**UNIVERSIDADE FEDERAL DE MINAS GERAIS**
**Instituto de Ciências Biológicas**
**Pós-graduação em Ecologia, Conservação e Manejo da Vida Silvestre**

Rodolfo Assis Magalhães

# MAMÍFEROS PRIORITÁRIOS PARA CONSERVAÇÃO E USO DE HÁBITAT PELO TATU-BOLA EM UMA ÁREA ANTROPIZADA NO NORDESTE DO BRASIL

Belo Horizonte
2020

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Dissertação apresentada ao Programa de Pós-graduação em Ecologia, Conservação e Manejo da Vida Silvestre (ECMVS) da Universidade Federal de Minas Gerais (UFMG), como requisito parcial à obtenção do título de mestre em Ecologia, Conservação e Manejo da Vida Silvestre.

Orientador (a): Prof. Dr. Flávio Henrique Guimarães Rodrigues.

Co-orientadores: Profa. Dra. Maria Auxiliadora Drumond e Dr. Rodrigo Lima Massara.

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No dia 21 de fevereiro de 2020, às 14:00 horas, na sala 171, bloco D3 do Instituto de Ciências Biológicas da Universidade Federal de Minas Gerais, teve lugar a defesa de dissertação de mestrado no Programa de Pós-Graduação em Ecologia, Conservação e Manejo da Vida Silvestre, de autoria do(a) mestrando(a) Rodolfo Assis Magalhães, intitulada: **"Mamíferos prioritários para conservação e uso de hábitat pelo tatu-bola em uma área antropizada no Nordeste do Brasil"**. Abrindo a sessão, o(a) orientador(a) e Presidente da Comissão, Doutor(a) Flávio Henrique Guimarães Rodrigues, após dar a conhecer aos presentes o teor das normas regulamentares do trabalho final, passou a palavra para o(a) candidato(a) para apresentação de seu trabalho. Estiveram presentes a Banca Examinadora composta pelos Doutores: Ana Maria de Oliveira Paschoal (Instituto Serradical), Adriano Pereira Paglia (UFMG) e demais convidados. Seguiu-se a arguição pelos examinadores, com a respectiva defesa do(a) candidato(a). Após a arguição, apenas os senhores examinadores permaneceram no recinto para avaliação e deliberação acerca do resultado final, sendo a decisão da banca pela:

(X) Aprovação da dissertação, com eventuais correções mínimas e entrega de versão final pelo orientador diretamente à Secretaria do Programa, no prazo máximo de 30 dias;
( ) Reavaliação da dissertação com avaliação pelos membros da banca do documento revisado, sem nova defesa, no prazo máximo de 30 dias, sob possibilidade de reprovação;
( ) Reformulação da dissertação com indicação de nova defesa em data estabelecida a critério do Colegiado em observância às Normas Gerais da Pós-graduação na UFMG a ao Regimento do PPG-ECMVS;
( ) Reprovação

Nada mais havendo a tratar, o Presidente da Comissão encerrou a reunião e lavrou a presente ata, que será assinada por todos os membros participantes da Comissão Examinadora.

Belo Horizonte, 21 de fevereiro de 2020.

Assinaturas dos Membros da Banca Examinadora

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Dedico,
Em poesia,
À causa:
A vinga
Sem queda,
Sem pausa,
Do tatu-bola da Caatinga
(Rodolfo Assis Magalhães)

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# RESUMO

O planejamento para conservação baseia-se tipicamente em dados espaciais de distribuição de elementos da biodiversidade suficientemente bem conhecidos (*i.e.,* substitutos de biodiversidade), mas uma efetiva conservação só é alcançada ao se considerar fatores sociais que podem influenciar o sucesso das ações de conservação, bem como ao se entender a biologia dos organismos a serem protegidos. Entretanto, ainda existe uma carência de informações sobre a biologia e conservação de espécies ameaçadas, como o tatu-bola *Tolypeutes tricinctus*. Aqui, nós objetivamos: (i) identificar espécies prioritárias para conservação, baseado nos seus status de conservação oficiais nas interações humano-fauna (*i.e.,* etnozoologia) na comunidade rural de Sumidouro no nordeste do Brasil; e (ii) investigar o uso de hábitat por *T. tricinctus* na mesma área. Nós utilizamos armadilhas fotográficas, busca ativa e um conjunto de métodos participativos, incluindo entrevistas semiestruturadas, para avaliar a diversidade e etnozoologia dos mamíferos (potenciais espécies-chaves culturais - ECC, espécies carismáticas/populares, malquistas/impopulares e mais caçadas) para a priorização. Nós usamos armadilhas fotográficas, busca ativa e modelos de ocupação para explorar a influência de fatores ecológicos e metodológicos, incluindo características do hábitat relacionadas à presença humana, nas probabilidades de ocupação e detecção de *T. tricinctus*. Nós priorizamos 11 espécies para conservação, das quais consideramos *Panthera onca* e *Tolypeutes tricinctus* as principais prioridades, devido aos seus status de conservação mais preocupantes. Também priorizamos *Mazama* sp., espécie considerada mais caçada e mais popular, assim como uma potencial ECC no passado em Sumidouro. Devido à grande popularidade e nível de ameaça, consideramos *T. tricinctus* e *Mazama* sp. as espécies mais recomendadas para serem usadas como espécies bandeira para conservação. Sobre o uso de hábitat por *T. tricinctus*, encontramos sua probabilidade de ocupação alta e constante na área de estudo. Enquanto isso, sua probabilidade detecção foi influenciada pelo método de amostragem, sendo aproximadamente 10 vezes maior por busca ativa do que por armadilhamento fotográfico. Assim, nós observamos que *T. tricinctus* pode ser amplamente distribuído em paisagens antropizadas. Nós também reforçamos a necessidade de se combinar diferentes métodos de amostragem e considerar vieses de detecção para produzir inferências confiáveis sobre processos ecológicos. Baseado na ampla distribuição e alta popularidade de *T. tricinctus* na área de estudo, juntamente com seu status de ameaça preocupante, acreditamos que esta população da espécie seja prioritária para projetos de conservação e de pesquisa. Nós também ressaltamos a necessidade e viabilidade da conservação de *Mazama* sp. em nossa área de estudo, bem como a necessidade de projetos de coexistência humano-fauna para promover a conservação de *Panthera onca*, a espécie mais ameaçada e impopular em Sumidouro. A porção oeste da nossa área de estudo é uma Área Prioritária para Conservação da Biodiversidade que abriga uma alta diversidade de mamíferos e agora possui parte das oportunidades para sua conservação conhecidas. Assim, apoiamos o desenvolvimento de ações de conservação nesta área, incluindo políticas públicas (*e.g.,* Áreas Protegidas). Finalmente, enfatizamos a importância de se engajar as comunidades locais em ações de conservação e projetos de pesquisa para alcançar melhores resultados para ambos.

**Palavras-chaves:** Caatinga, Ciência Cidadã, Etnobiologia, Floresta Tropical Sazonalmente Seca; Seleção de Hábitat.

**ABSTRACT**

Conservation planning relies typically on spatial data on the distribution of sufficiently known elements of biodiversity (*i.e.,* biodiversity surrogates), but an effective conservation may only be achieved by considering social factors that can influence the success of conservation actions as well as by understanding the biology of the organisms to be protected. However, there is still a lack of information on the biology and conservation of threatened species, such as the Brazilian three-banded armadillo *Tolypeutes tricinctus*. Here, we aimed to: (i) identify priority species for conservation based on their official conservation status and the human-fauna relationships (*i.e.,* ethnozoology) in the rural community of Sumidouro, northeastern Brazil; and (ii) investigate the habitat use by *T. tricinctus* in the same area. We used camera traps, active searching and a set of participatory methods, including semi-structured interviews, to assess mammal diversity and ethnozoology (potential cultural keystone species - CKS, charismatic/popular and disliked/unpopular species, and most hunted species) for prioritization. We used camera traps, active searching and occupancy models to explore the influence of ecological and methodological factors, including human-related habitat features, on the occupancy and detection probabilities of *T. tricinctus*. We prioritized 11 species for conservation, of which we considered *Panthera onca* and *Tolypeutes tricinctus* top-priorities, due to their especially worrying conservation status. We also prioritized *Mazama* sp., because it was considered the most hunted and popular species as well as a potential CKS in the past. Due to their great popularity and high level of threat, we considered *Tolypeutes tricinctus* and *Mazama* sp. the most recommended species to be used as flagships for conservation. Regarding habitat use by *T. tricinctus*, we found its occupancy probability high and constant throughout the study area. Meanwhile, its detection probability was influenced by the sampling method, being almost 10 times greater by active searching than camera trapping. Therefore, we found that *T. tricinctus* may be widely distributed in anthropized areas. We also reinforced the need for combining different sampling methods and take detection bias into account to draw reliable inferences about ecological processes. Based on the widespread distribution and the great popularity of *T. tricinctus* in our study area, together with its worrying conservation status, we believe this population of the species is a priority for conservation actions and research projects. We also highlight the need and feasibility of the conservation of *Mazama* sp. in our study area, as well as the need for human-fauna coexistence projects to promote the conservation of *Panthera onca*, the most threatened and unpopular animal in Sumidouro. The west portion of our study area is a Priority Area for Biodiversity Conservation that holds a high mammal diversity and that now has part of its local opportunities for conservation known. Hence, we advocate the development of conservation actions there, including public policies (*e.g.,* Protected Areas). Finally, we emphasize the importance of engaging local communities into conservation actions and research projects to achieve better outcomes for both.

**Key-words:** Caatinga, Citizen science, Ethnobiology, Habitat Selection, Seasonally Dry Tropical Forest.

## SUMÁRIO

# 1. INTRODUÇÃO GERAL

As atividades humanas têm ameaçado ou já causaram a extinção de diversas espécies em todo o mundo (IUCN, 2019; Johnson et al., 2017). Para mitigar tais perdas de biodiversidade, uma série de esforços têm sido desenvolvidos em contrapartida. Eles incluem esforços voltados à prevenção ou regulação de atividades humanas potencialmente poluidoras (*e.g.*, avaliação de impacto ambiental; AIA) (SÁNCHEZ; GALLARDO, 2005), mas também aqueles que buscam recuperar ou manter a biodiversidade, os quais integram, respectivamente a Ecologia da Restauração e Ciência da Conservação (KAREIVA; MARVIER, 2012; MCDONALD et al., 2016).

Esses esforços não são mutuamente excludentes e requerem planejamento para serem colocados em prática. O planejamento, por sua vez, requer que decisões sejam tomadas de forma bem fundamentada para a devida alocação de recursos, quaisquer que sejam, como humanos ou financeiros, por exemplo (GAME; KAREIVA; POSSINGHAM, 2013). Dado que os recursos disponíveis para esses esforços são limitados, o processo de fundamentação das tomadas de decisão requer que sejam estabelecidas prioridades para o direcionamento de esforços (GAME; KAREIVA; POSSINGHAM, 2013), como espécies ou áreas prioritárias para serem alvos de ações de conservação. No caso de espécies, por exemplo, tradicionalmente a identificação de espécies prioritárias para o direcionamento de esforços de conservação se dá por meio de avaliações de risco de extinção (ARPONEN, 2012).

O planejamento para conservação, seja para a identificação de áreas ou de espécies para serem alvos de ações de conservação, por exemplo, tradicionalmente não considera fatores sociais que podem influenciar o sucesso de implantação dessas ações (MILLER et al., 2006; BAN et al., 2013). A desconsideração desses fatores sociais, portanto, afeta negativamente a efetividade das ações de conservação implantadas, ao não contemplar as sociedades humanas e suas culturas como elementos da biodiversidade que podem ser suficientemente bem conhecidos e incorporados ao planejamento e implementação de ações de conservação (KNIGHT; COWLING; CAMPBELL, 2006; BAN et al., 2013). Contudo, mais recentemente, maior atenção tem passado a ser dada ao papel das comunidades humanas no processo de planejamento de ações de conservação, levando a uma mudança gradual de paradigma (KNIGHT; COWLING; CAMPBELL, 2006; BAN et al., 2013).

Outro fator limitante para a efetividade das ações de conservação é a ausência de informações sobre a distribuição da biodiversidade (RODRIGUES; BROOKS, 2007;

OLIVEIRA et al., 2017) e da biologia de muitas espécies, como ressaltado para uma série de espécies avaliadas quanto ao seu risco de extinção por IUCN (2019).

Uma forma eficiente de se adquirir informações sobre as espécies compreende a investigação de sua etnobiologia (e especificamente etnozoologia quando em se tratando de animais), que se refere ao conhecimento tradicional que as comunidades humanas possuem a respeito das espécies com as quais interagem (ALVES, 2012). Informações sobre distribuição e história natural das espécies podem ser obtidas, subsidiando ações de conservação, como estratégias de manejo (DRUMOND; GUIMARÃES; DA SILVA, 2015). Nesse contexto, o uso de métodos participativos é de vital importância não só para o entendimento das percepções de integrantes dessas comunidades, obtidas, por exemplo, via entrevistas, mas também devido ao valor que seus conhecimentos tradicionais têm para a coleta de informações sobre as espécies de interesse em campo (DRUMOND; GIOVANETTI; GUIMARÃES, 2009; DRUMOND; GUIMARÃES; DA SILVA, 2015).

A pesquisa etnozoológica pode também ser utilizada para a identificação de espécies que devem ser priorizadas para ações de conservação, ainda que elas não estejam ameaçadas de extinção em um dado momento em escalas de avaliação mais abrangentes (estadual, nacional, global). Espécies podem ser priorizadas para conservação em contextos locais em virtude da importância que elas apresentam para a cultura e a sobrevivência de determinadas comunidades humanas (*i.e.,* espécies-chaves culturais) (Bonifácio, Freire, & Schiavetti, 2016) e/ou devido à existência de grandes ameaças locais a essas espécies, como a sobre-exploração via caça em uma determinada localidade (ALVES, 2012; BONIFÁCIO; FREIRE; SCHIAVETTI, 2016). Por outro lado, espécies que causam prejuízos às pessoas e afetam negativamente seus modos de vida podem ser malquistas e impopulares em determinadas localidades, como mamíferos carnívoros (Treves and Karanth 2003). Nesse sentido, a pesquisa etnozoológica pode subsidiar estratégias para evitar e mitigar conflitos, bem como aumentar a aceitabilidade de ações de conservação direcionadas a essas espécies (BOWEN-JONES; ENTWISTLE, 2002; ALVES, 2012; REDPATH et al., 2013).

Aliada à pesquisa etnozoológica, a análise quantitativa de dados das espécies de interesse em vida livre permite a obtenção de informações acuradas sobre suas distribuições e os fatores que as afetam. Com isso, é possível melhor entender a ecologia das espécies (*e.g.,* Massara et al. 2016), recomendar ações para a conservação de suas populações (*e.g.,* Massara et al. 2018) e subsidiar a identificação de áreas prioritárias para conservação, utilizando-se dados de distribuição delas no âmbito do Planejamento Sistemático para Conservação (MARGULES; PRESSEY, 2000; MARGULES; PRESSEY; WILLIAMS, 2002).

Contudo, muitos métodos analíticos não levam em conta a detecção imperfeita (ou falsas ausências) gerada pelos métodos de amostragem, o que pode levar a conclusões equivocadas a respeito dos processos ecológicos em estudo (MACKENZIE et al., 2018). No contexto da priorização de áreas para conservação, a escassez de dados de distribuição das espécies, somada ao uso de informações que não levam em conta a detecção imperfeita, podem favorecer possíveis vieses em direção à priorização de áreas onde as espécies são melhor documentadas ou mais facilmente detectadas, como os locais de mais fácil acesso (MARGULES; PRESSEY; WILLIAMS, 2002; OLIVEIRA et al., 2017). Assim, a geração de novas informações sobre a distribuição das espécies é desejável e até mesmo necessária (OLIVEIRA et al., 2017), e também em escalas geográficas mais refinadas, utilizando dados de presença-ausência, os quais podem ser analisados por meio de modelos de ocupação em estudos sobre uso de hábitat, por exemplo (MACKENZIE et al., 2018).

Diante do exposto, neste trabalho, nós buscamos identificar espécies prioritárias para a conservação em uma comunidade rural localizada no estado da Bahia, nordeste do Brasil, e avaliar o uso de hábitat pelo tatu-bola *Tolypeutes tricinctus*. Essa espécie se encontra atualmente ameaçada de extinção e que já havia sido detectada em trabalhos preliminares nesta localidade. *T. tricinctus* é o único tatu endêmico do Brasil e um dos menos conhecidos, estando atualmente classificado como Em Perigo de extinção, principalmente devido à caça e à perda de hábitat (REIS et al., 2015; CASSANO et al., 2017). A caça pode ser especialmente danosa às populações de *T. tricinctus* devido à facilidade de captura e transporte de indivíduos da espécie. Tal facilidade deriva do pequeno porte e da capacidade única das espécies do gênero *Tolypeutes* de se enrolarem como uma bola como estratégia de defesa contra predação, permanecendo imóveis nessa posição (SANTOS et al., 1994). Já a perda de hábitat é tida como uma das maiores ameaças à espécie em virtude da alta degradação de hábitats nativos na Caatinga e especialmente no Cerrado (REIS et al., 2015), os dois únicos domínios fitogeográficos onde *T. tricinctus* ocorre (FEIJÓ et al., 2015).

