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# Large and medium-sized mammals of the Humaitá Forest Reserve, southwestern Amazonia, state of Acre, Brazil

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**Abstract:** Large and medium-sized mammals are essential to forest ecosystems as they are responsible for prey population control, seed dispersal and predation. A mammal survey was conducted in the Humaitá Forest Reserve (HFR), a 20 km$^2$ forest fragment located in the southeastern part of the state. The survey was carried out using census transects, camera traps, and occasional records such as bones and footprints. In all, 27 species of large to medium-sized mammals were recorded for the RFH, representing 48% of those expected for the region. *Dasyprocta fuliginosa*, *Pecari tajacu* and *Didelphis marsupialis* were the species with the highest number of records with camera traps. The occurrence of two species of cats (*Leopardus pardalis* and *Puma concolor*) and three endangered species (*Callimico goeldii*, *Myrmecophaga tridactyla* and *Priodontes maximus*) are important records for the RFH. The results may aid future research on the ecology, biogeography and conservation of mammals in the region.

## Introduction

Large and medium-sized mammals (weight >1 kg, primates and members of the family Sciuridae) play a fundamental role in the functioning of Amazonian ecosystems, such as prey population control and dispersion/predation of seeds. Moreover, they are an important source of protein and fat for human populations who live outside urban centers (Redford and Robinson 1987; Dirzo and Mendoza 2007; Stoner *et al*. 2007; Estes *et al*. 2011). Despite their great ecological importance, large and medium-sized mammals have been poorly studied in the state of Acre, and the available works focused on rapid surveys (e.g. Calouro 1999), assessments of the effects of subsistence hunting on mammals (e.g. Calouro and Marinho-Filho 2005; Rosas and Drumond 2007), and studies of primate autoecology (e.g. Bicca-Marques and Garber 2003; Rehg 2006).

Acre is a state of extreme importance for the conservation of mammals because 86.87% of its area is still covered by forests (INPE 2010). The state has an estimated mammal richness of 203 species (SEMA 2010), representing 29% of the total of Brazilian mammals (Paglia *et al*. 2012), and more than half of its territory is considered an area of "extreme" and "very high" biological importance for biodiversity conservation (Souza *et al*. 2003).

Although Acre is among the Amazonian states that maintains most of its original vegetation cover, the eastern region of the state has been extensively deforested and its forests fragmented. Habitat destruction and hunting are the main threats to large and medium-sized mammals, causing significant changes in the richness and abundance of species living in fragmented environments (Chiarello 1999; Peres 2001; Rosser and Mainka 2002). However, fragmented environments are seen as key elements for the recovery of landscapes, since they harbor most of the native biodiversity of the region (Viana and Pinheiro 1998), making the retention of certain species viable, which is more than that observed in completely deforested areas (Turner and Corlett 1996).

Thus, knowledge of the local fauna is the first step to enable future conservation policies, and provide basic information for more complex ecological and biogeographical studies. Thus, the aim of this study was to produce an inventory of the species of large and medium-sized mammals at Humaitá Forest Reserve, and to estimate their relative abundance using camera traps.

## Materials and Methods

*Study Area*

The Humaitá Forest Reserve (HFR) has a total area of approximately 20 km$^2$, with altitudes ranging from 130 m to 179 m. The HFR belongs to the Universidade Federal do Acre (UFAC) and is located in the municipality of Porto Acre (9°43' - 9°48' S; 67°33' - 67°48' W), state of Acre, northwestern Brazil. The HFR has a rectangular shapen (in its lateral limits, when viewed from above) and has two parallel tracks, approximately 12 km in length, which are about 2,000 m apart. The area is surrounded by the Humaitá Settlement Project as well as small farms. The Acre River limits the eastern border of the HFR (Figure 1). The climate is classified as Am (Köppen), and has an average rainfall of 1,944 mm and a mean temperature of 26°C (Duarte 2005).

The vegetation of the HFR has a clear structural difference with regard to the dominance of the arboreal component, suggesting a vegetation gradient along the toposequence plateau, the slope and the lowland. On the plateau the dominant vegetal formation is open forest with bamboo (*Guadua weberbaueri*) while on the lowland

there is a dominance of open forest with palms (Barroso *et al*. 2011).

