruensis</i>	Puru red howler	SO	-	-	-
<i>Ateles chamek</i>	Peruvian spider monkey	SO	-	EN	VU
<i>Aotus nigriceps</i>	Black-headed night monkey	SO	-	-	-
<i>Mico rondoni</i>	Rondon's marmoset	SO	-	VU	VU
<i>Leontocebus weddelli</i>	Weddell's saddle-back tamarin	ST	2(23)/0.3	-	-
<i>Saimiri ustus</i>	Bare-eared squirrel monkey	ST	6(59)/0.7	-	-
<i>Sapajus apella</i>	Brown capuchin	ST	8(58)/0.7	-	-
<i>Pithecia mittermeier</i>	Mittermeier's Tapajós saki	ST	1(4)/0.004	DD	-
<i>Plecturocebus brunneus</i>	Brown titi	SO	-	VU	VU
Rodentia					
<i>Dasyprocta variegata</i>	Agouti	ST	3(3)/0.003	-	-
Carnivora					
<i>Eira barbara</i>	Tayara	SO	-	-	-
<i>Nasua nasua</i>	South American coati	SO	-	-	-
<i>Leopardus pardalis</i>	Ocelot	T/SO	-	-	-
<i>Puma concolor</i>	Puma	T	-	-	VU
<i>Panthera onca</i>	Jaguar	T	-	-	VU
Certiodactyla					
<i>Dicotyles tajacu</i>	Collared peccary	T	-	-	-
<i>Tayassu pecari</i>	White-lipped peccary	T	-	VU	VU

According to the species extrapolation calculation, the increased effort would not result in the listing of additional species. The rarefaction curve reached the asymptote and the effort employed was sufficient to sample the richness (Figure 3).



FIGURE 2. Mammalian species recorded in the Kanindé Culture and Training Center and surroundings. A) *Cabassous unicinctus*, B) *Saimiri ustus*, C) *Plecturocebus brunneus*, D) *Leontocebus weddelli*.

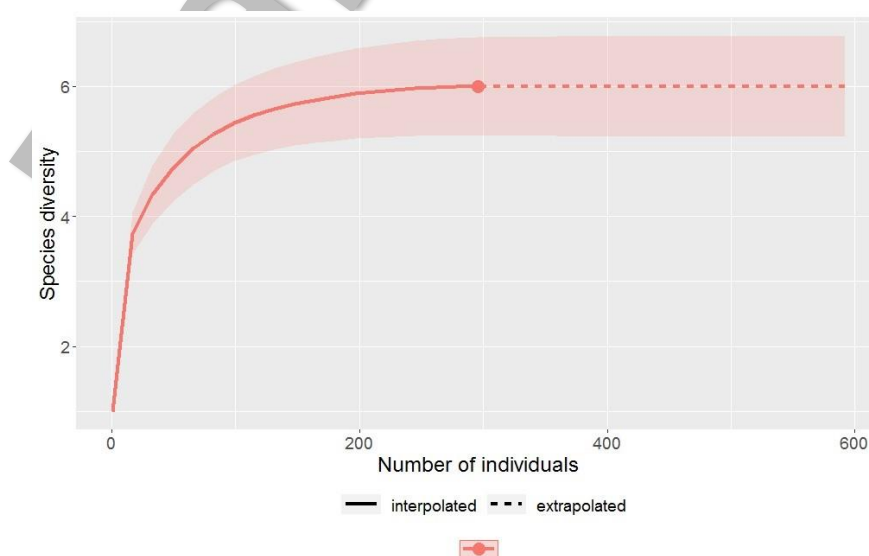


FIGURE 3. Rarefaction curve of medium and large mammal species recorded at the Kanindé Culture and Training Center, Porto Velho, Rondônia.

