



Indications of changes in hunting culture in the Central-South Region of Brazil in the last 25 years: a systematic literature review

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Abstract: Hunting has been banned in Brazil by a Federal Law (No. 5197), except in a few cases where it has been regulated, for over 50 years now. Since then, the country suffered dramatic land use change, especially in its Central-South region. In this study we investigate the possible influence of land use change on hunters' socioeconomic profile (e.g., education, income) and motivation (e.g., leisure or subsistence) in the Central-South Brazil since the implementation of the ban policy. On a systematic literature review we found 18 papers about hunting activities and hunters' profile in this region, one third of which presented evidence of change in hunting activities or in hunters' profile somehow related to land use change since 1967. With this small number of articles, it was not possible to fully assess whether there was a change in hunting culture in the target region as a result of changes in land use. However, the found studies present consistent evidence of changes in hunting culture, especially in regard to a trade on the hunted species, hunting techniques and hunters' profile. Considering the relevance of hunting in agricultural landscapes for wildlife conservation, we hope the present results stimulate further studies on this field.

Keywords: *Hunting; Habitat Transformation; Cultural Change; Wildlife Management, Agricultural Landscapes.*

Indícios de mudanças na cultura da caça na região Centro-Sul do Brasil nos últimos 25 anos: uma revisão sistemática da literatura

Resumo: A caça é uma atividade proibida no Brasil por uma Lei Federal (nº 5.197), exceto em alguns casos onde é regulamentada, há mais de 50 anos. Desde então, o país sofreu uma mudança dramática no uso da terra, especialmente na região Centro-Sul. Neste estudo investigamos a possível influência da mudança no uso da terra no perfil socioeconômico (e.g., educação, renda) e motivação (e.g., lazer, subsistência) dos caçadores no Centro-Sul do Brasil desde a implementação da política de proibição. Em uma revisão sistemática da literatura encontramos 18 artigos sobre atividades cinegéticas e o perfil dos caçadores nesta região, sendo que um terço apresentou evidências de alguma mudança nas atividades cinegéticas ou no perfil dos caçadores, relacionada à mudança do uso da terra desde 1967. Com este pequeno número de artigos, não foi possível avaliar plenamente se houve mudança na cultura cinegética na região-alvo em decorrência de mudanças no uso da terra. No entanto, os estudos encontrados apresentam evidências consistentes de mudanças na cultura da caça, principalmente no que diz respeito ao comércio das espécies caçadas, técnicas de caça e perfil dos caçadores. Considerando a relevância da caça em paisagens agrícolas para a conservação da vida selvagem, esperamos que os presentes resultados estimulem novos estudos nesta área.

Palavras-chave: *Caça; Transformação de Habitats; Mudança Cultural; Gestão da Vida Selvagem, Paisagens Agrícolas.*

Introduction

Globally, there is a wide range of hunting governance systems (Nasi *et al.* 2008, Ingram *et al.* 2021) from different property regimes to access rights and actors involved. Although it is not clear which governance systems and policy tools are more effective in promoting the sustainability of hunting activities, studies show that where hunting activities are completely banned, information about poaching (*i.e.*, illegal hunting activities) is restricted or inexistent (Nasi *et al.* 2008, Duporge *et al.* 2020, Ingram *et al.* 2021, Lavadinović *et al.* 2021). Without the implementation of well-established and regulated hunting management systems, long-term evaluations of the impact of hunting activities locally and regionally are usually missing (Nasi *et al.* 2008, Ingram *et al.* 2021). Such a situation has been reported in Brazil (Tomas *et al.* 2018, Bragagnolo *et al.* 2019; Vieira *et al.* 2019).