*Data Collection*

The survey of mammals of the HFR was carried out using two sampling methods at different times: observation trails in the years 1999 and 2000, and camera trapping during 2009 and 2010. Observations were made along 5 km of track trails marked on the edges of the reserve. During observations, the time, date, and number of species and individuals sighted were recorded. Fieldwork was performed in the morning, usually starting at 6 am and ending at mid-day (NRC 1981; Peres 1999). In all, 220 km were traveled in the months of October, November and December 1999 and May and June 2000.

Camera traps were also placed on the tracks bordering the HFR and, because they are old tracks (built over 20 years ago), the number of catches was maximized (Karanth and Nichols 1998). We used six camera traps TIGRINUS ANALOG 6.0 tied on trees at a height of 30 cm from the soil, and the locality was baited with sardines in oil and slices of bacon. The traps operated 24 hours per day, with the interval between two photographs set at 30 s. Sampling points were set up for 15 to 30 days, at a distance of 500 m to 1,000 m from one another. During the rainy season (December to March) sampling was concentrated on the western portion of the fragment, since movement throughout most of the area was prevented by flooded streams.

The total collection effort was calculated by multiplying the number of cameras used by the number of days that those were functioning, obtaining the result in trap-nights. Thus from October 2009 to August 2010 the total effort was 850 trap-nights.

During fieldwork with the camera traps, occasional records such as sightings, trails and collection of hair and bones (materials in good condition were deposited in the Zoological Collection of Mammals - CZM UFAC) were used to complement the list of large and medium-sized mammals of the fragment. The taxonomic nomenclature follows the recent list of mammals of Brazil published by Paglia *et al.* (2012).

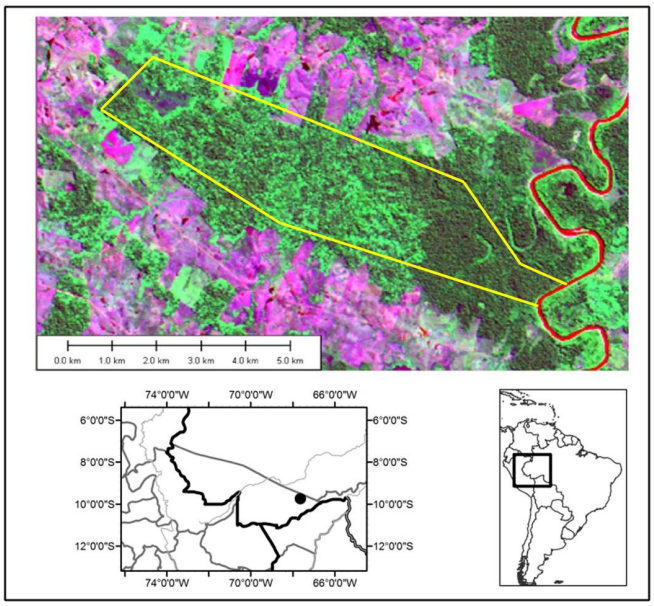


**Figure 1.** Location ofthe Humaitá Forest Reserve (HFR), municipality of Porto Acre, Acre, Braziland Acre River (in red). (Landsat image granted by FUNTAC/2008).

## Results and Discussion

In 1999 and 2000, 15 species of large and medium-sized mammals were recorded along the observation trails. In 2009 and 2010 twenty-one species were recorded, ten of which with camera traps. Therefore, between the two phases of data collection, 27 species of large and medium-sized mammals were recorded in the HFR (Table 1).

Of the few mammal inventories carried out in the state of Acre, the one performed by Calouro (1999) is noteworthy. During a rapid ecological assessment the author recorded 43 species of large and medium-sized mammals in the Serra do Divisor National Park (600 km away from HFR), one of the protected areas with greatest species richness of large and medium-sized mammals in the Neotropics.

Surveys of mammals using camera traps are still rare in the Amazon basin (Trolle 2003; Martins *et al*. 2007; Tobler *et al*. 2008; Negrões *et al*. 2011). Trolle (2003) recorded 13 species of mammals with six camera traps in his study in the Xixuaú Nature Reserve in the state of Roraima, Brazil. Tobler *et al*. (2008), with a total effort of 2,340 trap-nights, recorded 27 species of mammals with camera traps in the Peruvian Amazon and demonstrated the efficiency of the use of camera traps for large and medium-sized mammal inventories. The large number of species recorded by Tobler *et al*. (2008), compared to that found in the HFR in the present study, is probably due to the greater sampling effort and to the fact that the study was conducted in a continuous area (1,400 km$^2$), not in a forest fragment as in the HFR, since the larger the area, the more species are expected to occur on the site (MacArthur and Wilson 1967).