A área onde conduzimos este trabalho compreende as comunidades de Sumidouro, Baixio e Boa Vista, localizadas no município de Brotas de Macaúbas, estendendo-se até o município de Oliveira dos Brejinhos. Essa área situa-se no domínio da Caatinga (SILVA et al., 2017), mas em uma região de transição com o domínio do Cerrado (ARAÚJO, 2015). Trata-se de uma área não protegida, onde a vegetação nativa consiste basicamente em

Caatinga arbóreo-arbustiva (*i.e.,* floresta tropical sazonalmente seca), e os ambientes antropizados compreendem a infraestrutura de três parques eólicos adjacentes (*e.g.,* aerogeradores, linhas de transmissão, escritórios), estradas, cultivos agrícolas em regeneração e as comunidades propriamente ditas.

Esta dissertação está dividida em dois capítulos redigidos em inglês e na forma de manuscritos a serem submetidos aos periódicos científicos *Journal for Nature Conservation* e *Journal of Mammalogy*, respectivamente. No primeiro capítulo, intitulado *Combining scientific and traditional knowledge to identify priority mammals for conservation in an unprotected seasonally dry forest* nós objetivamos identificar espécies de mamíferos e prioritárias para a conservação, por meio do inventário da mastofauna e sua etnozoologia na comunidade de Sumidouro. Já no segundo capítulo, intitulado *Habitat use by the Brazilian three-banded armadillo: revealing generalist habits of a threatened species*, nós objetivamos investigar fatores ambientais, antropogênicos e metodológicos que potencialmente influenciam as probabilidades de ocupação e detecção de *T. tricinctus*.

Para o primeiro objetivo, referente ao primeiro capítulo, nós esperávamos que as espécies prioritárias para conservação pudessem abranger aquelas de alta importância cultural, caso essa importância se revelasse suficientemente alta, além de espécies ameaçadas de extinção, de acordo com avaliações de risco de extinção disponíveis para diferentes escalas. Para o segundo objetivo, referente ao segundo capítulo, nós esperávamos que elementos abióticos, como características do solo, elementos bióticos, como a fitofisionomia, e pressões humanas, como a presença de aerogeradores, influenciassem o uso de hábitat por *T. tricinctus*.

# 2. CAPÍTULO 1 - Combining scientific and traditional knowledge to identify priority mammals for conservation in an unprotected seasonally dry forest


**Abstract**

Species prioritization for conservation relies mainly on extinction risk assessments, but less on sociocultural factors that potentially influence conservation effectiveness. We used a standardized protocol that included camera traps, active searching and interviews to prioritize mammals for conservation by assessing their diversity (species inventory and perceived abundance) and ethnozoology (potential cultural keystone species - CKS, charismatic/popular, disliked/unpopular and most hunted species) in the rural community of Sumidouro, northeastern Brazil. We recorded 31 species, of which we expanded the known distributions of *Lycalopex vetulus* and *Cabassous tatouay*. We prioritized 11 species for conservation based on their conservation status and ethnozoology, being *Panthera onca* and *Tolypeutes tricinctus* top-priority species. *Panthera onca* is Critically Endangered and was considered the most disliked/unpopular, and thus the most probably susceptible to retaliatory killing. *Tolypeutes tricinctus* is Endangered and was perceived as abundant and charismatic/popular, thus, we considered it a potential flagship species for conservation. We also prioritized *Mazama* sp., although it is not at risk of extinction, because it was considered the most hunted and charismatic/popular species, and a possible CKS in the past. Consequently, we prioritized *Mazama* sp. to be used as a flagship species for conservation as well. Our results show that accounting for ethnobiology in conservation assessments allows a better understanding of the need and the opportunities for species' conservation at local scales, potentially leading to a more successful implementation of actions. We conclude that rapid biodiversity and ethnobiology assessments can be conciliated to simultaneously assess species occurrences and the opportunities for their conservation in a given planning area.


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**Key-words:** Caatinga; Citizen science; Ethnobiology; Human-wildlife coexistence; Poaching; Wind farm.

**Introduction**

Biodiversity conservation requires planning to inform resource-allocation decisions for implementing actions (GAME; KAREIVA; POSSINGHAM, 2013). Conservation planning relies mainly on spatial data on biodiversity distribution but less on data about human societies and their relationships with the environment (KNIGHT; COWLING; CAMPBELL, 2006; BAN et al., 2013). The incorporation of social information, such as cultural preferences and political structure into conservation planning is historically an exception, and such lack of information is now being recognized as a factor that preclude the effective implementation of conservation actions worldwide (BAN et al., 2013). Because biodiversity is not completely known anywhere, and data on its distribution are scarce or even biased for many areas (RODRIGUES; BROOKS, 2007), standardized social-ecological approaches are important not only for understanding biodiversity distribution, but also to provide its effective conservation in different socio-ecological contexts (BAN et al., 2013).

Given the incomplete knowledge on biodiversity, conservation planning is based on surrogates, which are related to the available data, such as better-known taxa, land classes, and they are assumed to be effective for the conservation of the entire biodiversity (RODRIGUES; BROOKS, 2007). Specifically, in Systematic Conservation Planning, they are used to prioritize areas for conservation (MARGULES; PRESSEY, 2000). As some taxa are well known and a growing number of species are at risk of extinction, species are a common element of biodiversity used as biodiversity surrogates, being generally the focus of conservation actions (FAVREAU et al., 2006; RODRIGUES; BROOKS, 2007; ARPONEN, 2012). In fact, species can be prioritized for various purposes, but independently, the prioritization should follow pre-defined, clear criteria (*i.e.,* prioritization scheme), which depend on the objectives of the developing actions (ARPONEN, 2012; GAME; KAREIVA; POSSINGHAM, 2013).

The prioritization of species to be the focus of conservation actions is typically based on measures of extinction risk (ARPONEN, 2012), but it is not necessarily related to the best resource allocation alternatives to provide positive outcomes (MILLER et al., 2006; ARPONEN, 2012; GAME; KAREIVA; POSSINGHAM, 2013). Not only biological aspects need to be considered during priority setting, but also the social aspects, such as local cultural preferences that constitute opportunities for conservation that may affect its effectiveness (MILLER et al., 2006; KNIGHT; COWLING, 2007). Then, the prioritization must consider the goals and the expected cost-effective ratio of each planned conservation action (ARPONEN, 2012; GAME; KAREIVA; POSSINGHAM, 2013)

In this sense, factors that make species or sub-sets of taxa priorities for conservation may vary at different geographic extents or contexts and, thus, those taxa that should be prioritized at broader scales are not necessarily the same when considering finer scales, and vice-versa (BOWEN-JONES; ENTWISTLE, 2002; ARPONEN, 2012). Some hunted species, for example, may play a pivotal role in shaping people's cultural identity and in providing their survival (*i.e.,* cultural keystone species - CKS; GARIBALDI; TURNER, 2004) and, therefore, can be prioritized for conservation due to their local vulnerability and the better acceptance of its conservation by local people, such as by the possibility of their sustainable use. Conversely, species that negatively impact people's livelihoods, by livestock predation or crop raiding, for example, may not be appropriate to be used as flagship species, even if they are at risk of extinction. These species may have weak conservation acceptance by the local people and their prioritization may emerge conservation conflicts (BOWEN-JONES; ENTWISTLE, 2002; REDPATH et al., 2013). Therefore, the assessment of the human-fauna relationships (*i.e.,* ethnozoology) can inform conservation planners to evaluate the requirements and the opportunities for species conservation case by case, enhancing its effectiveness (KNIGHT; COWLING, 2007; ALVES, 2012).

Medium and large sized mammals (>1 kg) are often targeted for conservation due to their potential to be used as biodiversity surrogates, the relative large body of knowledge on their biology (RODRIGUES; BROOKS, 2007), their importance for ecosystem functioning (LACHER et al., 2019), their vulnerability to habitat loss and hunting (BENÍTEZ-LÓPEZ et al., 2017; CROOKS et al., 2017), and their present close relationships with humans (ALVES, 2012). Nevertheless, many mammal species are still at risk of extinction or at least present populations in decline (IUCN, 2019), demonstrating the persistent need for conservation actions towards this group.

Despite of the Brazil's great mammal diversity, there are still sites that have not been adequately surveyed, even within protected areas (COSTA et al., 2005; OLIVEIRA et al., 2017). Specifically, the Caatinga is an exclusively Brazilian domain (SILVA et al., 2017) that is historically neglected for investments in scientific research and conservation actions (LEAL et al., 2005; SANTOS et al., 2011), despite being historically subjected to biodiversity loss derived from unsustainable human activities (*e.g.,* slash-and-burn agriculture, hunting, livestock) (LEAL et al., 2005). In the Caatinga, advances in the knowledge on mammals did not encompass many areas, indicating a lack of information of which species should be prioritized for conservation (CARMIGNOTTO; ASTÚA, 2017).

We aimed to identify priority medium to large-sized mammals for conservation according to their conservation status and ethnozoology in a human-modified landscape in the Caatinga of northeastern Brazil. We expected that priority species would not be necessarily those officially at risk of extinction according to the official lists of threatened species but could also include those that may present relevant relationships with people (*e.g.,* CKS, the most hunted species, charismatic/popular and disliked/unpopular species). Specifically, we used a standardized combination of camera traps, active searching, and a set of participatory methods, including semi-structured interviews, to assess mammal diversity and ethnozoology.

## Material and Methods

### *Study Area*

This study was carried out in the rural community of Sumidouro, in the municipality of Brotas de Macaúbas, state of Bahia, northeastern Brazil (Figure 1). Sumidouro is located in a transitional zone between the Caatinga and Cerrado domains (ARAÚJO, 2015; SILVA et al., 2017). The native vegetation consists of seasonally dry tropical forests of the Caatinga in contact with savannas of the Cerrado and Rupestrian grasslands. The human-related habitat features comprise temporary crops, pastures, abandoned croplands under regeneration, residences, and a complex of three adjacent wind farms. Although situated in the Brazilian semiarid region, the climate in Sumidouro is altitude tropical (SEI, 2014), and comprises rainy (November-March) and dry (April-October) seasons (ARAÚJO, 2015).

### *Collection of Ethnozoological Data*

We conducted semi-structured interviews with residents of Sumidouro from April to July 2019 (BERNARD, 2006). These interviews comprised topics about socioeconomic profile (gender, age, length of residence in the region, and profession) and the perception of informants about the relationships between people of Sumidouro and the native animals (*i.e.,* ethnozoology) (Appendix 1).

Regarding ethnozoology, semi-structured interviews comprised topics about animals in general and specifically about mammals. For mammals, the semi-structured interviews addressed an inventory of mammals of the region and those perceived as most abundant by the informants. For all animals in general, we asked for the species considered especially important for the culture and survival of people of Sumidouro (the potential CKS), the most popular and unpopular animals, and for the most hunted animals.

We considered popular and unpopular animals as those for which people have affection or disaffection, respectively. In this sense, popular species were the most charismatic ones and thus, those with the greatest potential to be used as conservation flagships (ALBERT; LUQUE; COURCHAMP, 2018). We assumed that the most unpopular animals would be those most susceptible to retaliatory killing.

For the topics about mammal inventory, most abundant mammals, popular and unpopular animals, and most hunted animals we collected data as free-lists. This free-listing method is used to collect lists of items, such as species, in interviews by assuming that: (i) people tend to list terms in order of familiarity; (ii) list length is positively related to the individual's knowledge on the subject; (iii) the more frequent an item is mentioned, the more prominent it is in that cultural domain (QUINLAN, 2005).

For the mammal inventory, we requested free-lists of animal species in general, and then we excluded non-mammalian species from the lists, resulting in free-lists of mammals only. We did that because we noticed, in a pilot study, that asking for "mammals" or using descriptions of mammal external characters (*e.g.,* presence of fur, hull or snout) biased the species listed and the order they were listed by informants. Also, we only included in the mammal inventory those species correctly described by the informants to minimize the occurrence of the loose talk phenomena, which occurs when people can name and talk about more items from a cultural domain than they can really identify (GATEWOOD, 1983). Hence, after the end of the free-lists in the mammal inventory, we presented a series of pictures of mammals that could potentially occur in the region, including melanic phenotypes, and then we asked informants to name and identify the species that they recognized as occurring there. Thus, we could also assess the mammal species that do not necessarily correspond to the scientific ones, which are derived from folk taxonomy (ethnospecies).

We selected informants using the snowball technique, a non-probabilistic sampling method in which new informants are indicated by those already interviewed, until the same people are indicated (*i.e.,* saturation) (VINUTO, 2014). We used, as selection criteria, individual field experience in natural habitats of the region and/or substantial knowledge about native animals (BERNARD, 2006). We also interviewed local residents that considered themselves as having enough knowledge to be included, as well as those we had contact and perceived that presented great knowledge on native animals.

During the period we conducted the semi-structured interviews, we also performed informal interviews with residents of Sumidouro as a complementary method to acquire additional qualitative data on the topics we were interested (ALVES; GONÇALVES; VIEIRA, 2012). We discussed and legitimized the information gathered with local informants at a workshop, in which we presented the information obtained by semi-structured interviews and checked its veracity with the audience (DRUMOND; GIOVANETTI; GUIMARÃES, 2009). The workshop was held at the headquarters of the Sumidouro and Baixio Rural Producers Association in July 2019.

During the period of data collection, we had key-informants with who we checked the information we obtained and/or participated of the active searches as field assistants. They presented substantial knowledge about animals of the region and they have established trusty relationships with the researchers.

This study was approved by the Ethics Committee of the Federal University of Minas Gerais (n. 05294018.2.0000.5149) and all interviews were preceded by an explanation about the study, its aims and scope.

*Data collected by camera trapping and active searching*

For the mammal inventory, besides the semi-structured interviews, we sampled 24 randomly selected camera sites in an area of 53 km² (Figure 1). All camera sites were at 1.5 km apart from each other and one camera was placed at each of 24 sites. We installed cameras 40 cm above the ground, and set them to operate for 24 hours per day with one-minute interval between videos. Sampling occurred during approximately 90 days, between April and July 2019. However, some cameras did not work well throughout the whole sampling period, due to operational defects, resulting in a total sampling effort of 2047 trap-days. We also conducted active searches for direct and indirect evidences of mammals in a 10-m-radius buffer around each camera site during the camera trap installation, checking (about 45 days after installation) and removal as well as along trails and roads dispersed throughout the study area. We included in our mammal inventory data obtained by camera trapping and active searching from two 15-day field surveys conducted between August-September 2017 and between October-November 2019 in the same study area.

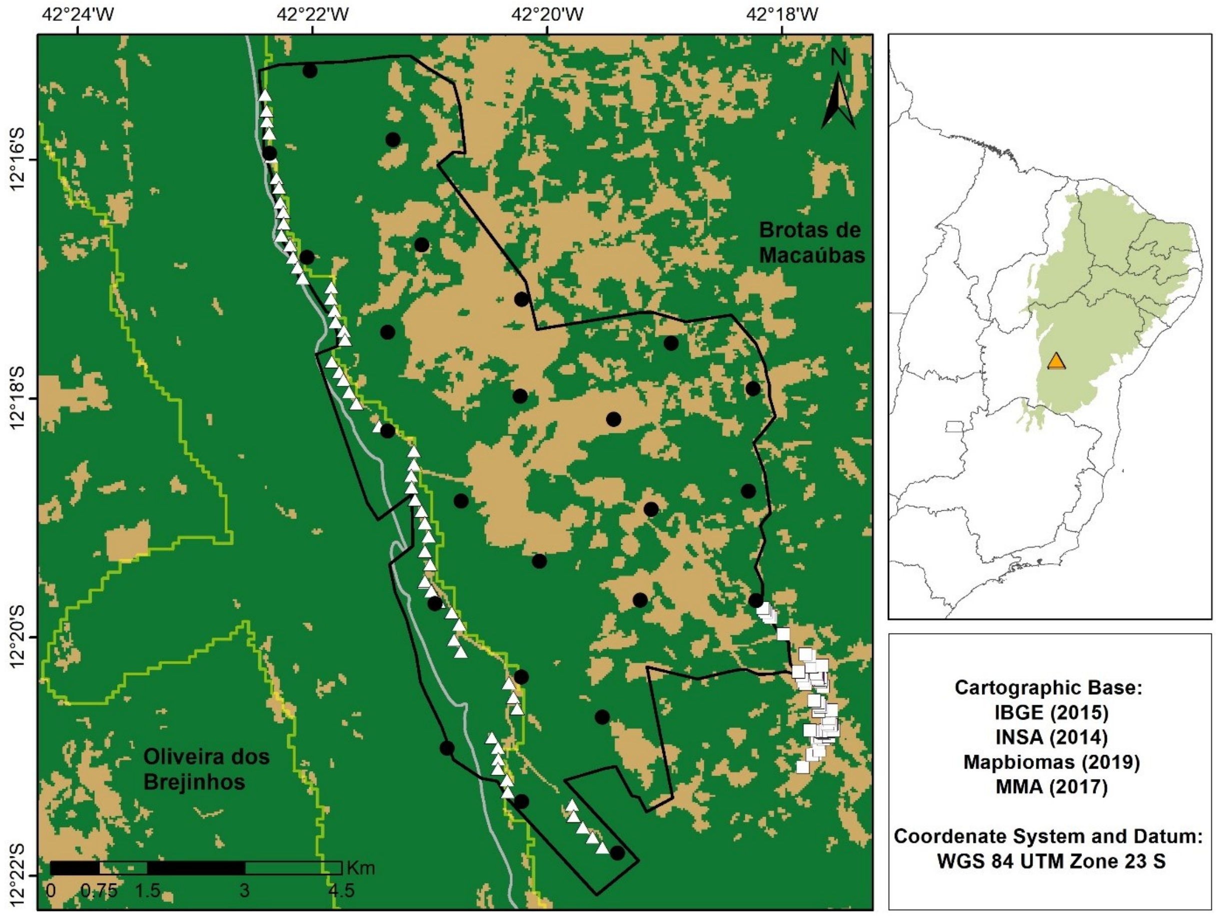


**Figure 1. Location of the study area (black line polygon) including Sumidouro community (residences represented by white squares) in the municipalities of Brotas de Macaúbas and Oliveira dos Brejinhos (divided by a solid grey line) in Bahia state, northeastern Brazil. The black dots are camera trap sites; white triangles are wind turbines The green background represents natural forests and savannas, the light brown background represents natural and anthropogenic open areas, and they are according to Mapbiomas (2019). The polygon outlined in light green is a Priority Area for Biodiversity Conservation, according to (BRASIL, 2017). The insert shows the geographic distribution of the Caatinga (shaded area) according to INSA (2014), and the location of the study area (orange triangle) in relation to Brazilian states, which follows IBGE (2015).**

*Data Analysis*

For data collected as free-lists, we calculated the Smith's Salience Index (Salience) in program Anthropac 4.0 (BORGATTI, 1990). This index measures the consensus level on a subject among informants, accounting for the number of interviews in which an item is cited (*i.e.,* frequency of citation) and the position of an item in the lists (SMITH, 1993; SMITH; BORGATTI, 1997). The higher the frequency of citation and the position in the lists the higher is the Salience of an item. Salience varies between a minimum value given by the reciprocal of list length (1/L) and a maximum at one (SMITH; BORGATTI, 1997). To measure the consensus about the potential role of animal species as CKS, we used only the frequency of citation.