Hunting has been banned in Brazil since 1967 by Federal Law No. 5197 (Brazil, 1967 – known as the Wildlife Protection Law), except in a few cases where it has been regulated. Since then, the activity has been consolidated as one of the biggest environmental taboos in Brazil (Tomas *et al.* 2018, Bragagnolo *et al.* 2019, Vieira *et al.* 2019). Mostly ineffective enforcement and the cultural rooting of the activity made it difficult to totally ban hunting despite the law (Tomas *et al.* 2018, Bragagnolo *et al.* 2019). The activity is still carried out for subsistence, species population control, commerce, and sport (Verdade 2004, Palmeira *et al.* 2008, El Bizri *et al.* 2015, Van Vliet *et al.* 2014, Mendonça *et al.* 2016; Fernandes-Ferreira & Alves 2017, da Silva *et al.* 2022). The lack of legal mechanisms to guarantee confidentiality and professional secrecy for biologists and other environmental professionals hinder the study of these activities (Verdade & Seixas 2013). Currently, the field of ethnozoology is one of the areas that most contributes to understand hunting in the country (Alves & Souto 2011). It is not surprising, therefore, that the scope, characteristics, and magnitude of this activity, as well as the change it has undergone over the past 50 years are mostly unknown for most regions of the country (Fernandes-Ferreira & Alves 2017; Tomas *et al.* 2018, Bragagnolo *et al.* 2019).

Since the implementation of the Wildlife Protection Law, Brazil has suffered dramatic land use change, with extensive socioeconomic and environmental impacts (Palmeira 1989; Gonçalves Neto 1997). Two significant elements in the context of hunting stand out in this process: agricultural expansion, with the consequent transformation of natural habitats, and rural exodus. Since the 1960's, a process of modernization of the agriculture field was consolidated in the country, with the implementation of an agro-industrial sector based on mechanized agriculture (Teixeira 2005, Matos & Pessoa 2011). Between 1970 and 2016, the annual soybean production in the country went from around 2 to 95.7 million tons; the production of sugarcane increased from 70 to 700 million tons; and cattle herds increased from 78 to 215 million heads (IBGE 2009, IBGE 2017a, IBGE 2017b). To accommodate such expansion, the area used for agricultural production went from 189 to more than 275 million hectares (Mha) of which approximately 64 Mha for agriculture and 211 Mha for livestock production, representing all together 35% of the Brazilian territory in 30 years (1970–2010) (Sparovek *et al.* 2011, IBGE 2016, IBGE 2017c). By 2022, more 7 Mha were expected to be converted for agriculture and livestock production in Brazil (Gasques *et al.* 2012). Local biodiversity decline

and extinction, and consequent change in biological communities' composition and dynamics were directly caused by land use change in all biomes (Magnusson 2006, Verdade *et al.* 2014a, Verdade *et al.* 2016). Consequently, human populations have increased their access to natural vegetation remnants and to game species (Turner and Corlett, 1996).

The Central-South is the most developed of the three Brazilian geoeconomics macro-regions. It comprises the states of Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Espírito Santo, Mato Grosso do Sul, and Goiás, besides the Federal District and the southern region of Minas Gerais, Mato Grosso and Tocantins states, (IBGE 2018). It also encompasses five of the six Brazilian biomes: Cerrado, Atlantic Forest, Amazon, Pampa, and Pantanal. This macro-region suffered the most intense processes of agricultural expansion and rural exodus since the 1970's (Grecchi *et al.* 2014, Overbeck *et al.* 2007).

With the benefits of agriculture expansion mainly focused on large properties, small-scale farming became increasingly unfeasible. Between the 1960s and 1980s, the southern region of Brazil (*i.e.*, the states of Rio Grande do Sul, Santa Catarina, and Paraná) has lost 45% of its rural population. Since the 1970's the central-western region (*i.e.*, the states of Mato Grosso, Mato Grosso do Sul, and Goiás) lost 35% of its population (Camarano & Abramovay 1999; Matos & Pessoa 2011). On the other hand, the southeast region of the country (*i.e.*, the states of São Paulo, Rio de Janeiro, Minas Gerais and Espírito Santo) received more than 10 million internal migrants (Camarano & Abramovay 1999; Matos & Pessoa 2011). As a result, the urbanization rate in the country increased from 56% to 84% from 1970 to 2010 (IBGE 2017a). Consequently, the Central-South region of Brazil has proportionally the highest rate of land use conversion for agriculture and livestock production of the country (Oliveira *et al.* 2007, Camarano & Abramovay 1999).