For the region where the HFR is located, 56 species of large and medium-sized mammals are expected to occur, according to the geographical distribution described in Rowe (1996), Emmons and Feer (1997), Eisenberg and Redford (1999), Gardner (2007) and Wilson and Mittermeier (2009). Thus, the 27 species recorded in the present study represent only 48.2% of the species that possibly occur in the area. When only the species recorded with the camera traps were analyzed, it was noted that 27.7% of the 36 species of terrestrial or arboreal-terrestrial mammals expected for the region were recorded. Thus, it is possible that with more effort using camera traps, new species might be recorded in the area. However, some species that are relatively easy to record, such as *Tapirus terrestris* (Linnaeus, 1758) and *Tayassu pecari* (Link, 1795), seem to have become extinct in the area probably as a result of hunting pressure that occurs in the region (Cullen *et al*. 2000; Michalski and Peres 2007; Salvador *et al*. 2010). Although not confirmed by interviews with residents, hunting pressure at the HFR is evident, as during the study several hunting dogs were recorded on the camera traps and some used shotgun shells were also found.

The primates with highest relative abundance (number of groups/10 km traveled) recorded in the 1999 and 2000 censuses were *Saguinus weddelli* and *Callicebus cupreus*.

The lowest relative abundance of primates recorded in the HFR was of *Aloutta puruensis* (Table 2). The Purús Red Howler Monkey was recorded only once during the surveys in 1999 and 2000, and during activities with camera traps the species was not seen and there was no record of vocalization. This may suggest a possible population depletion or even a local extinction of the species in the area, since large primates are particularly sensitive to habitat fragmentation and hunting pressure on Amazon (Peres 1997; Peres 2001; Michalski and Peres 2005). New sampling visualization tracks and interviews with people living around the reserve can confirm the hypothesis of the disappearance of the species in the area.

The relative abundance of mammals recorded by camera traps is shown in Table 2. The species with the largest number of records were *Dasyprocta fuliginosa, Pecari tajacu* and *Didelphis marsupialis* (Figure 2).

Studies that calculate relative abundance in the Amazon are still scarce (Martins *et al*. 2007; Tobler *et al*. 2008; Negrões *et al*. 2011). A comparison between our study and the study of Tobler *et al.* (2008), in southeastern Peru (table 2), shows three species (*Cuniculus paca, Dasyprocta fuliginosa* and *Leopardus pardalis*) with relative abundance noticeably superior to that found in HFR. Despite the fact that these significant differences may be due to fragmentation and hunting effects in the HFR (Chiarello 1999; Cullen *et al*. 2000; Cullen *et al*. 2001; Peres 2001), extrapolations from studies that are based on the relative abundance obtained from camera traps are not recommended because of the lack of standardization


**Figure 2.** Some mammals at the Humaitá Forest Reserve (HFR) that were photographed using camera traps. A: *Dasyprocta fuliginosa*. B: *Pecari tajacu*. C: *Leopardus pardalis*. D: *Priodontes maximus*. E: *Tamandua tetradactyla*. F: *Didelphis marsupialis*.

of such methods (Kasper *et al*. 2007; O'Brien 2010).

We recorded five species of carnivores in the HFR, *Leopardus pardalis* and *Eira barbara* being the ones that were recorded with the camera traps. The ocelot is a meso-predator, directly influencing the diversity of its prey (Fonseca and Robinson 1990), as well as influencing the abundance of other medium-sized felines (Oliveira *et al.* 2010). In the IUCN (International Union for Conservation

**Table 1.** Species of large and medium-sized mammals recorded for the Humaitá Forest Reserve (Acre, Brazil) and types of records: photographic record (P), trail visualization (V), bones (B) and footprints (F). IUCN categories: Data Deficient (DD) Least Concern (LC), Vulnerable (VU).