In the question about mammal inventory, after the conclusion of the free-lists (*i.e.,* during the presentation of the mammal pictures), the informants realized that more species not previously mentioned by them occurred in the region, as they saw pictures of the species. Although these species were not free listed, they were cited by the informants during the interviews, allowing us to calculate the frequency of citation of them, but not their Salience values. We verified whether the Salience index of free listed species and the frequency of citation of all the species cited during the mammal inventory (free listed or not) were correlated by using the Pearson's correlation test. Because we found a strong positive correlation between Salience and frequency of citation ($r = 0.76$; $p < 0.05$), we used only the frequency of citation as the measure of consensus about the occurrence of mammal species in the region to compose the mammal inventory. Consequently, we effectively used Salience only for the questions about the most abundant, the popular, the unpopular and the most hunted species. Identification and taxonomic nomenclature of the mammal species followed the Mammal Diversity Database (BURGIN et al., 2018).

We opted for a qualitative species prioritization scheme to provide reliable and fast support for species conservation in our study area. Despite being simple and more subjective, qualitative criteria are less likely to be unused due to lack of data, as they require less quantitative information for decision-making, which are harder to obtain (ARPONEN, 2012; GAME; KAREIVA; POSSINGHAM, 2013). We prioritized species for conservation based on their level of threat, their local social relevance, and the acceptance of their conservation by the residents of Sumidouro. Firstly, we evaluated the need for conservation actions towards the maintenance and recovery of their local populations based on the level of threat on them and their social relevance. For this, we used: (i) the assessments made by Cassano et al. (2017) for the state of Bahia, Brasil (2014) and ICMBio (2018a, 2018b) at the national level, and IUCN (2019) at the global level, to obtain the worse conservation status of each species; (ii) the hunting pressure, based on the most hunted species in Sumidouro, and; (iii) the social relevance of the species as being potential CKS there. In other words, the higher the level of threat (*i.e.,* conservation status and hunting pressure) and the social relevance of a species, the higher its priority for conservation. Next, we evaluated the feasibility of the conservation of the species through the acceptance of their conservation in the local context. For this, we used the assessments of CKS, popular and unpopular species we made by semi-structured interviews. Finally, we combined the level of threat of the species (*i.e.,* conservation status and hunting pressure), their potential as CKS, and their popularity to prioritize species to be used as flagships for conservation actions to be carried out in the area (BOWEN-JONES; ENTWISTLE, 2002).

**Results**

We conducted 30 interviews. Informants were mostly male farmers (n = 28); the average age was 56 years; and average residence time in the region was 47 years. The only two women of our sample were not indicated by other informants; one considered herself as having enough knowledge to be interviewed, and the other was included because we noticed that she fitted the selection criteria.

We recorded 31 species, being 30 recorded by interviews and 19 recorded by camera trapping or active searching (Table 1; Appendix 2). *Mazama* sp. was the most frequently cited species in the semi-structured interviews (n = 28; 97%).

During the mammal inventory, informants identified some species using folk names that, as long as we know, have not been cited in the literature before. Some of them were prevalent in informants' vocabulary: *gato-macaial* for *Leopardus pardalis* (n = 13; 100%) and *caminheiro* (the walker) for *Procyon cancrivorus* (n = 4; 100%) (Appendix 3).

Some informants recognized two or more ethnospecies for the same scientific species, according to their body sizes (for armadillos of the genus *Dasypus;* three ethnospecies); fur characteristics (for some native felids; two ethnospecies for each scientific species); and predation behavior (specifically for *Puma concolor*, but without physical characteristics that differentiates the two mentioned ethnospecies) (Appendix 3). Conversely, some informants did not distinguish *Cerdocyon thous* from *Lycalopex vetulus* during the identification task, referring to both of them as the ethnospecies *raposa*. However, other informants differentiated these species, recognizing only *Cerdocyon thous* as occurring in Sumidouro (Table 1; Appendix 3).

For the other topics of the semi-structured interviews, the number of respondents varied. Regarding perception of abundance, 26 (93%) of 28 informants provided free-lists of most abundant mammals, whereas two (7%) did not know the answer (Table 2). *Mazama* sp. and *Tolypeutes tricinctus* were considered the most abundant species (S = 0.476, S = 0.404, respectively), and the reported motivation for this classification was the frequency of encounters (detection).

**Table 1. Inventory of mammals of Sumidouro community, Bahia state, northeastern Brazil. Number of citations (frequency of citations) refers to the number and frequency of citation of each scientific species identified during semi-structured interviews conducted with residents of Sumidouro between April and July 2019. * - priority species for conservation, based on their need for conservation actions and feasibility of their conservation. Type of record - Bu (Burrow); Ct (Camera trapping); Fc (Feces); Fp (footprint); In (Interview); Si (Sighting); Th (Thorn). Conservation status - CR (Critically Endangered); DD (Data Deficient); EN (Endangered); LC (Least Concern); NT (Neat Threatened); VU (Vulnerable). Conservation status are from Cassano et al. (2017) for the state of Bahia, MMA (2014) and ICMBio (2020) at the national level, and IUCN (2019) at the global level.**

| Species | Number of citations (frequency of citations) | Type of record | Conservation status | | |
|---|---|---|---|---|---|
| | | | Bahia | Brazil | IUCN |
| **Didelphimorphia** | | | | | |
| Didelphidae | | | | | |
| *Didelphis albiventris* | 17 (59%) | In, Ct | - | - | LC |
| **Pilosa** | | | | | |
| Myrmecophagidae | | | | | |
| *Myrmecophaga tridactyla* * | 21 (72%) | In, Ct, Fp | VU | VU | VU |
| *Tamandua tetradactyla* | 21 (72%) | In | - | - | LC |
| **Cingulata** | | | | | |
| Chlamyphoridae | | | | | |
| *Euphractus sexcinctus* | 25 (86%) | In, Ct | - | - | LC |
| *Cabassous tatouay* | 19 (66%) | In, Ct | DD | DD | LC |
| *Tolypeutes tricinctus* * | 25 (86%) | In, Ct, Si, Fp, Bu | EN | EN | VU |
| Dasypodidae | | | | | |
| *Dasypus novemcinctus* | 24 (83%) | In, Ct, Fp | - | - | LC |
| *Dasypus septemcinctus* | 19 (66%) | In | - | - | LC |
| **Artiodactyla** | | | | | |
| Cervidae | | | | | |
| *Mazama* sp. * | 28 (97%) | In, Ct, Fp, Si | - | - | - |
| Tayassuidae | | | | | |
| *Pecari tajacu* * | 24 (83%) | In | NT | - | LC |
| **Primates** | | | | | |
| Callitrichidae | | | | | |
| *Callithrix penicillata* | 21 (72%) | In, Si | - | - | LC |
| Cebidae | | | | | |
| *Sapajus* sp. | 2 (7%) | In | - | - | - |
| Atelidae | | | | | |
| *Alouatta* sp. | 3 (10%) | In | - | - | - |
| **Carnivora** | | | | | |
| Canidae | | | | | |
| *Cerdocyon thous* | 8 (28%) | In, Ct, Fc, Fp, Si | - | - | LC |
| *Lycalopex vetulus* * | - | Ct, Fp, Si | VU | VU | LC |
| Felidae | | | | | |
| *Herpailurus yagouaroundi* * | 14 (48%) | In, Ct, Si | VU | VU | LC |
| *Leopardus pardalis* * | 13 (45%) | In, Ct, Fp | VU | - | LC |
| *Leopardus tigrinus* * | 16 (55%) | In, Ct | VU | VU | VU |
| *Panthera onca* * | 25 (86%) | In, Ct | CR | VU | NT |
| *Puma concolor* * | 24 (83%) | In, Ct, Fp | VU | VU | LC |
| Procyonidae | | | | | |
| *Nasua nasua* | 5 (17%) | In | - | - | LC |

| Species | Number of citations (frequency of citations) | Type of record | Conservation status | | |
|---|---|---|---|---|---|
| | | | Bahia | Brazil | IUCN |
| *Procyon cancrivorus* | 5 (17%) | In | - | - | LC |
| Mustelidae | | | | | |
| *Eira barbara* | 1 (3%) | In | - | - | LC |
| Mephtidae | | | | | |
| *Conepatus semistriatus* | 24 (83%) | In, Ct, Fp | - | - | LC |
| **Lagomorpha** | | | | | |
| Leporidae | | | | | |
| *Sylvilagus brasiliensis* | 25 (86%) | In, Ct, Fc, Fp, Si | - | - | LC |
| **Rodentia** | | | | | |
| Dasyproctidae | | | | | |
| *Dasyprocta prymnolopha* | 21 (72%) | In, Ct, Fp | - | - | LC |
| Caviidae | | | | | |
| *Galea spixii* | 24 (83%) | In, Ct, Si | - | - | LC |
| *Kerodon rupestris* * | 19 (66%) | In | - | VU | LC |
| *Hydrochoerus hydrochaeris* | 1 (3%) | In | - | - | LC |
| Erethizontidae | | | | | |
| *Coendou prehensilis* | 9 (31%) | In, Th | - | - | LC |
| Cuniculidae | | | | | |
| *Cuniculus paca* | 6 (21%) | In | - | - | LC |

**Table 2. Free-list of most abundant animals according to residents of Sumidouro community, Bahia state, northeastern Brazil. Salience - Smith Salience Index calculated from free-lists of most abundant animals requested during semi-structured interviews carried out between April and July 2019. [1] - we assumed *raposa* as an ethnospecies referred to both *Cerdocyon thous* and *Lycalopex vetulus*. [2] - refers to *Herpailurus yagouaroundi*, *Leopardus pardalis* and *Leopardus tigrinus*. [3] - refers to all species of the order Cingulata. [4] - all ethnospecies (see Appendix 3).**

| Species | Salience |
|---|---|
| *Mazama* sp. | 0.476 |
| *Tolypeutes tricinctus* | 0.404 |
| Native canids (*raposa*) [1] | 0.217 |
| *Dasyprocta prymnolopha* | 0.169 |
| *Dasypus novemcinctus* | 0.161 |
| *Galea spixii* | 0.107 |
| Smaller native felids [2] | 0.096 |
| *Pecari tajacu* | 0.058 |
| *Kerodon rupestris* | 0.058 |
| Armadillos [3] | 0.048 |
| *Sylvilagus brasiliensis* | 0.029 |
| *Euphractus sexcinctus* | 0.026 |
| *Myrmecophaga tridactyla* | 0.013 |
| *Puma concolor* [4] | 0.010 |
| *Panthera onca* | 0.010 |
| *Dasypus septemcinctus* | 0.004 |

The existence of a current CKS was denied by 24 (86%) of 28 informants, but three (10%) cited *Mazama* sp., while one (3%) mentioned *Dasypus novemcinctus* as a former CKS in the past; one informant did not know the answer. The reported motivation to consider those species as CKS in the past was the importance that they once presented for the survival of the people of the region, when they were the main source of meat during the so called "time of hunger" (*tempo da fome*). In this sense, 25 (96%) of 26 informants confirmed the current existence of hunting practice in the region, while one (4%) denied it. *Mazama* sp. was perceived as the most hunted species in Sumidouro (S = 0.790; Table 3). The reported motivations to target *Mazama* sp. for hunting included its size, and consequently the amount of meat; the flavor of its meat; and its abundance.

In fact, abundance was reported as a criterion to target species in general for hunting. However, *Tolypeutes tricinctus* was not specifically mentioned as a most-hunted species, although it was perceived as one of the most abundant animals in the region. The informants mentioned that the capture of individuals of *Tolypeutes tricinctus* usually occurs when they are coincidently encountered, not constituting a common hunting target. The mentioned reason for that is the belief, among Sumidouro residents, that its meat is dangerous for sick people and pregnant women (*carne remosa*), so it can even be avoided by some individuals (Appendix 3). However, some informants considered the meat of *Tolypeutes tricinctus* tasty and secure to be consumed by healthy people. In general, the motivations to hunt native species included food supply, medicinal use, and retaliation to attacks to livestock and even to people (Appendix 3).

Hunting in Sumidouro communities is historically motivated by its necessity for people's survival (*i.e.,* subsistence hunting), according to the informants. They reported that hunting has decreased in the last decades, due to the opening of roads and the increased flux of food traders in the region, what reduced the necessity of hunting to survive (Appendix 3). Informants also attributed the arriving of the wind farms as responsible for the reduction of hunting in the region, due to two main reasons: job provision, what increased the capacity to buy food and medicine; and the express prohibition of hunting (*e.g.,* by installing warning plates) associated to the supervision of the enterprises and their surroundings by the public environmental regulatory agencies. Nevertheless, informants recognized the existence of sport hunting, but mostly in the past by hunters that came from other places to specially hunt birds (Appendix 3). Sport hunting is currently practiced by residents of Sumidouro as well, but it is more common in other adjacent communities, according to the informants. This practice was witnessed by one of the authors (R. A. Magalhães), when meat crumbs of *Tolypeutes tricinctus* was served in a local festivity, showing that, although this species was not considered as a most-hunted one, it is, in fact, hunted for recreational purposes in specific occasions (Appendix 3).

Popular species were listed by 12 (43%) of 28 informants, whereas 12 (43%) did not considered their existence; two (7%) informants did not know the answer, and other two (7%) considered all animals equally popular. For those informants who listed popular animals, *Mazama* sp. and *Tolypeutes tricinctus* presented the highest Salience values (S = 0.347, S = 0.250, respectively; Table 3). The motivations to consider animals as popular included perceived high abundances, and, respectively, pet use and inspiration of curiosity/admiration for *Mazama* sp. and *Tolypeutes tricinctus*.

Unpopular animals were listed by 28 (97%) of 29 informants, while one (3%) denied their existence. Large felids (*onças*), represented by *Panthera onca* and *Puma concolor*, were perceived as the most unpopular animals (Table 3). Informants manifested this perception as fear and/or the desire that these species should disappear or be killed. The unpopularity of these species was associated to attacks to livestock and even to people. Although some informants did not differentiate *Panthera onca* from *Puma concolor* regarding popularity, when we consider the Salience values from those informants that did so, *Panthera onca* was perceived as the most unpopular species (S = 0.824).