Acknowledging that a dramatic overall cultural change happened in rural areas of Central-South Brazil, it is still unclear how these deep changes in the rural social-ecological systems have locally impacted hunting activities. Therefore, in this research we carried out a literature review on hunting activities taking place in the Central-South region of Brazil to investigate if there is evidence of a possible relationship between agriculture expansion and intensification and local hunters' socioeconomic profile (*i.e.*, education, income) and motivation (*i.e.*, sport or subsistence) in this region.

Material and Methods

To assess hunting activities taking place in the Central-South region we conducted a systematic search of literature following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses framework (Moher *et al.*, 2009 – Figure 1). We searched and analyzed publications found for each of the following sets of keywords separately at Google Scholar: i) in Portuguese: *caça ilegal*, *caça de subsistência*, *caça esportiva*, *caça recreacional* and *caça Brasil*; and ii) in English: hunting Brazil, Brazilian hunters, wildlife poaching Brazil, illegal hunting Brazil, recreational hunting Brazil and subsistence hunting Brazil. For each keyword, we searched first for 'order of relevance' (*i.e.*, a ranking that shows the most cited, popular and/or best matched results for the keywords used) and after searched only for papers between 2010 and 2020, to guarantee that recent papers were not being overlooked. We registered all the 20 first studies found for each keyword in each

search mode (*i.e.*, order of relevance and recent documents) ($n = 440$), independently of their title, and all studies subsequent that had titles of interest ($n = 134$) (Figure 1).

The research was conducted in June 2020 and we considered for evaluation every type of scientific and technical documents found, such as articles, thesis and technical reports, that addressed hunting in Brazil. We prioritized Google Scholar as a research platform to access Brazilian journals and unpublished information from these and other documents. We searched for documents by each keyword separately because the number of articles published on the topic was very low and common systematic research (using a code with Boolean operators) resulted in few results.

After excluding duplicates from the total of 574 records found, we screened 268 documents by their titles and abstract and selected all documents addressing the thematic of hunting in Brazil ($n = 105$). We fully accessed the text of these studies and select 63 publications of relevance for our study, with specific information/data on hunting activity and hunters' profile and motivations in Brazil. We excluded from this selection, for example, studies addressing policies and

legal instruments and discussing philosophical or ethical aspects. We then classified the documents according to the following aspects: geographic location (by state), type of document (*e.g.*, article, thesis, report), taxa/group assessed (*e.g.*, mammals, birds, reptiles), data nature (*i.e.*, studies that quantify hunting activities, that evaluate the effect of hunting activities on wild populations indirectly or qualitatively investigate hunting characteristics), data source/characteristics (*e.g.*, field assessment, online platforms) and type of study area (*e.g.*, inside protected areas, rural or urban areas). This step aimed at having an overview of all studies conducted on the topic in Brazil in order to compare the information found for different regions with the one found for the Central-South region.

We then reviewed the studies carried out specifically in the Central-South Brazil ($n = 18$) and identified their objectives, year of data collection and taxa/group studied. For the sake of simplicity, in this study we included as part of the Central-South macro-region the following states: Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Espírito Santo, Mato Grosso do Sul, Goiás; and the whole area of states which officially have only a part of their area belonging to this region: Minas Gerais, Mato Grosso and Tocantins. We also collected all evidence available in these studies about hunters' profile (*e.g.*, age, income, education), motives (*e.g.*, meat, property defense, hobby) and hunting characteristics (*e.g.*, equipment, effort). Finally, we conducted a content analysis of their results and discussion to assess the possible relationship between land use change since hunting ban by the Wildlife Protection Law (Brazil 1967) and hunters' profile and motivation in the region and we present their methods and main results.