| TAXON | COMMON NAME | PERIOD OF RECORD | TYPE OF RECORD | IUCN STATUS |
|---|---|---|---|---|
| **ARTIODACTYLA** | | | | |
| **Cervidae** | | | | |
| *Mazama americana* (Erxleben, 1777) | Red brocket deer | 2009-2010 | **F; B** | **DD** |
| *Pecari tajacu*(Linnaeus, 1758) | Collared peccary | 1999-2000; 2009-2010 | **P; B; V** | **LC** |
| **CARNIVORA** | | | | |
| **Felidae** | | | | |
| *Leopardus pardalis* (Linnaeus, 1758) | Ocelot | 2009-2010 | **P** | **LC** |
| *Puma concolor* (Linnaeus, 1771) | Cougar | 2009-2010 | **V** | **LC** |
| **Mustelidae** | | | | |
| *Eira barbara* (Linnaeus, 1758) | Tayra | 1999-2000; 2009-2010 | **V; P** | **LC** |
| **Procyonidae** | | | | |
| *Nasua nasua* (Linnaeus, 1766) | Coati | 1999-2000; 2009-2010 | **V** | **LC** |
| *Potos flavus* (Schreber, 1774) | Kinkajou | 1999-2000 | **V** | **LC** |
| **CINGULATA** | | | | |
| **Dasypodidae** | | | | |
| *Dasypus novemcinctus* Linnaeus, 1758 | Nine-banded armadillo | 2009-2010 | **P; F** | **LC** |
| *Priodontes maximus* (Kerr, 1792) | Giant armadillo | 2009-2010 | **P** | **VU** |
| **DIDELPHIMORPHIA** | | | | |
| **Didelphidae** | | | | |
| *Didelphis marsupialis* Linnaeus, 1758 | Black-eared opossum | 2009-2010 | **P** | **LC** |
| **PILOSA** | | | | |
| **Megalonychidae** | | | | |
| *Choloepus* sp. Illiger, 1811. | Two-toed sloth | 2009-2010 | **B*** | **LC** |
| **Myrmecophagidae** | | | | |
| *Myrmecophaga tridactyla* Linnaeus, 1758 | Giant anteater | 2009-2010 | **V** | **VU** |
| *Tamandua tetradactyla* (Linnaeus, 1758) | Lesser anteater | 2009-2010 | **P** | **LC** |
| **PRIMATES** | | | | |
| **Atelidae** | | | | |
| *Alouatta puruensis* Lönnberg, 1941 | Purús Red Howler Monkey | 1999-2000 | **V** | **LC** |
| **Callitrichidae** | | | | |
| *Callimico goeldii* (Thomas, 1904) | Goeldi's Monkey | 1999-2000 | **V** | **VU** |
| *Saguinus weddelli weddelli* (Deville, 1849) | Saddle-back tamarin | 1999-2000; 2009-2010 | **V** | **LC** |
| *Saguinus imperator imperator* (Goeldi, 1907) | Emperor tamarin | 1999-2000; 2009-2010 | **V** | **LC** |
| **Cebidae** | | | | |
| *Cebus unicolor* Spix, 1823 | Spix's White-fronted Capuchin | 1999-2000 | **V** | **LC** |
| *Saimiri boliviensis* (I. Geoffroy and de Blainville, 1834) | Bolivian squirrel monkey | 1999-2000; 2009-2010 | **V** | **LC** |
| *Sapajus macrocephalus* (Spix, 1823) | Large-headed Capuchin | 1999-2000 | **V** | **LC** |
| **Pitheciidae** | | | | |
| *Callicebus cupreus* (Spix,1823) | Red titi monkey | 1999-2000; 2009-2010 | **V** | **LC** |
| *Pithecia irrorata* Gray, 1842 | Gray's Bald-faced Saki | 1999-2000 | **V** | **LC** |
| **RODENTIA** | | | | |
| **Caviidae** | | | | |
| *Hydrochoerus hydrochaeris* (Linnaeus, 1766) | Capybara | 2009-2010 | **P** | **LC** |
| **Cuniculidae** | | | | |
| *Cuniculus paca* (Linnaeus, 1766) | Spotted paca | 2009-2010 | **P** | **LC** |
| **Dasyproctidae** | | | | |
| *Dasyprocta fuliginosa* Wagler, 1832 | Black agouti | 1999-2000; 2009-2010 | **P; V** | **LC** |
| **Erithizontidae** | | | | |
| *Coendou prehensilis* (Linnaeus, 1758) | Brazilian Porcupine | 1999-2000; 2009-2010 | **B** | **LC** |
| **Sciuridae** | | | | |
| *Urosciurus* cf. *spadiceus* Olfers, 1818 | Southern Amazon red squirrel | 1999-2000; 2009-2010 | **V** | **LC** |