**Table 3. Free-lists of the most hunted, popular and unpopular animals in the perception of residents of Sumidouro, Bahia state, northeastern Brazil, the respective Salience values, and the respective motivations to classify species into these categories, including the uses given to them. Folk names of some taxa and some type of uses are given in parentheses. Salience - Smith Salience Index calculated from free listing of most hunted, popular and unpopular animals requested during semi-structured interviews carried out between April and July 2019. [1] - see Appendix 3. Food - when parts of an animal are used as food source; medicinal - when parts of an animal are used as medicine; retaliation - when an animal is killed as a retaliation for the losses and injuries caused by it to people. [2] - refers to *Puma concolor* and *Panthera onca*. [3] - we assumed *raposa* as an ethnospecies referred to both *Cerdocyon thous* and *Lycalopex vetulus*.**

| Category | Salience | Motivation/Use [1] |
|---|---|---|
| **Most hunted animals** | | |
| *Mazama* sp. | 0.790 | food, medicinal |
| *Penelope superciliaris* | 0.381 | food |
| *Dasyprocta prymnolopha* | 0.238 | food |
| *Rhynchotus rufescens* | 0.173 | food, medicinal |
| *Pecari tajacu* | 0.104 | food |
| *Dasypus novemcinctus* | 0.094 | food |
| Armadillos | 0.047 | food, medicinal |

| Category | Salience | Motivation/Use [1] |
|---|---|---|
| *Nothura* sp. (*codorna*) | 0.043 | food |
| *Galea spixii* | 0.043 | food |
| *Crypturellus noctivagus zabele* | 0.033 | food |
| Large felids (*onças*) [2] | 0.022 | food, medicinal, retaliation |
| *Euphractus sexcinctus* | 0.022 | food |
| Native canids (*raposa*) [3] | 0.011 | food, medicinal, retaliation |
| *Kerodon rupestris* | 0.009 | food |
| *Patagioenas picazuro* | 0.007 | food |
| *Crypturellus* sp. (*inhambú*) | 0.006 | food |
| **Popular animals** | | |
| *Mazama* sp. | 0.347 | perception of high abundance; pet use (pet) |
| *Tolypeutes tricinctus* | 0.250 | perceived uniqueness to the region; perception of high abundance; harmlessness; and inspiration of curiosity/admiration (aesthetic) |
| *Rhynchotus rufescens* | 0.167 | its beautifulness (aesthetic) |
| *Sicalis flaveola* | 0.146 | its beautiful sing (aesthetic); pet use (pet) |
| *Penelope superciliaris* | 0.139 | perception of high abundance; its beautifulness (aesthetic) |
| *Columbina picui* | 0.125 | not mentioned |
| *Cariama cristata* | 0.104 | predation of pests and dangerous animals (biological control); vocalization as indicative of upcoming rain (ethnozooindicator of weather and climate) |
| *Zenaida auriculata* | 0.097 | not mentioned |
| Psittacidae (*papagaio*) | 0.083 | not mentioned |
| *Nothura* sp. (*codorna*) | 0.056 | its beautifulness (aesthetic) |
| *Galea spixii* | 0.042 | not mentioned |
| *Ortalis* sp. (*aracuã*) | 0.042 | vocalization as indicative of upcoming rain (ethnozooindicator of weather and climate) |
| *Crypturellus noctivagus zabele* | 0.028 | not mentioned |
| Birds | 0.028 | not mentioned |
| *Patagioenas picazuro* | 0.014 | not mentioned |
| **Unpopular animals** | | |
| Large felids (*onças*) [2] | 0.896 | reported attacks to livestock and even to people |
| *Panthera onca* | 0.824 | reported attacks to livestock and even to people |
| Snakes | 0.250 | possible risk to attack people and reported attacks to livestock |
| *Puma concolor* | 0.068 | reported attacks to livestock and even to people |
| Native canids (*raposa*) [3] | 0.063 | reported attacks to poultry |
| *Gnorimopsar chopi* | 0.036 | reported attacks to croplands |
| *Myrmecophaga tridactyla* | 0.018 | possible risk to attack using its powerful front claws when stressed by people and/or dogs |
| Psittacidae (*periquito*) | 0.009 | reported attacks to cultivated fruit trees |

We classified 11 species as priorities for conservation (Table 1). Of them, nine are currently at risk of extinction or Near Threatened. We also prioritized *Mazama* sp., because it was considered the most hunted species (*i.e.,* highest hunting pressure) and the most probable CKS in the past (*i.e.,* highest sociocultural relevance). We considered *Panthera onca* and

*Tolypeutes tricinctus* as top-priority species for conservation, due to their distinctly worrying conservation status. Finally, we prioritized *Mazama* sp. and *Tolypeutes tricinctus* to be used as flagship species, due to their great popularity (*i.e.,* highest local acceptance of its conservation), their high level of threat, and, in the case of *Mazama* sp., also because of its great sociocultural relevance.

**Discussion**

Our results suggest a high mammal diversity for our study area, when compared to the diversity recorded in Protected Areas situated in the Caatinga domain. Considering only native mammals that can be reliably identified by interviews, camera trapping and active searching (*e.g., Didelphis* spp., Xenarthra, Carnivora, larger rodents), the richness and composition of our sampled community (31 species; 9 threatened species) was similar to those achieved by Pereira and Geise (2009) (30 species; 9 threatened species) and Campos et al. (2019) (26 species; 9 threatened species) in the Caatinga. However, in our study, some taxa still lack confirmation by field methods and/or identification at the species level. This pattern of great biodiversity is possibly a consequence of the number of ecosystems (*i.e.,* environmental heterogeneity) present in the region, which possibly results in positive heterogeneity-richness relationship (STEIN; GERSTNER; KREFT, 2014), as it is known for transitional areas between Caatinga and adjacent domains (CARMIGNOTTO; ASTÚA, 2017).

We found two species outside their known distributions. The first, *Cabassous tatouay,* is Data Deficient, and its distribution in the Caatinga domain remains controversial (ANACLETO et al., 2015). However, it has already been recorded in the Chapada Diamantina region (PEREIRA; GEISE, 2009). Thus our record reinforces the occurrence of *Cabassous tatouay* in the Caatinga domain. The second species, *Lycalopex vetulus*, is associated to the Cerrado and its transitional zones, including those with the Caatinga, where a knowledge gap exists (LEMOS et al., 2013). Our record of *Lycalopex vetulus* adds to others already made in the Caatinga (*e.g.,* COSTA; COURTENAY, 2003; PEREIRA; GEISE, 2009; OLIFIERS; DELCIELLOS, 2013). However, as well as for those records, we also recorded *Lycalopex vetulus* outside the driest and most typical areas of the Caatinga, hence it remains unclear if *Lycalopex vetulus* maintain populations there.

Ethnospecies were attributed to armadillos of the genus *Dasypus* according to their sizes. However, only *Dasypus novemcinctus* and *Dasypus septemcinctus* potentially occur in the area (WETZEL et al., 2008). We could identify the largest ethnospecies as *Dasypus* *novemcinctus*. The intermediate and the smallest ethnospecies, in turn, could not be specifically associated to one species of the genus. *Dasypus novemcinctus* and *Dasypus septemcinctus* can be better distinguished by the number of mobile bands (WETZEL et al., 2008). Their sizes, however, can lead to misidentification, once young individuals of *Dasypus novemcinctus* can be similar in size to adults of *Dasypus septemcinctus* (MEDRI; MOURÃO; RODRIGUES, 2011).

The highest consensus about the occurrence of *Mazama* sp. in the area probably derives from its historical importance as food source for the people of Sumidouro. *Mazama* spp. are important for the survival of the people of the Brazilian semiarid region, where they are used as food source, medicine and handcrafts (ALVES; ALVES, 2011; BONIFÁCIO; FREIRE; SCHIAVETTI, 2016). The prominent cultural relevance of an animal species for the cultural identity and survival of a people is related to its uses, which often requires killing individuals in their habitats (*i.e.,* hunting) (GARIBALDI; TURNER, 2004). Thus, it is reasonable that the same species may be both highly hunted and a CKS, such as it was found for *Mazama gouazoubira* by Bonifácio, Freire and Schiavetti (2016) and possibly for *Mazama* sp. in the past in Sumidouro.

Species targeting for hunting in Sumidouro appears to be generally motivated by the perceived abundance (or detectability), which is known as a factor that influences the hunting pressure on a species, and it can even be the most important one (DA SILVA NETO et al., 2017). However, cultural preferences also influence hunting targeting, such as meat flavor (KOSTER et al., 2010). Abundance, meat flavor and the amount of meat were reported as the motivations to target *Mazama* sp. for hunting. Therefore, the hunting of this species is motivated by multiple factors in our study area, and not only by energetic optimization, as it that has been also observed for different animals in other studies (*e.g.,* (ALTRICHTER, 2006; PEREIRA; SCHIAVETTI, 2010; DA SILVA NETO et al., 2017).

Cultural preferences also influence the hunting pressure on *Tolypeutes tricinctus* in Sumidouro. The danger of some bushmeat for sick people and pregnant women (*carne remosa*), as we found for *T. tricinctus* in Sumidouro, was also found by Castilho *et al.* (2017) in relation to porcupines in the Atlantic Forest of southeastern Bahia, where the consumption of them was also attributed to opportunistic encounters. The recurrence of the same belief in such distant communities, then, indicates that this belief may be widespread and valid for different animals in different socio-ecological systems.

The hunting in the Brazilian semiarid region is an important practice for the survival of the poor and often isolated people who live there, providing food, medicine, handcrafts, and protection against dangerous animals (ALVES; GONÇALVES; VIEIRA, 2012). However, as it was observed in Sumidouro, the dependency on hunting to survive can decrease when the needs for protein are met by other means (CASTILHO et al., 2017). In this sense, our findings corroborate the thesis that poverty is an important factor that motivates hunting, even though poverty itself is difficult to define and measure (KNAPP; PEACE; BECHTEL, 2017). However, the direct use of raw materials from natural ecosystems may be caused not only by poverty, but also due to the relationship between it and isolation, as the influx of food traders through the opening of roads was considered one factor for the reduction of hunting in Sumidouro. In fact, according to the informants, Sumidouro was highly geographically isolated until few decades ago. Such isolation and poverty together may be the reasons for the different uses given to several species in Sumidouro (Table 3; Appendix 3). Isolation of human communities can also lead to linguistic differentiation between them (HONKOLA et al., 2018), which may have been responsible for the prominence of apparently exclusive folk names for some species in informants' vocabulary (Appendix 3).

Besides the necessity for survival, hunting can present several and not excluding motivations, including pleasure (*i.e.,* sport hunting) (FORSYTH; MARCKESE, 1993; ALVES, 2012; KNAPP; PEACE; BECHTEL, 2017). In Sumidouro, the sport hunting was recognized by the informants as being the most common reason to hunt nowadays. However, differently from subsistence hunting, sport hunting is illegal in Brazil (Article 29, Federal Law 9,605/1998 - Law of Environmental Crimes). In this sense, law enforcement can be important for the reduction of hunting (CASTILHO et al., 2017). Consequently, the legalization of the hunting of native species, as well as the weakening of the environmental licensing, both currently present in Brazil's political debate (ABESSA; FAMÁ; BURUAEM, 2019), should increase the hunting pressure on native species in the region.

Although law enforcement is important to reduce hunting in general, we believe that it might direct this practice towards species that are easier to hunt, such as those abundant and easy to find and capture, but also easy to transport and hide, such as smaller species. *Tolypeutes tricinctus* fit all these criteria, and its meat is also considered tasty, so we believe that the hunting pressure on it in Sumidouro and adjacent communities might have not decreased at the same rate of the other species as a consequence of law enforcement against hunting.

*Tolypeutes tricinctus* is currently an Endangered species (Table 1). However, it is common and widespread in our study area (Chapter 2), possibly as a result of an apparent low hunting pressure on it. Therefore, conservation actions towards the maintenance of this population of the species should be important for its conservation. The high detection and widespread distribution of *T. tricinctus* in the area makes also possible to study its biology there (Chapter 2) and possibly manage its population. Additionally, we considered *Tolypeutes tricinctus* as a priority species to be used as a flagship for conservation due to its worrying conservation status and its local great popularity. In fact, there has already been an attempt to use *Tolypeutes tricinctus* as a flagship species for conservation as the mascot of the 2014 FIFA World Cup in Brazil, but it did not provide positive conservation outcomes (BERNARD; MELO, 2019).

Conversely, large felids (*onça*s), but especially *Panthera onca*, were perceived as the most unpopular animals in Sumidouro and were listed as most hunted animals, being hunted especially in retaliation to attacks to livestock and even to people. However, as long as we know, the only reported attack to domestic animals that has been already identified by specialists in the area was one that we analyzed, which as caused by *Puma concolor* (Appendix 2). This species is much more likely to be responsible for the attacks, once it presents much a larger population than *Panthera onca* in the Caatinga domain, and it is more adaptable to anthropized ecosystems, being responsible for the majority of the identified attacks to livestock in Brazil (AZEVEDO et al., 2013; MORATO et al., 2013). Conversely, *Panthera onca* is in a much worse situation in Bahia state as well as in the Caatinga, where it is Critically Endangered (MORATO et al., 2013). Given their unpopularity, both large felids are not recommended to be used as flagships for conservation actions towards the management of their populations *in situ*, unless other actions focused on human-fauna coexistence have been carried out before or are carried out together (*e.g.,* see the People and Jaguars Coexistence Project; MARCHINI, 2014).

We also classified *Mazama* sp. as a priority species for conservation, including to be used as a flagship species, even though the possible species of the genus potentially occurring in the area are not currently threatened (*M. americana* and *M. gouazoubira*). *Mazama* sp. was considered the most hunted species in Sumidouro, and hunting may have already caused *Mazama* sp. to be uncommon in another region in southeastern Bahia (CASSANO;

BARLOW; PARDINI, 2012; CASTILHO et al., 2017). Hence, if the sport hunting of native animals becomes legal in Brazil, the hunting pressure over this species may become high enough to make it uncommon in our study area as well, given that this practice has decreased in Sumidouro due to law enforcement. Moreover, the phylogeny of the *Mazama* genus remains controversial, and there is still a lack of data on the biology of its species (DUARTE; GONZÁLEZ; MALDONADO, 2008). Therefore, *Mazama* sp. is a priority for conservation, and it is of interest for scientific research.

In conclusion, our findings reinforce the importance of carrying out biodiversity and ethnobiology assessments to subsidize conservation planning. By doing this, scientists and conservation practitioners can better understand species distributions and the feasibility of their conservation according to local sociocultural factors. In Sumidouro community, priority species are not only those that officially need protection, based on their extinction risk assessments, but they also include *Mazama* sp., the most hunted and the most culturally important species. Therefore, even though our study is geographically restricted and deals with a small sample, it highlights the role of sociocultural factors and of participatory methods in conservation planning to enhance its effectiveness. Based on our results, we also reinforce the need for the development of research projects and conservation actions in the Caatinga domain, specifically in its economically poorest but culturally and biologically rich areas that remains neglected for investments, such as our study area.

# 3. CAPÍTULO 2 - Habitat use by the Brazilian three-banded armadillo: revealing generalist habits of a threatened species

**Abstract**

Exploring the factors involved in the distribution of organisms is important for understanding their natural histories and to provide their effective conservation. However, the ecology of some threatened species remains poorly understood. Here we show the first quantitative investigation of habitat use by the Brazilian three-banded armadillo, *Tolypeutes tricinctus*, a threatened species endemic to Brazil. We used camera trapping and active searches to explore the influence of ecological and methodological factors, including human-related habitat features, on the occupancy and detection probabilities of *T. tricinctus* in a human-modified landscape in northeastern Brazil. The occupancy probability of *T. tricinctus* was high throughout the study area, whereas its detection probability was influenced by the sampling method, being almost 10 times higher by active searches than by camera trapping. Our results support previous studies, indicating that *T. tricinctus* can be widely distributed in human-modified landscapes that present low hunting pressure on the species. Based on our findings, we advocate that ecological and conservation projects should consider the differences in effectiveness between camera trapping and active searches and take detection bias into account to design future studies and make reliable inferences about *T. tricinctus* ecology. Further studies in areas with different types and levels of human pressures and habitat features may help to better elucidate the drivers of the species distribution.

**Key-words:** Caatinga, Habitat selection, Citizen science; Seasonally Dry Tropical Forests, Wind farms.

## Introduction

The distribution of organisms over time and space depends on environmental conditions, type and quality of the resources, and ecological interactions between individuals (MORRIS, 2003). Therefore, organisms are better adapted to live in some places than in others, and may occupy a non-random set of available habitats (MORRIS, 2003; MORRIS; CLARCK; BOYCE, 2008).

The comprehension of the factors responsible for the distribution of the species is intrinsically important for the knowledge of their natural histories, but also for decision-making processes in population monitoring, management, and conservation (JONZÉN, 2008). In times of global biodiversity crisis, this understanding is fundamental for protecting endangered species, especially those poorly know species whose geographic ranges are concentrated in threatened and neglected ecosystems, such as the case of the Brazilian three-banded armadillo *Tolypeutes tricinctus* (Linnaeus 1758), an endangered and endemic species from Brazil (REIS et al., 2015).

Before 1988, scientists have not recorded *T. tricinctus* in nature for at least 20 years (SANTOS et al., 1994), and only recently it became an object of specific research (LOUGHRY et al., 2015) and conservation actions (*e.g.,* National Action Plan; ICMBIO, 2014). Thus, even though different aspects of its natural history are being discovered (*e.g.*, ATTIAS et al., 2016), it remains poorly understood (REIS et al., 2015). *T. tricinctus* is the only cingulate endemic to Brazil, occurring mainly in the semi-arid scrub forests and savannas of the northeastern and central regions of the country (FEIJÓ et al., 2015). The core of its distribution corresponds to the Caatinga (FEIJÓ et al., 2015; SANTOS et al., 2019), a Brazilian phytogeographical domain basically represented by seasonally dry tropical forests (SILVA et al., 2017). The Caatinga is historically neglected for investments in scientific research and conservation actions, and unsustainable human activities such as slash-and-burn agriculture, harvesting of firewood, hunting, and livestock, have been causing habitat and biodiversity losses (LEAL et al., 2005; SILVA et al., 2017).

Besides habitat loss, hunting is considered another major threat not only to *T. tricinctus,* but also to its congender *T. matacus* (Desmarest, 1804) (MIRANDA et al., 2014; NOSS; SUPERINA; ABBA, 2014). Armadillos of the genus *Tolypeutes* are unique among cingulates in presenting the capacity of rolling up into a ball as a defense mechanism, providing protection for unarmored areas of their bodies (WETZEL et al., 2008). However, while it seems an efficient defense strategy against natural predators, this make these species easy to hunt (SANTOS et al., 1994).

The combination of the impacts of hunting and habitat loss on *T. tricinctus*, together with its endemism and the poor knowledge about its biology, made it a top priority armadillo species for scientific research and conservation actions (SUPERINA; PAGNUTTI; ABBA, 2014). Thus, in order to shed light to the ecology of *T. tricinctus* and contribute to its future conservation, this study provides evidence of factors that may influence the spatial and temporal patterns of habitat use by *T. tricinctus* in an unprotected area, where human activities, such as deforestation, hunting and livestock are present.