Results

In total, 63 papers contributed to a general assessment of hunting activity in the country, including hunting pressure and its impact on game species, as well as hunters' profile. These studies main characteristics and geographic distribution in the country can be seen on Table 1 and Figure 2, respectively. The studies were classified in articles ($n = 56$), theses ($n = 6$) and a report ($n = 1$), with 22 published between 2000 and 2010, and 41 between 2011 and 2020. Most of them dealt with mammals, birds, and reptiles combined ($n = 34$), six with mammals and birds; 18 with mammals, four with birds, and one with reptiles only.

Out of the 63 selected publications, 29 directly quantified hunting activities. This means that these studies presented estimates of hunted animal numbers and biomass removed from ecosystems, allowing to evaluate possible impacts of hunting on wild populations. The studies that used databases ($n = 4$) present an overview of the game species and hunters' profile. However, they are limited by data availability, which were restricted in most studies (*e.g.*, partial identification of species, data available only for some regions, different collection efforts in each region). Studies that assessed the effect of hunting activities on wild populations indirectly ($n = 10$) usually compared the number of animals found in an area with hunting activities with the number of animals found in areas with less hunting or no hunting at all. These studies allow us to assess whether hunting in the study area has negative effects on the main game species, but do not allow for a quantitative assessment of hunting effort or comparisons with other studies in distinct areas (Table 1). In studies that investigated the characteristics of

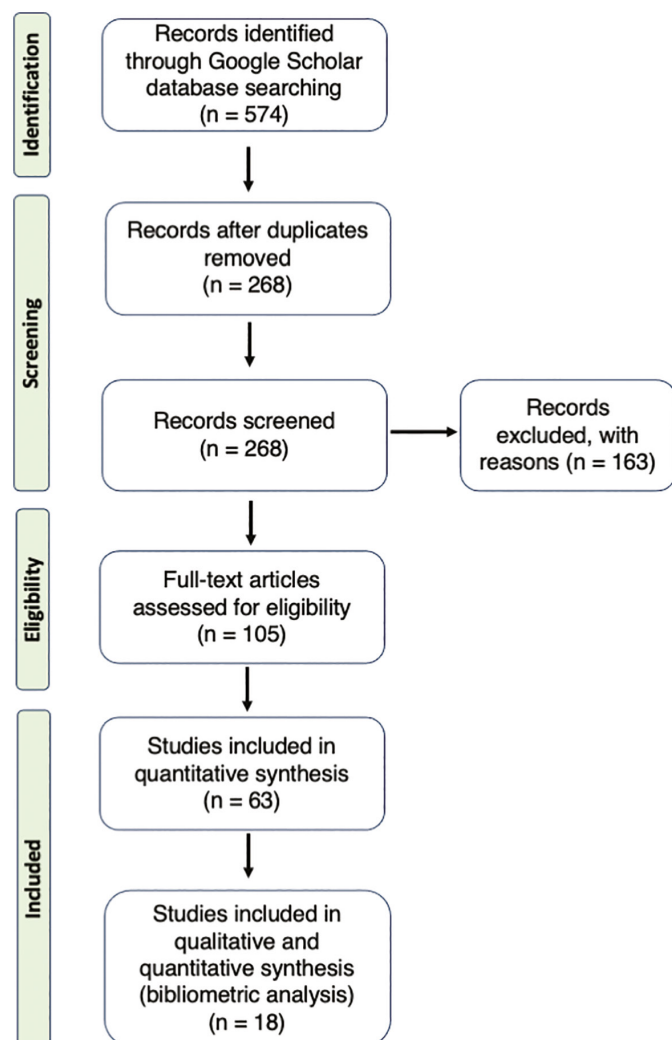


Figure 1. Flow diagram depicting the study selection process based on PRISMA guidelines.

Table 1. Studies found in the literature review (references) that evaluate hunting activities or the hunter profile in Brazil (n = 63) categorized by the nature and source/characteristics of data collection.