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of Nature) red list, the species is listed as of least concern (IUCN 2012). In the Red Book of Brazilian Endangered Animals, only a subspecies of ocelot (*L. p. mitis*), that does not occurs in the state of Acre, is considered threatened (Chiarello *et al*. 2008).

Another cat recorded in the area was *Puma concolor*. This species was observed only once during the study period. Despite its wide geographic distribution, populations of *P. concolor* from northeastern, southern and southeastern Brazil are threatened with extinction (Chiarello *et al*. 2008) The presence of the puma is important for the HFR as it is a key species for maintaining ecosystems and being threatened by habitat destruction (Terborgh *et al*. 2001; Sana and Cullen 2008). Despite the ecological value of the puma, records of these species in the area cause concern due to possible problems between man and predator, since conflicts between large cats and ranchers near forest fragments are recurrent (Michalski *et al*. 2006; Palmeira and Barrella 2007; Oliveira *et al*. 2012).

The record of *Priodontes maximus* may have been facilitated by the existence of food taboos amongst hunters in the state of Acre. The food taboo refers to beliefs in some cultures, in which some animals are discarded because of food preferences or cultural beliefs (Ross 1978). The giant armadillo (Figure 2) is hunted outside the state of Acre (Peres 2000), but in this region there is a food taboo that states that if a person kills a giant armadillo someone in their family will die (Calouro and Marinho-Filho 2005). Thus, these forms of food taboos and beliefs may be helping to conserve this species in the fragment and the state.

**Table 2.** Relative abundance of primates groups in the RFH.

| SPECIES | GROUPS/10 KM TRAVELED |
|---|---|
| *Alouatta puruensis* | 0.04 |
| *Callicebus cupreus* | 0.64 |
| *Callimico goeldii* | 0.09 |
| *Cebus unicolor* | 0.32 |
| *Sapajus macrocephalus* | 0.27 |
| *Pithecia irrorata* | 0.36 |
| *Saguinus weddelli* | 0.82 |
| *Saguinus imperator* | 0.36 |
| *Saimiri boliviensis* | 0.41 |

**Table 3.** Species recorded with camera traps in the Humaitá Forest Reserve (Acre, Brazil) and respective relative abundance[1].

| SPECIES | N. OF RECORDS AT HFR | RELATIVE ABUINDANCE[1] | |
|---|---|---|---|
| | | HFR | SOUTHEASTERN PERU[2] |
| *Cuniculus paca* | 3 | 3.5 | 14.1 |
| *Dasyprocta fuliginosa* | 10 | 11.8 | 20.5* |
| *Hydrochoerus hydrochaeris* | 1 | 1.2 | - |
| *Tamandua tetradactyla* | 1 | 1.2 | 0.9 |
| *Dasypus novemcinctus* | 1 | 1.2 | 0.9 |
| *Priodontes maximus* | 2 | 2.4 | 3 |
| *Leopardus pardalis* | 3 | 3.5 | 13.2 |
| *Eira barbara* | 1 | 1.2 | 3.4 |
| *Pecari tajacu* | 3 | 3.5 | 8.1 |
| *Didelphis marsupialis* | 7 | 8.2 | 6.8 |

[1] Number of records/ camera trap-nights x 1000. [2] Tobler *et al.* 2008. * Individuals of the same genus.

The list of species presented here contributes significantly to the knowledge of the fauna of the HFR. Studies such as this are important to guide future work on ecology and biogeography of the species recorded herein especially those threatened with extinction. Therefore, the preliminary knowledge of large and medium-sized mammals featured in this article will serve as a starting point for the development of ecological research to investigate the effects that habitat fragmentation and poaching have on the community of mammals in the region of the Humaitá Settlement Project.

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