We used a standardized combination of two sampling methods (camera traps and active searching) and occupancy models (see MACKENZIE et al. 2006) to explore how factors (or variables) influenced the occupancy (or distribution) of *T. tricinctus* in a human-modified landscape located in the Caatinga domain. We expected a positive relationship between *T. tricinctus* occupancy and the occurrence of soft, sandy soils. *T. tricinctus* depends on soil to forage and dig burrows, which are probably important for thermoregulation and nesting (ATTIAS et al., 2016), and armadillos may preferentially dig them in soft, sandy soils because they require less energy to dig (PLATT; RAINWATER; BREWER, 2004; ARTEAGA; VENTICINQUE, 2008; SANTOS, 2011). Regarding resource availability, we expected *T. tricinctus* occupancy to be positively related to water resources and to the presence of termites of the genus *Syntermes*, as it can feed mostly on them (Guimarães, 1997).

For human-related habitat features, we expected the presence of roads, human constructions (*e.g.,* residences, wind farms), anthropogenic ecosystems (*e.g.*, croplands) and cattle to be negatively related to *T. tricinctus* occupancy, as these factors should imply habitat loss and degradation for the species (REIS et al., 2015). Finally, we explored possible interactions between *T. tricinctus* and other armadillos as well as its potential predators. We expected *T. tricinctus* occupancy to be either positively or negatively influenced by the presence of other armadillos. Because cingulates are a monophyletic group whose members share similar life history characteristics (VIZCAÍNO; LOUGHRY, 2008), we expected niche overlap among the armadillo species, which may result in competition and consequent spatial avoidance among them (FERREGUETTI; TOMAS; BERGALLO, 2016). However, as *T. tricinctus* can act as a commensal, using burrows of other armadillos (GUIMARÃES, 1997; ATTIAS et al., 2016), we also expected a positive relationship between *T. tricinctus* occupancy and the presence of other armadillos. We also expected a negative relationship between *T. tricinctus* occupancy and the *Panthera onca and Puma concolor*, which are the only known *Tolypeutes* predators (TABER et al., 1997).

For the temporal component of habitat use, we investigated habitat features influencing *T. tricinctus* detection along the sampling period at each occupied site. Detection may vary spatially due to habitat characteristics, but also temporarily due to variations (or fluctuations) in animal behavior pattern and/or environmental conditions (BAILEY; SIMONS; POLLOCK, 2004). Therefore, detection can also be interpreted or be a proxy for intensity or frequency of use of occupied sites (MASSARA et al., 2018). In this context, we expected *T. tricinctus* detection to be positively influenced by soft, sandy soils, presence of termites, and presence of water bodies, but negatively influenced by roads, human constructions, cattle, and anthropogenic ecosystems.

*T. tricinctus* dependence on burrows for thermoregulation is a consequence of the incomplete capacity of armadillos and other xenarthrans to regulate their body temperatures by means of their physiology (ATTIAS et al., 2018). Hence, we expected extremely high or low temperatures to decrease *T. tricinctus* detection. Also, we expected higher detection probability in forested locations in days of extremely high or low temperatures because these locations may act as temperature buffers (MOURÃO; MEDRI, 2007). Like occupancy, we did not expect a specific (*i.e.*, positive or negative) relationship between *T. tricinctus* detection and the detection of other armadillos, but we did expect a negative relationship between *T. tricinctus* detection and the detection of its potential predators.

Detection can also reflect the methodological capacity to record the target species (MACKENZIE et al., 2018) and thus, we expected higher detection of *T. tricinctus* in open locations, as these locations present more adequate substrates for footprint impressions and less obstacles to camera sensors, which may indeed facilitate species detection by either active searching or camera trapping, respectively. Because sampling methods present different effectiveness in recording different species (SILVEIRA; JÁCOMO; DINIZ-FILHO, 2003; MUNARI; KELLER; VENTICINQUE, 2011), we expected differences in detection probability of *T. tricinctus* according to the method employed (camera trapping or active searching), but we were uncertain about the type of method that would be more effective in detecting the species. Finally, we expected a positive relationship between *T. tricinctus* detection and the sampling effort.

## Materials and Methods

*Study Area.* — This study was conducted in a series of adjacent, small rural properties totaling 53 km² in the communities of Sumidouro, Baixio, and Boa Vista in the municipality of Brotas de Macaúbas, state of Bahia, northeastern Brazil (Figure 1). Although officially situated in the Caatinga, the study area is part of a transitional region between the Caatinga and Cerrado domains (ARAÚJO, 2015; SILVA et al., 2017). The climate in Brotas de Macaúbas comprises well-defined rainy (November-March) and dry (April-October) seasons, with an average annual temperature and rainfall of 19.9 ºC and 714.2 mm, respectively (ARAÚJO, 2015). The temperature and rainfall are influenced by the high-altitude, windward areas within the municipality (ARAÚJO, 2015), which is the case of our study area, whose elevations vary from 1,000-1,300 m.a.s.l (MIRANDA, 2005). These areas have higher rainfall and lower temperatures than the surrounding low-altitude, leeward areas (ARAÚJO, 2015). The soil types from our study area vary from Litholic Neosols (sensu SANTOS et al. 2018) or Leptosols (sensu IUSS 2014) at higher elevations in its western portion, and Red-yellow Latosols or Ferralsols at lower elevations to the east (INEMA 2014). The western portion of the area is partially located in a Priority Area for Biodiversity Conservation (BRASIL, 2017).

The rural properties are used for livestock and wind power production. The native vegetation consists basically of shrubby-arboreal Caatinga (*i.e.,* seasonally dry tropical forest). Anthropized areas comprise the wind farm infrastructure (*e.g.*, wind turbines, power transmission lines), roads, and former croplands in regeneration, characterized by large zones of exposed soil partially covered by ruderal herbaceous and/or shrubby vegetation.

*Camera Trapping and Active Searching.* — A total of 24 camera sites (*i.e.,* sampling units) were randomly distributed 1.5 km apart throughout the study area (Figure 1). This minimum distance was chosen to minimize lack of independence (overdispersion) between sampling units. We placed cameras along game trails and human paths to maximize detection but respecting the previous randomly locations, as well as the distance between cameras. We installed cameras at ~40 cm above the ground and set them to operate 24 hours per day with one-minute interval between videos. Sampling was carried out between April and July 2019, totalizing 90 days. In the middle of the sampling period (*i.e.*, ~45 days after installation) we visited all sites to check the cameras and replace defective ones, clear memory cards, and replace batteries. Additionally, we conducted for 30 minutes an active search for direct and indirect evidences of *T. tricinctus* in a buffer of 10 m radius surrounding each camera site. Active searches were conducted at two occasions: during camera trap checking and removal.

During each active search we registered whether any evidence of *T. tricinctus* was found (0) or not (1) at each sampling unit.

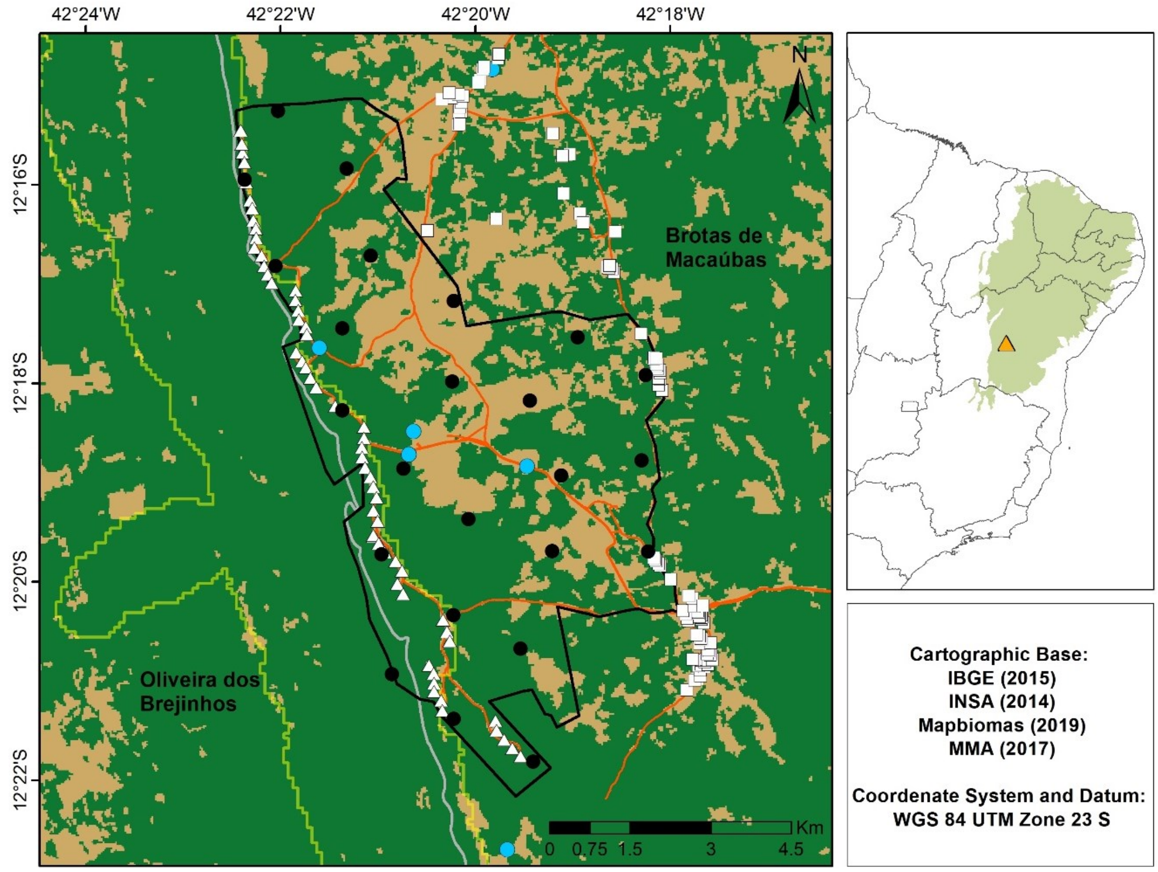


**Figure 1. Location of the study area (black line polygon) in the municipalities of Brotas de Macaúbas and Oliveira dos Brejinhos (divided by a solid grey line) sampled for *T. tricinctus* in Bahia state, northeastern Brazil. The black dots are camera trap sites; blue dots are water dams and springs; white triangles are wind turbines; white squares are residences; orange lines are roads. The green background represents natural forests and savannas, and the light brown background represents native and anthropogenic open areas, and they follow Mapbiomas (2019). The polygon outlined in light green is a Priority Area for Biodiversity Conservation, according to MMA (2017). The insert shows the geographic distribution of the Caatinga (shaded area) according to INSA (2014), and the location of the study area (orange triangle) in relation to Brazilian states according to IBGE (2015).**

During the active searches, we also sampled for termites of the genus *Syntermes* and used it as a proxy for prey occurrence at each camera site, as these termites can be predominant in the diet of *T. tricinctus* (GUIMARÃES, 1997). The nests of *Syntermes* can be completely subterranean, subterranean with a pile of loose soil on the surface, or a compact above-ground mound (CONSTANTINO, 1995). Hence, we searched for inhabited nests with identifiable entrances or composed by above-ground mounds and collected individuals for identification by excavating the nests. For the identification of the individuals collected in the nests, we followed Constantino (1995, 1999). All individuals we collected in our sampled sites were identified as belonging to the genus *Syntermes*.

*Soil Sampling and Analysis*. — To investigate the sand content and soil toughness, we determined soil texture and stoniness by collecting deformed samples (~200 g) in depths of 0-20 cm and 20-40 cm at each camera site. Then, we performed granulometric analysis by using sieving and sedimentation techniques to assess the proportion of each soil particle size-class (in mass fraction): boulders and stones (>2 mm), sand (2 mm - 0.05 mm), silt (0.05 mm - 0.002 mm), and clay (<0.002 mm) (DONAGEMA et al., 2011).

To verify if the proportions of particle size-class of both soil depths were associated, we used Pearson's correlation test, and we found strong positive correlations between all of them ($|r| \geq 0.7$), so we considered only the shallow depth (0-20 cm) for further analysis. Next, we tested for correlations among particle size-classes, and we found strong negative correlations between sand and clay as well as between sand and the boulders and stones. Hence, we used only the sand content as a soil covariate in our analysis.

*Modeling T. tricinctus Occupancy and Detection as a Function of Covariates*. — Occupancy probability ($\Psi$) is defined as the probability that a species is recorded (*i.e.,* detected) at least once at a site $i$ during the sampling period, whereas detection probability ($p$) is the probability that a species is recorded at a site $i$ at a time (or occasion) $t$, given the site is occupied (MACKENZIE et al., 2002). Both parameters can be modeled as a function of covariates. We *a priori* selected a total of 14 covariates that we believed would influence occupancy ($\Psi$) and/or detection ($p$) probabilities of *T. tricinctus*.

To explore factors that influence *T. tricinctus* occupancy, we used, as a soil covariate, the sand content (Table 1). Regarding resource availability, we used two covariates in our analysis. We calculated the minimum distances from each site to water bodies, using ArcGis 10.5 (ESRI, 2016), and identified whether or not termites of the genus *Syntermes* were recorded (*i.e.,* 0 or 1) at each site in at least one of the two active search occasions (Table 1). Only springs and small artificial dams dispersed throughout the study area and surrounding it held water during the sampling period and, therefore, we only considered them for analysis. We also calculated the minimum distances from each site to roads and human constructions (*i.e.,* residences and wind turbines), and classified habitat types into cropland (0) or native vegetation (1) at each camera site. To explore the influence of cattle and other armadillos on *T. tricinctus* occupancy probability, we calculated the number of records of each of them during the whole sampling period for each site and used these records as covariates (Table 4).

For this, we considered as independent records those obtained at the same camera site with at least one-hour interval. However, due to the scarce number of records of each armadillo species we obtained, we combined the records of all species of armadillos as one single covariate, as we believe that *T. tricinctus* may present the same expected interactions (*i.e.,* competition or commensalism) with any other armadillo. We could not test for the effect of predators on *T. tricinctus* occupancy and detection probabilities because we obtained only one record of its potential predators during the sampling period.

To model potential variation in the detection of *T. tricinctus* at occupied sites, we also used sand content, detection of *Syntermes*, and distances to water bodies, roads, wind farms, and residences, as well as the habitat types as covariates in our analysis (Table 1). We used five additional covariates to model detection probability only. Of these, we created four 'survey' covariates that varied for each site and occasion: mean temperature of a five-day period, the number of records of armadillos and cattle, and the sampling effort (in days) for each method (Table 1). We obtained temperature data directly from thermometers held by the wind farms. We did not only use the number of records of cattle as a proxy for habitat degradation that may have influenced *T. tricinctus* occupancy and/or detection but also to explore a potential reduction in the capability of the cameras to record other species when cattle were using the sites. We noticed that sometimes cattle moved the cameras off from their pre-defined positions or rested in front of the cameras. Finally, we also used the type of the method employed at each occasion as a covariate to evaluate the influence of methodological factors on *T. tricinctus* detection (Table 1).

We tested for correlation among our selected covariates and we found strong negative correlation between distance to wind turbines and distance to residences. Thus, we excluded distances to wind turbines of our analysis, what resulted in a total of 13 covariates used to model occupancy ($\Psi$) and detection ($p$) probabilities of *T. tricinctus* (Table 1).

*Data Analysis.* — To model the influence of the covariates on occupancy ($\Psi$) and detection ($p$) probabilities of *T. tricinctus*, we used single-species single-season occupancy modelling, which assumes no variation in occupancy (*i.e.*, closed assumption) over the sampling period (*i.e.*, season) (MACKENZIE et al., 2018). For this, we built a matrix of detection histories, reflecting whether *T. tricinctus* was detected (1) or not (0) during each of 18 periods of five consecutive days (*i.e.,* occasions) of camera trapping. We also included the detection history of *T. tricinctus* obtained from the two active searching occasions, resulting in a total of 20 occasions along the season.

**Table 1. Covariates used to model occupancy (*Ψ*) and detection (*p*) probabilities of *T. tricinctus* in a human-modified landscape in the Caatinga of Bahia state, northeastern Brazil. The code used in the modelling, the mean and range (minimum-maximum) values and the expected effect on occupancy and detection are given for each covariate. Habitat types comprise native vegetation (shrubby-arboreal Caatinga) and former croplands. The sand content is given in mass fraction (g/g). Distance covariates are given in meters (m). The total number of records of armadillos and cattle were calculated for each site by camera trapping. The detection of *Syntermes* indicates whether the genus was found or not in a 10 m radius surrounding each camera trap site during at least of one of two active search occasions. Temperature is given in degrees Celsius (°C). Sampling effort was calculated for both camera trapping and active search together, and is given in days. The type of method refers to camera trapping or active search. NE - not evaluated.**

| Covariate | Mean and Range Values (minimum-maximum) | Expected Relationship with *Ψ* | Expected Relationship with *p* |
|---|---|---|---|
| Habitat type | 0 or 1 | + (native vegetation)<br>- (former cropland) | As intensity of use: + (native vegetation, especially in extreme temperatures),<br>- (former croplands)<br>As a methodological factor: - (native vegetation),<br>+ (former croplands) |
| Distance to water bodies (m) | 2,170.33 (287.8-4,056.98) | - | - |
| Distance to roads (m) | 449.15 (0-1,298.48) | + | + |
| Distance to residences (m) | 3,151.01 (160.11-5,603.40) | + | + |
| Sand content (g/g) | 0.70 (0.41-0.89) | + | + |
| Total number of records of armadillos for each site | 0.63 (0-4) | + (effect of commensalism),<br>- (effect of competition) | NE |
| Total number of records of cattle for each site | 7.04 (0-40) | - | NE |
| Detection of *Syntermes* at each site | 0 or 1 | + | + |
| Temperature (°C) | 20.54 (17.89-22.87) | NE | + (mild temperatures)<br>- (extreme temperatures) |
| Number of records of armadillos for each occasion and site | 0.04 (0-3) | NE | + (effect of commensalism),<br>- (effect of competition) |
| Number of records of cattle for each occasion and site | 0.43 (0-10) | NE | - |
| Sampling effort (days) | 4.10 (0-5) | NE | + |
| Method employed | 0 or 1 | NE | + or - for each method |

We built models containing our *a priori* hypothesis for occupancy and detection probabilities and fit them in Program MARK (WHITE; BURNHAM, 1999). For models with temperature as a covariate for *p*, we fit a quadratic relationship for the temperature (*i.e.,* "(temperature)$^2$"), as we hypothesized that the detection of *T. tricinctus* would be lower in extremely high or low temperatures, but higher at mild ones. This procedure resulted in the model structures "(temperature)$^2$" and "(temperature)$^2$*habitat", according to our *a priori* hypothesis. We adopted the step-down strategy to build the models (Lebreton et al. 1992). This strategy consists in first modelling *p* using the fixed structure of the most parametrized model of $\Psi$ (*i.e.,* containing all covariates), and then modelling $\Psi$ using the fixed structure of the most parsimonious model of *p*.