The number of mammals we found were substantial compared to Medeiros *et al.* (2019), whose study, conducted in forest fragments in the state of Rondônia, recorded nine mammal species using linear transects, feces, and tracks. The vulnerable species compiled were the same as those in the present study. The observed richness was similar to that observed by Ferronato *et al.* (2018), who recorded 23 mammal species in a continuous forest management area of 73 079.15 hectares. This shows the importance of forest fragments, such as those we surveyed, to guarantee the presence of mammals, especially in places with high deforestation rates, similar to the state of Rondônia (Gusmão *et al.*, 2014; Cavalcante *et al.*, 2018).

Among the registered species, *Mico rondoni* is classified as Vulnerable. This primate species is endemic to the state of Rondônia (Ferrari *et al.*, 2010) and occurs at low density (Messias & Valença-Montenegro 2018; Ferronato *et al.*, 2018). *Saimiri ustus* and *Sapajus apella* were the most abundant species. Their predominance can be explained by the high plasticity in the diets of the species which are considered generalist species with high adaptation capacity in areas with disturbance (Pinheiro *et al.*, 2018; Oliveira *et al.*, 2019). The third highest abundance rate was found in *L. weddelli*, which exhibits high flexibility and adaptability in vegetation with a regenerative structure, a feature that is compatible with its small size and edge effect formation (Sussman & Kinzey, 1984).

Pithecia mittermeier was the primate species with the lowest abundance rate and possibly occurs in low abundance in forest remnants (Gusmão *et al.*, 2014; Cavalcante *et al.*, 2018). Indirect records were obtained for *Alouatta puruensis* and *Ateles chamek*, large species that are targeted for hunting. Hunting is the main threat to the persistence of atelid populations in Rondônia (Belfort *et al.*, 2020; Ramos *et al.*, 2020; Oliveira *et al.*, 2022).

The white-lipped peccary (*Tayassu pecari*) is one of the most targeted species for slaughter and meat consumption through hunting, whereas the collared peccary (*Dicotyles tajacu*), also a hunted species, adapts to environmental changes by inhabiting low-hunting regimes (Gomes, 2017). Hunting preferentially focuses on larger mammals (Alves & van Vliet, 2018; Oliveira *et al.*, 2022). This preference reflects a cost-benefit ratio to maximize meat production with less effort in addition to palatability, with an emphasis on ungulates and large rodents (Ramos *et al.*, 2020). Together, these factors may pose a threat to maintaining populations of both *T. pecari* and *D. tajacu* in a fragmented landscape with hunting pressure. For Cingulata, the only record was that of the nine-banded armadillo, which is possibly a reflection of the principal habits of nocturnal and crepuscular species, which are not conventionally recorded using the method adopted in the present study (Santos *et al.*, 2019).

Another aspect is that armadillos, such as the agoutis, require smaller home ranges and are less susceptible to the effects of hunting (Ramos *et al.*, 2008), which may favor their enumeration, although both species are targets for hunting. Similarly, we had a few records, three, of *Dasyprocta variegata*. *Dasyprocta* is highly adaptable to forest fragments (Boyle & Smith 2010; Santos-Filho *et al.*, 2012). The few records of terrestrial mammals are a reflection of the method used which was more suited to recording arboreal species (NCR, 1981). Remnant forests are important and need to be maintained and conserved, as they are relevant for the conservation of mammals and may harbor a part of the overall biodiversity (Botelho *et al.*, 2018; Shanne *et al.*, 2020; Silva *et al.*, 2021). However, there is a need to create ecological corridors between other remnants to ensure gene flow and to meet the ecological demands of the species (Pardini *et al.*, 2005; Boyle & Smith, 2010).

ACKNOWLEDGMENTS

To Kanindé Ethno-Environmental Defense Association. We dedicate this research to the memory of Elcy Bandeira. To the reviewers and editors for their contributions to the improvement of the article.

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Editor: Diego J. Lizcano
 Recibido: 2021-03-26
 Revisado: 2021-04-15
 Aceptado: 2021-04-28
 Publicado: 2021-06-04