Data nature	Data source/characteristics	References
Studies that quantify hunting activities and evaluate different aspects of the activity (n = 29)	Collect/use direct data on hunting activities (n = 25)	Costa Neto 2000, De Souza-Mazurek <i>et al.</i> 2000, Peres 2000, Desbiez <i>et al.</i> 2011, Rosas & Drumond 2007, Terra 2007, Nobre 2007, Valsecchi & do Amaral 2010, Peters <i>et al.</i> 2011, Vieira 2013, Valsecchi <i>et al.</i> 2014, Van Vliet <i>et al.</i> 2014, El Bizri <i>et al.</i> 2015, Mendonça <i>et al.</i> 2016, El Bizri <i>et al.</i> 2018, Rosa <i>et al.</i> 2018, Pires <i>et al.</i> 2018, Torres <i>et al.</i> 2018, Castilho <i>et al.</i> 2019, Chaves <i>et al.</i> 2019, Constantino 2019, Oliveira and Calouro 2019, Da Silva <i>et al.</i> 2020, De Lima <i>et al.</i> 2020, De Oliveira <i>et al.</i> 2020.
	Use databases or online platforms (e.g., environmental police apprehensions) (n = 4)	Fuccio <i>et al.</i> 2003, Ramos 2013, Chagas <i>et al.</i> 2015, Sousa & Srbek-Araujo 2017.
Studies that evaluate the effect of hunting activities on wild populations indirectly (without quantifying) (n = 10)	Collect/use direct data or database on species presence/absence in areas with different levels of hunting activity	Chiarello 2000, Cullen Jr. <i>et al.</i> 2000, Peres 2001, Mazzolli <i>et al.</i> 2002, Pianca 2004, Calouro 2005, Araújo <i>et al.</i> 2008, Da Silva <i>et al.</i> 2018, Pereira-Ribeiro <i>et al.</i> 2018, Yves <i>et al.</i> 2018.
Studies that qualitatively investigate hunting characteristics (e.g., species, uses, techniques, etc.) (n = 24)	Investigate the socioeconomic profile of hunters (e.g., gender, age, income) (n = 17)	Alves <i>et al.</i> 2009, Barboza 2009, Barbosa <i>et al.</i> 2010, Dantas-Aguiar <i>et al.</i> 2011, Alves <i>et al.</i> 2012, Barbosa <i>et al.</i> 2011, De Souza & Alves 2014, Melo <i>et al.</i> 2014, Van Vliet <i>et al.</i> 2015, Barboza <i>et al.</i> 2016, Barbosa <i>et al.</i> 2018, Fragoso <i>et al.</i> 2018, Policarpo <i>et al.</i> 2018, Souto <i>et al.</i> 2018, Santos <i>et al.</i> 2019, Soares <i>et al.</i> 2018, Souto <i>et al.</i> 2019.
	They do not investigate the socioeconomic profile of hunters (n = 7)	Mourão 2006, Ribeiro <i>et al.</i> 2007, Hanazaki <i>et al.</i> 2009, Pereira & Schiavetti 2010, Bezerra <i>et al.</i> 2012, Nóbrega 2012, Carvalho <i>et al.</i> 2019.