We used the Akaike Information Criterion adjusted for small sample sizes (AICc) to evaluate the models better supported by our data ($\Delta$ AICc $\leq 2$) (BURNHAM; ANDERSON, 2002). Using our most parametrized model, we checked for overdispersion (or lack of independence), applying the goodness-of-fit test developed exclusively for the single-species single-season occupancy analysis (MACKENZIE; BAILEY, 2004) in Program PRESENCE (HINES, 2006). We used the maximum likelihood methods available in Program MARK to estimate occupancy and detection probabilities of *T. tricinctus* (MACKENZIE et al., 2002). Due to model selection uncertainty, we calculated the model-averaged estimate of occupancy probability of *T. tricinctus* for the study area (BURNHAM; ANDERSON, 2002).

## Results

We obtained 11 records of *T. tricinctus* by camera trapping at 10 sampling units, whereas we detected *T. tricinctus* by active search at 11 sampling units, being at 7 of them exclusively by this method. The total sampling effort by camera trapping and active searching was 1,921 trap-days and 24 search-hours, respectively. Together, these methods resulted in a *naïve* occupancy of *T. tricinctus* of 0.67.

The goodness-of-fit test revealed no evidence of overdispersion ($\chi^2 = 807.50$; $\hat{c} = 1.00$; P = 0.73). Our analysis showed uncertainty among $\Psi$ model structures, of which three were better supported (Table 2). The covariates "distance to roads" ($\beta = 0.03$; 95% CI = -0.03-0.10) and "sand content" ($\beta = -40.00$; 95% CI = -126.27-46.27) apparently influenced the occupancy probability of *T. tricinctus*. However, the null (intercept only) model was ranked among the most parsimonious models ($\Delta$ AICc = 0.21), predicting that none of these covariates had a strong influence on *T. tricinctus* occupancy probability, which was high and constant in the area ($\Psi = 1.00$; 95% CI = 0.71-1.00).

The detection probability of *T. tricinctus* varied according to the sampling method (Table 2), being active searching the most efficient method (β = 2.58; 95% CI = 1.66-3.51). The detection probability by active searching ($p$ = 0.29; 95% CI = 0.17-0.45) was ~10 times greater than by camera trapping ($p$ = 0.03; 95% CI = 0.02-0.05). None covariate we interpreted as intensity or frequency of use of occupied sites influenced the detection of *T. tricinctus* in our study area.

## Discussion

The occupancy probability of *T. tricinctus* was high and constant across our sampling units, indicating that this species is widely distributed throughout the study area independently of environmental features and anthropogenic pressures on natural habitats. This pattern corroborates the perception of residents from a local community that *T. tricinctus* is one of the most common and abundant species in the area (see Chapter I).

To the best of our knowledge, there is no published study that has quantitatively evaluated habitat use by *T. tricinctus* and thus, the conclusions made about its habitat use have been based on field observations and perceptions of informants in ethnographic studies (*e.g.,* Bocchiglieri, 2010; Sena, 2017). Although those data are extremely important for understanding the natural history of *T. tricinctus*, they do not take into account possible detection bias, that can lead to misinterpretation about patterns of habitat use (MACKENZIE et al., 2018). Also, these studies did not address the sampling designs and recommendations to make reliable inferences about resource selection (THOMAS; TAYLOR, 2006).

The occupancy probability of *T. tricinctus* we found is similar to those already found for *Dasypus novemcinctus* and *Euphractus sexcinctus* in the Atlantic Forest of Brazil (FERREGUETTI; TOMAS; BERGALLO, 2016), which are considered relatively common and generalist regarding habitat use (MEDRI; MOURÃO; RODRIGUES, 2011). Although *T. tricinctus* is considered a rare species (REIS et al., 2015), it can achieve high population densities and detection rates in areas without severe hunting pressure and habitat loss (BOCCHIGLIERI, 2010). However, even more common and generalist armadillos may become rare in sites subjected to habitat loss and overexploitation (FERREGUETTI; TOMAS; BERGALLO, 2016; RODRIGUES; CHIARELLO, 2018), and *T. tricinctus* has also been found in degraded and anthropogenic habitats, such as deforested areas, soybean crops, and pine plantations (BOCCHIGLIERI, 2010). Therefore, our results reinforce that *T. tricinctus* can be widespread in human-modified landscapes and may be as generalist as other armadillos regarding habitat use. Of course, more investigations are necessary, especially in areas with other remarkably low quality habitats, as recent studies have found negative influences of these anthropogenic habitats on the occupancy probability of armadillos, such is the case of *D. novemcinctus* (RODRIGUES; CHIARELLO, 2018).

In our study area, habitat loss has probably increased in the recent years due to the wind farms, although it is not too critical when compared to other depleted areas. Meanwhile, the hunting pressure on *T. tricinctus* is apparently low and opportunistic, and hunting in general has apparently decreased in recent years due to law enforcement and reduction of poverty and isolation of the local communities (see Chapter 1). Hence, our results suggest that *T. tricinctus* can be widespread and common in unprotected human-modified landscapes subjected to lower hunting pressures, as also previously observed by Bocchiglieri (2010). Conversely, *T. tricinctus* can be rare in protected areas that are less susceptible to anthropogenic conversion of natural habitats, such as the Serra da Capivara National Park in northeastern Brazil, but where hunting pressure is higher (L. M. M. de Sena, pers. com.). These findings together lead to the conclusion that hunting might be the most important threat to *T. tricinctus*, but further studies are still necessary to test this hypothesis.

The high occupancy and detection probabilities of *T. tricinctus* we found, for example, might also result from an indirect positive influence of habitat loss, through the reduction of the populations of its potential predators. The low number of records of *Panthera onca* and *Puma concolor* we obtained did not allow us to model the effect of predation risk on *T. tricinctus* occupancy and detection probabilities. This low numbers of records may relate to the habitat loss and hunting on these species in the area, which are considered the main threats to them (AZEVEDO et al., 2013; MORATO et al., 2013). Although hunting in general has decreased in our study area in recent years, *Panthera onca* and *Puma concolor* are the most unpopular and frequent hunting animals in the area (see Chapter I).

Similarly, habitat loss might increase the availability of some food items from the diet of *T. tricinctus*, through alterations in the structure of insect communities, including termites (FILGUEIRAS et al., 2019). The only study focused on the diet of *T. tricinctus* found *Syntermes* termites as the main item in its diet (GUIMARÃES, 1997). However, the study did not take into account the availability of the food items (*i.e.,* resource selection), thus the feeding preferences of *T. tricinctus* remain uncertain. Therefore, *T. tricinctus* might not select for *Syntermes* termites in our study area, and this might be the reason we have not found any influence of these termites on the occupancy and detection probabilities of *T. tricinctus.*

**Table 2. Model selection results for the top 10 models used to estimate *T. tricinctus* occupancy (*Ψ*) and detection (*p*) probabilities in a human-modified landscape in the Caatinga of Bahia state, northeastern Brazil. Covariates: armadillos - total number of records of armadillos by camera trapping at each site; armadillos_oc - number of records of armadillos by camera trapping at each site and occasion; cattle - total number of records of cattle by camera trapping at each site; cattle_oc - number of records of cattle by camera trapping at each site and occasion; effort - sampling effort in days at each occasion; habitat - if shrubby-arboreal Caatinga or former croplands; method - if camera trapping or active searching at each occasion; residences - distance to residences (m); roads - distance to roads (m); sand - sand content in the soil (g/g); syntermes - detection/non-detection of *Syntermes* termites along two active search occasions; temperature - mean temperature in Celsius degrees at each occasion; water - distance to water dams and springs (m). The sign (+) indicates additive effects among covariates. AICc - Akaike's Information Criterion adjusted for small sample sizes.**

| Model | AICc | Δ AICc | AICc Weights | Model Likelihood | Number of Parameters | Deviance |
|---|---|---|---|---|---|---|
| **Modelling *p*** | | | | | | |
| *Ψ*(cattle+armadillos+syntermes+habitat+residences+water+roads+sand), *p*(method) | 179.90 | 0.00 | 0.82 | 1.00 | 11 | 135.90 |
| *Ψ*(cattle+armadillos+syntermes+habitat+residences+water+roads+sand), *p*(effort) | 182.89 | 2.99 | 0.18 | 0.22 | 11 | 138.89 |
| *Ψ*(cattle+armadillos+syntermes+habitat+residences+water+roads+sand), *p*(.) | 201.27 | 21.37 | 0.00 | 0.00 | 10 | 164.35 |
| *Ψ*(cattle+armadillos+syntermes+habitat+residences+water+roads+sand), *p*(cattle_oc) | 205.98 | 26.08 | 0.00 | 0.00 | 11 | 161.98 |
| *Ψ*(cattle+armadillos+syntermes+habitat+residences+water+roads+sand), *p*(sand) | 207.74 | 27.84 | 0.00 | 0.00 | 11 | 163.74 |
| *Ψ*(cattle+armadillos+syntermes+habitat+residences+water+roads+sand), *p*(water) | 207.83 | 27.93 | 0.00 | 0.00 | 11 | 163.83 |
| *Ψ*(cattle+armadillos+syntermes+habitat+residences+water+roads+sand), *p*(roads) | 207.98 | 28.08 | 0.00 | 0.00 | 11 | 163.98 |
| *Ψ*(cattle+armadillos+syntermes+habitat+residences+water+roads+sand), *p*(syntermes) | 208.10 | 28.20 | 0.00 | 0.00 | 11 | 164.10 |
| *Ψ*(cattle+armadillos+syntermes+habitat+residences+water+roads+sand), *p*(armadillos_oc) | 208.10 | 28.20 | 0.00 | 0.00 | 11 | 164.10 |
| *Ψ*(cattle+armadillos+syntermes+habitat+residences+water+roads+sand), *p*(habitat) | 208.32 | 28.42 | 0.00 | 0.00 | 11 | 164.32 |
| *Ψ*(cattle+armadillos+syntermes+habitat+residences+water+roads+sand), *p*(residences) | 208.34 | 28.44 | 0.00 | 0.00 | 11 | 164.34 |
| *Ψ*(cattle+armadillos+syntermes+habitat+residences+water+roads+sand), *p*($(\text{temperature})^2$) | 216.82 | 36.92 | 0.00 | 0.00 | 12 | 164.45 |
| *Ψ*(cattle+armadillos+syntermes+habitat+residences+water+roads+sand), *p*($(\text{temperature})^2$*habitat) | 237.62 | 57.72 | 0.00 | 0.00 | 14 | 162.95 |
| **Modelling *Ψ*** | | | | | | |
| *Ψ*(roads), *p*(method) | 153.94 | 0.00 | 0.25 | 1.00 | 4 | 143.83 |
| *Ψ*(.), *p*(method) | 154.14 | 0.21 | 0.22 | 0.90 | 3 | 146.94 |
| *Ψ*(sand), *p*(method) | 155.12 | 1.18 | 0.14 | 0.55 | 4 | 145.01 |

| Model | AICc | Δ AICc | AICc Weights | Model Likelihood | Number of Parameters | Deviance |
|---|---|---|---|---|---|---|
| *Ψ*(water), *p*(method) | 156.10 | 2.16 | 0.08 | 0.34 | 4 | 145.99 |
| *Ψ*(cattle), *p*(method) | 156.34 | 2.41 | 0.07 | 0.30 | 4 | 146.24 |
| *Ψ*(residences), *p*(method) | 156.53 | 2.60 | 0.07 | 0.27 | 4 | 146.43 |
| *Ψ*(syntermes), *p*(method) | 157.01 | 3.07 | 0.05 | 0.22 | 4 | 146.90 |
| *Ψ*(habitat), *p*(method) | 157.05 | 3.11 | 0.05 | 0.21 | 4 | 146.94 |
| *Ψ*(armadillos), *p*(method) | 157.05 | 3.12 | 0.05 | 0.21 | 4 | 146.94 |

We also did not detect any influence of water resources on either occupancy or detection probabilities of *T. tricinctus*, even though we have sampled during the dry season. It is believed that *T. tricinctus* does not live close to water resources (neither artificial nor natural), but the reasons for that are not clear (SENA, 2017). However, a positive relationship between the occupancy probability of other armadillos and water resources was found in recent studies (FERREGUETTI; TOMAS; BERGALLO, 2016; RODRIGUES; CHIARELLO, 2018) and thus, this relationship deserves further investigations for *T. tricinctus* as well.

The lack of influence of the sand content on the occupancy and detection probabilities of *T. tricinctus* may relates to the sandy characteristic of the soils of our study area, consequently, we were not capable to effectively evaluate for the influence of soils with low sand contents. The same happened to temperature, which showed little variation along each sampling occasion, even though it presented higher daily variations. Hence, temperature may influence the detection probability of *T. tricinctus* only in a finer temporal scale (*i.e.,* daily), as already found for *T. matacus* (ATTIAS et al., 2018), but without influences in larger temporal scales, such as the five-day occasions considered here. We also did not found influence of other armadillos on *T. tricinctus* occupancy and detection, and it might be related to the small number of records of the other armadillos.

The detection probability of *T. tricinctus* varied according to the sampling method, being the detection though active searching almost 10-fold superior to camera trapping. Both methods are commonly used in studies with armadillos (*e.g.,* ANACLETO, 2007; ABBA; CASSINI, 2010; FERREGUETTI; TOMAS; BERGALLO, 2016). Camera trapping is generally considered an efficient non-intrusive and low environmentally disturbing method, whose efficiency does not vary significantly in almost all field conditions (SILVEIRA; JÁCOMO; DINIZ-FILHO, 2003). Also, it is accurate for species and individual identification, and cameras are easily handled by non-trained personnel (SILVEIRA; JÁCOMO; DINIZ-FILHO, 2003; LYRA-JORGE et al., 2008). However, camera trapping presents much higher initial costs than active-search based methods (*i.e.,* track counts and direct animal counts), although the costs of camera trapping are proportionately lower in long-term studies (SILVEIRA; JÁCOMO; DINIZ-FILHO, 2003; SRBEK-ARAUJO; CHIARELLO, 2005; LYRA-JORGE et al., 2008).

Active-search based methods, in turn, are considered highly efficient to record species occurrence (although some species are very difficult to identify), but they heavily depend on environmental conditions and on experienced personnel, and generally do not permit the identification of individuals, like camera trapping does (SILVEIRA; JÁCOMO; DINIZ-FILHO, 2003; MUNARI; KELLER; VENTICINQUE, 2011). In this study, we spent a total of 24 hours of active searching to detect direct or indirect evidences of *T. tricinctus* at 46% of the sampling units, whereas we spent 1,921 trap-days (*i.e.,* ~46,100 trap-hours) to detect it at 42% of the sampling units (*i.e.,* the *naïve* occupancies by each method). The costs with field personnel for the both methods were the same, once they were applied simultaneously. However, camera trapping involved an additional cost of more than 9,000 USD, not including maintenance and replacement expenses. Thus, active searching presented greater cost-benefit when compared to camera trapping to register *T. tricinctus*.

Other studies using camera traps have found higher detection probabilities for other armadillos in the Cerrado and in the Atlantic Forest of Brazil (FERREGUETTI; TOMAS; BERGALLO, 2016; RODRIGUES; CHIARELLO, 2018) when compared to the estimates we obtained by this method for *T. tricinctus*. Meanwhile, the camera-trapping success in recording *T. tricinctus* by Campos *et al.* (2019) in a protected area of the Caatinga was 0.005 records/trap-day, which is similar to the camera-trapping success we obtained (0.006 records/trap-day). Camera traps detect animals in a limited conical shaped zone, and they are designed to detect larger animals, being biased towards the detection of them (LYRA-JORGE et al., 2008; MEEK et al., 2015). Thus, the relative low performance of camera trapping to detect *T. tricinctus* may be explained by its size, as *T. tricinctus* is one of the smallest Brazilian armadillos (MEDRI; MOURÃO; RODRIGUES, 2011), with mean body mass of ~1,300 g in our study area (n = 19; R. A. Magalhães, unp. data).

Our sampling design may have also favored the detection of *T. tricinctus* by active searching, as the searches covered an area of 10 m radius (63 m²) surrounding each camera trap site, expanding the sampling to outside the detection zone of the camera traps. Active searching also enables the record of different types of evidences of species occurrence, which in the case of the vestiges of *T. tricinctus* (*e.g.,* tracks, forage burrows) were easily identifiable and resulted only in a few excluded due to uncertainty in identification.

Moreover, we employed highly skilled people from local communities to conduct active searches, who were identified and recruited from previous studies conducted in the area, and this may have also favored a higher detection probability for *T. tricinctus* by active searching. In other words, our experience reinforces the importance of the traditional ecological knowledge and the engagement of local communities into research and conservation initiatives as relevant tools to make them effective.

In summary, we provided the first quantitative evidence that *T. tricinctus* may be generalist regarding habitat use, being tolerant to habitat loss. Although hunting and habitat loss are considered the main threats to *T. tricinctus*, we found this species common and widespread in a human-modified landscape where there is an apparent low hunting pressure on it. This pattern suggests that hunting might be the most important threat to *T. tricinctus*, but it deserves further investigations.

Because we sampled only one area, the ranges of our predictor variables were constrained to only one landscape context, which might have limited us to properly evaluate the effect of some of these variables on *T. tricinctus* occupancy and detection probabilities (*e.g.,* occurrence of predators and prey, and sand content in the soil). Still, hunting and habitat loss may increase in the future with the loosening of environmental laws and the expanding of the anthropogenic activities into natural habitats, reducing *T. tricinctus* occurrence (BOCCHIGLIERI, 2010).

Hence, despite the evidence we found, we recommend further studies in different geographical scales and in landscapes with different habitat features and human pressures to better elucidate the drivers influencing *T. tricinctus* distribution. We also advocate the engagement of local people into research and conservation projects to achieve better outcomes, as we found by taking advantage of their traditional knowledge in the active searches we conducted. Finally, our results reinforce the importance of taking detection probability into account and to use different methods to draw accurate inferences about ecological processes.

# 4. CONCLUSÃO

De modo geral, este trabalho reforça a importância de se considerar e engajar as comunidades locais em projetos de pesquisa e conservação. Aqui, tal inclusão foi realizada por meio de metodologias participativas e compreendendo as relações humano-fauna na comunidade de Sumidouro (Capítulo 1), bem como pelo aproveitamento do conhecimento tradicional sobre objetos de estudo, como fizemos para as buscas ativas conduzidas para amostragem de *Tolypeutes tricinctus* (Capítulo 2).

Como esperávamos, não só espécies ameaçadas de extinção foram priorizadas para conservação em Sumidouro. Ao consideramos critérios de relevância cultural e vulnerabilidade local à sobre-exploração, além dos status de ameaça, também priorizamos *Mazama* sp., a espécie mais caçada, mais popular e uma potencial espécie-chave cultural no passado em Sumidouro. Além disso, com base na etnozoologia das espécies priorizadas, nós fomos capazes de sugerir ações de conservação com maior probabilidade de aceitação e consequente sucesso de implantação. Assim, concluímos que as informações etnozoológicas de fato auxiliaram no planejamento para conservação em nossa área de estudo.

Nós registramos uma diversidade de mamíferos relativamente alta em nossa área de estudo, incluindo nove espécies ameaçadas de extinção. De fato, a porção oeste da nossa área de estudo é atualmente classificada como uma Área Prioritária para a Conservação da Biodiversidade (BRASIL, 2017). De acordo com os moradores de Sumidouro, a maior parte desta porção da área de estudo não é de posse privada de nenhum morador da região. Devido a isso, a criação de Áreas Protegidas na região se torna mais factível, uma vez que requer menos desapropriações de terra para serem implementadas. Além disso, as obrigações legais referentes ao licenciamento ambiental das usinas eólicas e de outros empreendimentos que possam vir a ser instalados na região podem ser planejadas de modo a subsidiar a implementação e o manejo de Áreas Protegidas (*e.g.,* compensações ambientais por meio de criação de Reservas Particulares do Patrimônio Natural e financiamento de planos de manejo).

Nesse sentido, embora não tenha sido contemplado nesse trabalho, nós também identificamos hábitats prioritários para a conservação, de acordo com a percepção de moradores de Sumidouro (Anexo 1). Esses hábitats foram aqueles com maior potencial aceitação de sua conservação pela comunidade. Tais hábitats compreendem recursos hídricos superficiais (nascentes e córregos) e seus ambientes associados (ripários), bem como áreas de vegetação florestal nativa lenhosa, devido ao comum uso de madeira para confecção de cercas e como lenha em Sumidouro.

Considerando a alta relevância biológica conhecida da área de estudo (especialmente sua porção oeste que é prioritária para conservação) e sendo conhecida parte das oportunidades para conservação na comunidade de Sumidouro (espécies e hábitats prioritários), nós recomendamos o direcionamento de esforços de conservação para esta área, seja por meio de projetos de pesquisa e conservação como este, ou por meio de políticas públicas, como a criação de Áreas Protegidas.

Especificamente se tratando de *T. tricinctus*, a ampla distribuição da espécie em nossa área de estudo torna possível estudar outros aspectos de sua biologia que são ainda pouco conhecidos, mas importantes para sua conservação, como dieta, padrões de atividade, comportamento reprodutivo. Ademais, *T. tricinctus* é bem conhecido e bem quisto em Sumidouro e parece não ser um alvo comum de caça, favorecendo a aceitação de sua conservação na área (*i.e.,* oportunidades para conservação; KNIGHT; COWLING, 2007). Logo, parece viável o desenvolvimento de ações de conservação direcionadas ao manejo desta população da espécie. Consequentemente, nós consideramos esta população de *T. tricinctus* como prioritária para o direcionamento de esforços para a conservação da espécie.

Com base nos nossos resultados, nós acreditamos que a caça possa constituir a ameaça mais grave à espécie, embora esta hipótese mereça investigação empírica futura. Partindo desse pressuposto, nós acreditamos que esforços para a conservação de *T. tricinctus* devam priorizar medidas de controle e redução da caça sobre ela. Essas medidas podem incluir, por exemplo, aquelas que objetivem direta ou indiretamente a redução da pobreza nas comunidades que interagem com *T. tricinctus* e a efetiva fiscalização da caça, que são fatores que nós encontramos como sendo responsáveis por uma aparente redução da caça em Sumidouro. Não menos importante, a implementação e manejo efetivo de Áreas Protegidas permanece como medida prioritária para a conservação da espécie, prevenindo a perda de hábitat e a caça sobre ela, especialmente considerando-se que *T. tricinctus* é encontrado em apenas um pequeno número de Áreas Protegidas até então existentes (REIS et al., 2015).

Em síntese, nós encontramos evidências quantitativas do padrão já observado anteriormente de que *T. tricinctus* pode ser comum e bem distribuído em paisagens modificadas pelo homem sujeitas a moderados níveis de perda de hábitat. Dada a sua distribuição ampla e a viabilidade de sua conservação verificada em nossa área de estudo, nós consideramos esta população de *T. tricinctus* prioritária para a conservação da espécie. Considerando a viabilidade de conservação de *T. tricinctus*, a alta biodiversidade registrada e o fato de nossa área de estudo já ser classificada como prioritária para conservação, nós reforçamos a sua prioridade para direcionamento de esforços de conservação, incluindo políticas públicas, como a criação de Áreas Protegidas. Nós também ressaltamos a importância de que tais ações de conservação sejam planejadas de modo a levar em consideração o conhecimento tradicional das comunidades locais e utilizar metodologias participativas visando ao engajamento dessas comunidades para a obtenção de melhores resultados.

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**ANEXO 1 - Resumo de trabalho apresentado no V Simpósio Brasileiro de Biologia da Conservação**

**Integrando conhecimentos científico e popular para identificação de espécies e hábitats prioritários para a conservação em uma paisagem impactada no nordeste do Brasil**

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Embora a conservação da biodiversidade seja crucial para a manutenção dos ecossistemas, é impraticável conservar sem priorizar elementos da biodiversidade e respectivas áreas de maior relevância a este fim. A priorização de espécies baseia-se em seus *status* de ameaça, frequentemente desconsiderando fatores socioculturais que interferem na efetividade das ações de conservação. Mamíferos de médio e grande porte (>1 kg) são comumente priorizados devido à sua vulnerabilidade a atividades antrópicas, importância para o funcionamento de ecossistemas, e popularidade/carisma (*i.e.,* espécies-bandeira). Este estudo objetivou identificar mamíferos de médio e grande porte e hábitats percebidos como prioritários para conservação por uma comunidade rural localizada em área prioritária para conservação da Caatinga, no estado da Bahia, Brasil. A mastofauna foi inventariada utilizando armadilhamento fotográfico e busca ativa em duas ocasiões (agosto-setembro/2017; abril-julho/2019), além de entrevistas semiestruturadas com moradores locais que possuíam conhecimento sobre mamíferos, selecionados por meio da indicação dos próprios moradores (*i.e.*, método bola-de-neve). A partir das entrevistas, também foram coletadas informações etnozoológicas (espécies-chave culturais, populares/carismáticas e vulneráveis à caça e/ou abate por retaliação) e a percepção dos moradores quanto a hábitats prioritários para a conservação. Os dados obtidos nas entrevistas foram analisados pelo Índice de Saliência de Smith (S). Registramos 29 espécies, das quais oito encontram-se ameaçadas: *Leopardus pardalis, Leopardus tigrinus, Lycalopex vetulus, Myrmecophaga tridactyla, Panthera onca, Puma concolor, Puma yagouaroundi* e *Tolypeutes tricinctus*. Ao todo, realizamos 31 entrevistas, mas o número de respondentes por pergunta variou. Nenhum informante ($n_{total} = 30$) considerou a existência de espécies-chave culturais, mas 43% ($n_{total} = 28$) identificaram espécies populares/carismáticas, destacando-se *Mazama* sp. ($S = 0,347$; $S_{min} = 0,014$) e *Tolypeutes tricinctus* ($S = 0,250$; $S_{min} = 0,014$). Espécies vulneráveis a abate por retaliação foram citadas por 93% dos informantes ($n_{total} = 30$), destacando-se *Panthera onca* ($S = 0,824$; $S_{min} = 0,009$). Já 88% ($n_{total} = 26$) identificaram espécies mais caçadas na região, sendo *Mazama* sp. o alvo preferencial ($S = 0,790$; $S_{min} = 0,006$). Áreas próximas a recursos hídricos foram percebidas como prioritárias para conservação ($S = 0,560$; $S_{min} = 0,018$), seguidas de áreas de vegetação nativa arbóreo-arbustiva ou florestal ($S = 0,262$; $S_{min} = 0,018$). A percepção desses hábitats como prioritários relaciona-se à oferta de serviços ecossistêmicos, como provisão de água e madeira. Além das espécies ameaçadas, *Mazama* sp. também pode ser priorizada para conservação, devido à sua eminente vulnerabilidade local à caça. *Panthera onca*, por sua vez, encontra-se Criticamente Em Perigo no estado da Bahia e apresenta alto potencial local para abate por retaliação. Portanto, a legalização da caça de animais silvestres no Brasil, atualmente em debate, poderia ser especialmente danosa para as populações locais dessas espécies. Já *Tolypeutes tricinctus,* além de endêmico do Brasil e atualmente Em Perigo na Bahia, é considerada uma espécie popular/carismática localmente, favorecendo o engajamento da comunidade local à sua conservação e seu eventual uso como espécie-bandeira. Futuramente, espera-se avaliar a correspondência entre as distribuições espaciais das espécies e dos hábitats prioritários levantados pelos moradores, contribuindo para a efetiva conservação da biodiversidade local.

Palavras-chave: Caatinga; caça; espécies ameaçadas; espécie-bandeira; etnozoologia.

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## APÊNDICE 1 - Roteiro de Entrevista

| **Question number (objective)** | **Social profile** |
|---|---|
| 1 | Gender |
| 2 | Name |
| 3 | Age (in years) |
| 4 | Length of residence in the region (in years) |
| 5 | Occupation |
| | **Mammal diversity** |
| 6 (mammal inventory) | What animals occur in Sumidouro? |
| 7 (perceived abundance) | Which of the mammals (those with fur, carapace, snout, hull) you cited are more abundant? List they in order of abundance. |
| | **Human-fauna interactions (ethnozoology)** |
| 8 (potential cultural keystone species) | Is there any native animal that is or has already been especially important for the culture and survival of the people of Sumidouro? |
| 9 (popular animals) | Is there any native animal that is kind of charismatic, that people have that people would be sad if it would disappear, because they have affection for it? If yes, list animals, starting from the most liked one. |
| 10 (unpopular animals) | Is there any native animal that causes losses or that people do not like or be afraid from? If yes, list animals, starting from the most disliked one. |
| 11 (hunted species) | Do people hunt or have they already hunted in Sumidouro? If yes, list the most hunted animals, starting from the most hunted one. |

## APÊNDICE 2 - Registros de mamíferos e outros animais

***Didelphis albiventris* in April 2019.**

***Myrmecophaga tridactyla* in April 2019.**

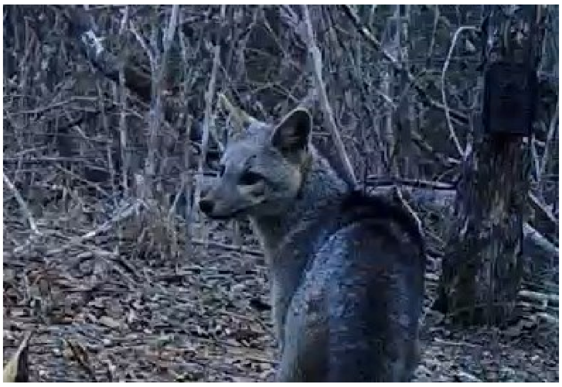
***Cabassous tatouay* in October 2019.**

***Euphractus sexcinctus* in June 2019.**

***Tolypeutes tricinctus* in August 2017.**

***Dasypus novemcinctus* in October 2019.**

***Mazama sp.* in June 2019.**



***Cerdocyon thous* in August 2017.**

***Lycalopex vetulus* in April 2019.**

***Herpailurus yagouaroundi* in August 2017.**

***Leopardus pardalis* in September 2017.**

***Leopardus tigrinus* in May 2019.**

***Panthera onca preying on Tolypeutes tricinctus* in September 2017.**

**A young *Puma concolor* in May 2019.**

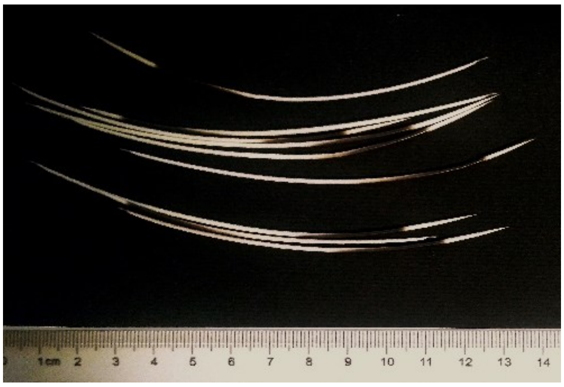
**Free-ranging horse cub attacked by *Puma concolor* in September 2019.**

***Conepatus semistriatus* in August 2017.**

***Sylvilagus brasiliensis* in April 2019.**

***Dasyprocta prymnolopha* in June 2019.**

*Galea spixii* in June 2019.




Thorns of *Coendou prehensilis* given by an informant during an interview in June 2019.

*Crypturellus noctivagus zabele* in June 2019.

## APÊNDICE 3 - Informações etnozoológicas adicionais

### Transcriptions of Respondent's Answers in Audio Recorded Interviews

A small number of informants agreed to have the audio of their (semi-structured) interviews recorded. For those who agreed, we present some parts that illustrate our results.

- Informant C. R. P. S., 36 years old:

> "*Em outro tempo aí, o povo vivia mais da caça (...). Hoje ninguém sobrevive mais disso. E também, hoje as coisas estão mais fáceis. É que em outro tempo aí, era mais complicado de estrada, de tudo, então a pessoa vivia mais da terra mesmo. Explorava-se mesmo o que tinha na região. Mas hoje, a maioria das coisas vem de fora*". / "In another time, people relied on hunting to live (…). Currently, nobody relies on hunting to live. Also, things are easier to acquire. In another time, roads, everything was complicated, so the person relied on its land to survive. It was explored what existed in the region. But, nowadays, the majority of things comes from outside".

> "*E também tem aquela questão da onça, que vem tendo um conflito aí entre os criadores e o animal mesmo* (...). *Teve gente aí que* (...) *já perdeu criação, e ela [Panthera onca] está atacando direto,* (...) *gado e esses jegues,* (...) *os filhotinhos mesmo* (...). *Ele não é mais esperto do que o gado, e acaba sendo presa fácil pra ela.* (...). *Mas também não é dizer que tem que sumir com ela daqui*". / "And there is that jaguar issue too, that has been having a conflict here between ranchers and that animal indeed. (…). There was people here that (…) have lost their livestock, and it [*Panthera onca*] is attacking frequently (…) cattle and those donkeys, (…) the cubs indeed (…). It isn't smarter than the adult cattle individuals, and then it becomes an easy prey for it [*Panthera onca*]. (…) But neither it is to say that it must get her out from here".

- Informant O. S., 49 years old:

> "*Parou esse tipo de matança. Esse tempo é o tempo que tinha fome. Nesse tempo, saía-se pra o mato com cachorro, com espingarda, matando os*

*bichinhos*; *era precisando. Mas hoje em dia, melhorou muito. Carro está passando na porta carregado de tudo. E os bichinhos estão tendo* (...). *Acabou a fome". / "*It has stopped this kind of killing. That time was the hunger time. In that time, someone went out to the field with dogs, rifles, killing the animals; it was by necessity. But, nowadays, it has gotten better a lot. Automobiles are passing by full of everything. And the animals are there (…). Things got better. Hunger is over".

- Informant M.M.A., 59 years old:

"*Tamanduá [Myrmecophaga tridactyla] estando acuado de cachorro é pior do que onça* (...). *Aquele bicho tem uma unha que vou te falar, viu*". / "*Tamanduá [Myrmecophaga tridactyla]* being cornered by a dog is worse than the jaguar (…). That animal has a nail [its claws indeed] that I'll tell you".

"*Gambá [Conepatus semistriatus] eu já utilizei. É gostoso*". / "*Gambá [Conepatus semistriatus]* I've already used. It's tasty".

"*Uma vez mataram aí* (...). *A carne dele [Myrmecophaga tridactyla] é esfiapenta; carnona dura* (...). *Não deu certo não*". */* "Once, someone killed it there (…). Its meat *[Myrmecophaga tridactyla]* is frayed; such a tough meat (…) It didn't work".

- Informant M. R., age not mentioned:

"*Antigamente todo mundo sempre sobrevivia de uma cacinha. Vivia-se no mato, era fácil. Pegava-se um bichinho, trazia pra casa, pra comer com a família. E agora, por causa dessa firma que tem aí, além de eles* [animais caçados] *já serem poucos, a agente não está podendo obter mais esses bichos. O IBAMA não quer* (...). *Alguns anos aí mais pra trás, vinham uns meninos aí, até de Seabra mesmo [uma cidade vizinha]. Eles traziam uns cachorros, e tinha um capoeirão muito grande lá embaixo.* (...). *Quando ela [codorna, Nothura sp.] voava, pá [som de tiro]!* (...). *Eles saíam daqui ó! Olha o saco, ó!* (...). *Cheinho de codorna* (...). *Agora acabou*". / "In the past, everybody survived from hunting. People used to pick up an animal, and bring it to home to eat with the family. And now, due to this company [wind farms], besides the animals are already few, we are not being allowed to get these animals anymore. The IBAMA [a public environmental regulatory agency of Brazil] doesn't want (...). Some years ago, some guys used to come here, even from Seabra [a nearby town]. They brought dogs, and there was a very large *capoeira* [anthropized area under regeneration] down there. When it [*Nothura sp.*, *codorna*] took off, *pá* [shot sound]! (...). When they went out, see! The bags, see! (…). Full of *codornas*. Now, it's over".

*Eu já peguei esse bichinho [Leopardus tigrinus]. O couro dava dinheiro* (...). *Botava uma coisa que fede* [na armadilha], sabe? (...). *Aí eu botava* (...) *um mundéu de pau*. *Fazia um mundéu* (...). *Deixa a boca pra ele entrar, e lá você bota uma isca, na trava de trás, aí ele já chega, a boca está aberta, ele vê o cheiro e emboca pra comer, e aqui tem uma trava que, puxou lá a isca, a tampa desce* (...). *Aí tampa a boca* (...). *Já peguei, moço... dava um dinheirinho na certeza* (...). *Já tinha um comprador certo ali na Lagoa do Dionísio. Ele dizia: 'ô moço, essas armadilhas que você faz, faz bastante, faz bastante pra ver se cai um montão de gato lá que eu compro'* (...). *A carne, aqui tinha um menino que comia. Só ele".* / "I've already caught this animal *[Leopardus tigrinus]*. Its skin used to raise money for us (…). We put something that sticks [into the trap], you know? (…). Then I built a *mundéu* [a kind of trap] (…). You let an entrance, to allow him go into the trap, and there you put the bait, in the back lock, then he comes, the entrance is open, he smells and goes into to eat, and there is a lock that, when the bait is pulled, the cover goes down (…). Then it covers the entrance (…). I've already caught, man… it used to surely make money (…). There was a loyal client there in Lagoa do Dionísio [a nearby village]. He used to say: 'hey, man, these traps you make, please make a lot, make a lot to see if a lot of cats are caught there, so I'll buy' (...). Its meat, here, there was a guy that used to eat it. Only him".

*Aquele [Leopardus pardalis] também, o couro, aqui pra nós, dava um dinheirão* (...). *A gente botava eles em um mundéu, em uns poleiros, e os bichos não caíam.* (...). *Só que pra esse outro, o poleiro era maior um pouco [do que aquele utilizado para Leopardus tigrinus], porque ele [Leopardus pardalis] é maior, né*". / That one [*Leopardus pardalis*], its skin also gave much money to us (...). We put them into a *mundéu* [a kind of trap] (…). For this one, the perch was a little bigger [than that one used for *Leopardus tigrinus*], because they [*Leopardus pardalis*] are bigger, right".

“Não precisa correr pra pegar ele [*Tolypeutes tricinctus*]. Ele vai andando, a gente trisca nele, ele fecha. Vira uma bola (...). Pra desarmar ele, só ele mesmo. (...). Se fosse um de nós, não desarmaria ele (...). Pra desarmar, (...) pega-se um facão, dá-se umas duas cacetadas. (...). Aí ele desarma. / “It’s not necessary to run to catch him [*Tolypeutes tricinctus*]. He walks, we scratch him, he closes. He turns into a ball (…). To disarm him, only himself (…). If it was one of us, it wouldn’t disarm (…). To disarm, (…) one must take a machete, and give a couple of clubs (…). Then he disarms.

## Folk Names Associated to the Scientific Species Recorded

In the following table, we present the folk names that could be associated to each scientific species we recorded in our study area, considering all methods we employed. Only one species was not recorded by interviews (*Lycalopex vetulus*), but it was referred as the ethnospecies *raposa*, together with *Cerdocyon thous*. After each folk name, we also presented the number and frequency of citation of each of them.

| Species | Folk names (number of citations; frequency) |
|---|---|
| **Didelphimorphia** | |
| Didelphidae | |
| *Didelphis albiventris* | saruê (17; 100%) |
| **Pilosa** | |
| Myrmecophagidae | |
| *Myrmecophaga tridactyla* | tamanduá-bandeira (21; 100%) |
| *Tamandua tetradactyla* | mixila (21; 100%) |
| **Cingulata** | |
| Chlamyphoridae | |
| *Euphractus sexcinctus* | tatu-peba (25; 100%) |
| *Cabassous tatouay* | tatu-rabo-de-couro (16; 84%); tatu-de-rabo-mole (4; 21%) |
| *Tolypeutes tricinctus* | tatu-bola (25; 100%) |
| Dasypodidae | |
| *Dasypus novemcinctus* | tatu-galinha (2; 8%); tatu-preto (15; 63%); tatu-verdadeiro (7; 29%) |
| *Dasypus septemcinctus* | fininha (1; 5%); tatu-meão (2; 11%); tatuí (8; 42%); tatu-china (8; 42%) |
| **Cetartiodactyla** | |
| Cervidae | |
| *Mazama* sp. | veado (28; 100%); canela-seca (1; 4%) |
| Tayassuidae | |
| *Pecari tajacu* | caititu (24; 100%); porco-do-mato (1; 4%) |
| **Primates** | |
| Callitrichidae | |
| *Callithrix penicillata* | mico (1; 5%); saguim (1; 5%); soim (20; 95%) |
| Cebidae | |
| *Sapajus* sp. | macaco (2; 100%) |
| Atelidae | |

| Species | Folk names (number of citations; frequency) |
|---|---|
| *Alouatta* sp. | macaco (1; 33%); bugio (1; 33%); barbado (1; 33%) |
| **Carnivora** | |
| Canidae | |
| *Cerdocyon thous* | raposa (8; 100%)[1] |
| *Lycalopex vetulus* | raposa (0) [1] |
| Felidae | |
| *Herpailurus yagouaroundi* | gato-raposo (12; 86%); gato-vermelho (2;14%) |
| *Leopardus pardalis* | gato-macaial (13; 100%); barba-dura (1; 8%); jaguatirica (2; 15%) |
| *Leopardus tigrinus* | gato-do-mato (3; 19%); gato-pintado (9; 56%); gato-mamoninha (4; 25%); gato-macambira (2; 13%);<br>gato-preto[2] (5; 31%); tustão (1; 6%) |
| *Panthera onca* | onça-pintada (24; 96%); onça-preta[2] (19; 76%) |
| *Puma concolor* | suçuarana-de-lombo-preto (2; 8%); onça-de-lombo-preto (2; 8%); onça-melada (2; 8%); onça-parda (4; 17%);<br>onça-vermelha (5; 21%); suçuarana (18; 75%); suçuarana-veadeira (1; 4%); suçuarana-boiadeira (1; 4%) |
| Procyonidae | |
| *Nasua nasua* | quati (5; 100%) |
| *Procyon cancrivorus* | caminheiro (4; 100%) |
| Mustelidae | |
| *Eira barbara* | meleiro (1; 100%) |
| Mephtidae | |
| *Conepatus semistriatus* | gambá (24; 100%) |
| **Lagomorpha** | |
| Leporidae | |
| *Sylvilagus brasiliensis* | coelho (15; 60%); lebre (11; 44%) |
| **Rodentia** | |
| Dasyproctidae | |
| *Dasyprocta prymnolopha* | cutia (21; 100%) |
| Caviidae | |
| *Galea spixii* | preá (21; 100%) |
| *Kerodon rupestris* | mocó (19; 100%) |
| *Hydrochoerus hydrochaeris* | capivara (1; 100%) |
| Erethizontidae | |
| *Coendou prehensilis* | cacheiro (9; 100%) |
| Cuniculidae | |
| *Cuniculus paca* | paca (6; 100%) |

## Description of Ethnospecies Cited in Semi-structured Interviews

Here we present the ethnospecies recorded during the semi-structured interviews, the number of times each of them was cited during these interviews, the number and frequency of citation of the folk names that could be associated to each of them, notes about the classification of the ethnospecies, and the scientific species that could be attributed to each of them.

| Ethnospecies | Number citations of each ethnospecies | Folk names (number of citations; frequency of citation) | Notes | Scientific species |
|---|---|---|---|---|
| *Dasypus* sp1 (largest species) | 2 | *tatu-galinha* (1; 50%); tatu-verdadeiro (1; 50%) | Only two species of *Dasypus* are known to potentially occur in the area: *D. novemcinctus* and *D. septemcinctus* which are not reliably identified only by their sizes | *Dasypus novemcinctus* |
| *Dasypus* sp2 (intermediate species) | 2 | *tatu-meão* (1; 50%); *tatuí* (1; 50%) | | *Dasypus novemcinctus* or *D.septemcinctus* |
| *Dasypus* sp3 (smaller species) | 2 | *tatu-china* (2; 100%) | | |
| Canidae sp1 (native canids) | 26 | *raposa* (26; 100%) | some informants differentiate *Cerdocyon thous* from *Lycalopex vetulus,* stating that only *C. thous* occur in the area. However, we recorded *L. vetulus* by camera trapping and active searching. | *Cerdocyon thous* or *Lycalopex vetulus* |
| gray fur *Herpailurus yagouaroundi* | 12 | *gato-raposo* (12; 86%) | the folk name refers to the resemblance of its fur to the fur of *Cerdocyon thous* | *Herpailurus yagouaroundi* |
| reddish fur *Herpailurus yagouaroundi* | 2 | *gato-vermelho* (2; 14%) | - | |
| spotted *Leopardus tigrinus* | 16 | gato-do-mato (3; 19%); gato-pintado (9; 56%);<br>gato-mamoninha (4; 25%); gato-macambira (2; 13%);<br>tustão (1; 6%) | - | *Leopardus tigrinus* |
| melanic *Leopardus tigrinus* | 5 | *gato-preto* (5; 31%) | - | |
| spotted *Panthera onca* | 24 | *onça-pintada* (24; 96%) | - | *Panthera onca* |
| melanic *Panthera onca* | 19 | *onça-preta* (19; 76%) | - | |
| uniformly reddish *Puma concolor* | 12 | *onça-melada* (2; 8%); *onça-parda* (4; 17%);<br>*onça-vermelha* (5; 21%); *suçuarana* (18; 75%) | - | *Puma concolor* |
| *Puma concolor* with darker back | 4 | *suçuarana-de-lombo-preto* (2; 8%); *onça-de-lombo-preto* (2; 8%); | - | |
| *Puma concolor* that usually attacks deer | 1 | *suçuarana-veadeira* (1; 4%) | No specific physical characteristic that differentiates these two ethnospecies was reported | |
| *Puma concolor* that usually attacks cattle | 1 | *suçuarana-boiadeira* (1; 4%) | | |

**Descriptions of Uses Given to Animals**

Here we describe the uses given by each species mentioned as being used as food, medicine or symbolically. Some species and their uses were spontaneously cited by informants during the semi-structured interviews. In other words, these species were not free listed as most hunted species, but their uses were mentioned during the interviews. We considered only species that at least one informant described the use as food, medicine or a symbol (columns "For what to use" and "How to use").

| Species | Use | Part used | For what to use | How to use |
|---|---|---|---|---|
| *Cabassous tatouay* | food | - | - | not mentioned |
| | medicinal | tail tip | bleeding | holding it tight |
| | medicinal | tail | deafness | heat the tail in the fire, collect the "brine" (a liquid) that comes out of it and drip it into the ear |
| *Coendou prehensilis* | food | - | - | meat cooked with orange leaves |
| | medicinal | thorns | stroke | not mentioned |
| | medicinal | thorns | respiratory diseases | toast the thorns, powder them and drink them with water or sugarcane liquor (*cachaça*) |
| *Conepatus semistriatus* | food | - | - | not mentioned |
| | medicinal | anal gland fluid | not mentioned | put into a bottle with water, let it maturate and, then, drink it |
| | medicinal | anal gland fluid | toothache | store the liquid in a pot, soak it in cotton and pass it on the aching tooth |
| | medicinal | meat | ill being generated in the postpartum period (*resguardo quebrado*) | not mentioned |
| | medicinal | skin | skin wound healing | scrape the skin and boiling it |
| *Crotalus durissus* | symbolic | rattle | to avoid bites from other snakes | carry with the person |
| *Didelphis albiventris* | food | - | - | not mentioned |
| | medicinal/symbolic | bones | to help women in labor who cannot give birth | hanging the bone on the neck |

| Species | Use | Part used | For what to use | How to use |
|---|---|---|---|---|
| | medicinal | bones | to help women in labor who cannot give birth | toast the bones, powder them and drink them with water or sugarcane liquor (*cachaça*) |
| | medicinal | bones | rheumatism | toast the bones, powder them and drink them with water or sugarcane liquor (*cachaça*) |
| *Leopardus pardalis* | food | - | - | not mentioned |
| | commercial | skin | trading | not mentioned |
| *Leopardus tigrinus* | food | - | - | not mentioned |
| | commercial | skin | trading | not mentioned |
| *Mazama* sp. | food | - | - | not mentioned |
| | medicinal | - | long lasting cough | not mentioned |
| | medicinal | shin marrow | to help children to walk | drink boiled infusion |
| Native canids (*raposa*) | food | - | - | not mentioned |
| | medicinal | lard | rheumatism or "stiff nerve" (result of injury) | frying the lard and massaging over body parts |
| | medicinal | lard | as anesthesia for toothache | pass lard-soaked cotton on the tooth |
| *Salvator* sp. (*teiú*) | food | - | - | not mentioned |
| | commercial | skin | trading | not mentioned |
| | medicinal | skin | flu and stroke | toast the skin, powder it and pass it on the nose |
| | medicinal | lard | deafness | fry the lard, soak it in cotton and pass it with a swab in the ear |
| *Rhynchotus rufescens* | food | - | - | not mentioned |
| | medicinal | feather | stroke | not mentioned |
| *Panthera onca* | food | - | - | not mentioned |
| | medicinal | lard | rheumatism or "stiff nerve" (result of injury) | fry the lard and massaging over body parts |
| *Tolypeutes tricinctus* | food | - | - | not mentioned |
| | medicinal | movable bands | bronchitis, gastritis, back problems | toast the bands, powder them and drink them with water or sugarcane liquor (*cachaça*) |

**Reports from Participant Observations**

The people of Sumidouro live basically from their lands, by agriculture and cattle rising. However, with the arrival of the wind farms, some of them start working for the enterprise temporarily or constantly. Moreover, according to some residents, the wind farms brought electricity for the community in 2010, because it was needed for the construction of the enterprise, while electricity was predicted to be installed only in 2020. Consequently, the residents of Sumidouro are apparently very grateful for the arrival of the wind farms.

The practice of sport hunting was witnessed by one of the authors (R. A. Magalhães) during a festivity in Sumidouro community in October 2019, when meat crumbs of *Tolypeutes tricinctus* was served. According to some residents that were at that event, the animal was hunted in an adjacent community and acquired by an unidentified resident of Sumidouro. Key-informants suggested two motivations for this practice. Some considered that it probably was an opportunistic occasion, when possibly a well-known hunter from an adjacent community had previously encountered and captured individuals of *Tolypeutes tricinctus*, and then stocked its meat. Next, the resident of Sumidouro would have been ordered the meat from the hunter to serve it in the festivity, because a foreign person would have asked for local bushmeat to try it. Another key-informant reported that bushmeat is sometimes consumed by specific residents of Sumidouro in festivities, and that sometimes they hunt, sometimes they acquire from hunters from adjacent communities. None of the key-informants mentioned whether the meat was bought or exchanged for other goods, or if it was given for camaraderie by the hunter.