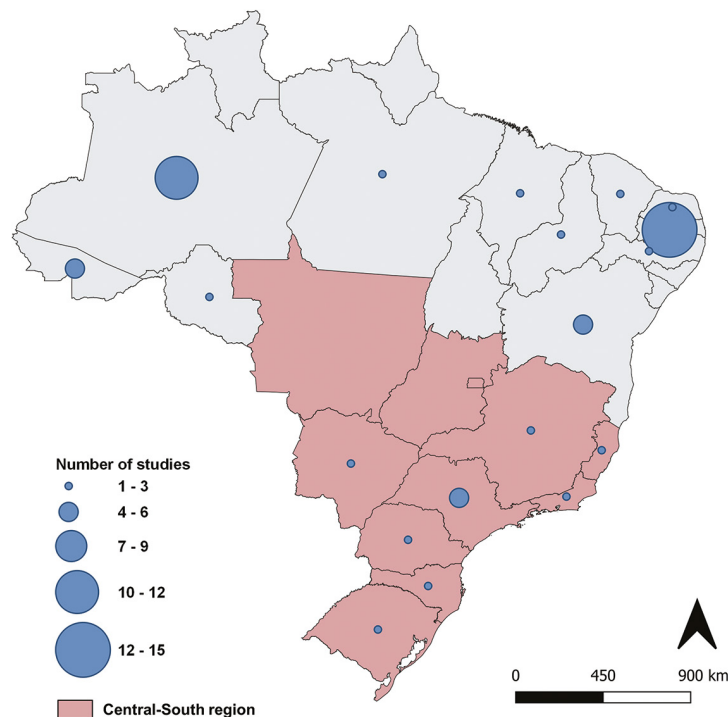


Figure 2. Distribution of documents found in literature review (articles, dissertations, theses and reports) that sought to quantify and qualify hunting activities and the hunters' profile in Brazil in each state (n = 58): Paraíba (n = 15), Amazonas (n = 10), Acre (n = 5), São Paulo (n = 4), Bahia (n = 4), Espírito Santo (n = 3), Pará (n = 3), Pernambuco (n = 2), Rio Grande do Norte (n = 2), Ceará (n = 1), Maranhão (n = 1), Mato Grosso do Sul (n = 1), Minas Gerais (n = 1), Paraná (n = 1), Piauí (n = 1), Rio de Janeiro (n = 1), Rio Grande do Sul (n = 1), Rondônia (n = 1), and Santa Catarina (n = 1). Studies that covered more than one state (n = 5) are not represented in this figure. The circles on the map are positioned in the center of the state.

hunting, the description of the target species and other relevant aspects ($n = 24$), such as their use by human population, hunting techniques and hunters' profile, predominated (Table 1). This type of study enabled the identification of species that may be under greater pressure and allow a better view of the socio-ecological system where hunting activities take place.

Most studies found were concentrated in the North and Northeast regions (71,4%) and about 40% of the studies were carried out exclusively inside protected areas and indigenous lands (Table 2). The documents had 52 different first authors with frequent co-authorship among them, which suggests a consistent number of researchers currently publishing on the topic.

Eighteen studies (28% out of selected cases) were conducted in Central-South Brazil (a region that represents 36,5% of the Brazilian territory), with the potential to contribute to the assessment of hunting activities and the profile of hunters in this region. However, only nine addressed hunting in agricultural landscapes, including coastal communities (Table 2). These studies aimed, in general, to determine the diversity and abundance of game species as well as hunting frequency and sustainability (Table 3) and few ($n = 9$) presented evidence about hunters' profile (e.g., age, income, education), motives for hunting (e.g., meat, property defense, hobby) and hunting characteristics (e.g., equipment, effort) (Table 4). In total, the studies targeted 87 game species, of which 53 were mammals (3 are exotic or domestic), 29 birds and 5 reptiles (Table 5). Six species of mammals and four of birds that have only been identified up to the genus level may be considered in duplicate (e.g., *Didelphis sp.* could be *D. aurita* – already counted – or *D. albiventris* – not counted).

Six of these studies put light over the possible relationship between land use change and hunting culture in the Central-South Brazil: Mazzolli *et al.* 2002, Desbiez *et al.* 2011, El Bizri *et al.* 2015, Sousa & Srбек-Araujo 2017, Rosa *et al.* 2018 and Carvalho *et al.* 2019 (Table 6). Half of these studies targeted particularly the exotic species *Sus scrofa*, which has spread for most of the Center-South region of the country (Rosa *et al.* 2018). *Sus scrofa* has been reported in the selected publication as wild pig, feral pig and wild boar. In Brazilian Pantanal it is called *Monteiro* hog.

El Bizri *et al.* (2015), Sousa and Srбек-Araujo (2017) and Rosa *et al.* (2018) present data that point to an increase in hunting conducted by urban people with higher income for sport in some areas of the Center-South region. The data from El Bizri *et al.* (2015) indicate that i) a large portion of hunting in Brazil seems to be carried out in Cerrado areas, ii) that sport hunting may be increasing annually, based on the annual growth in the number of videos posted in social media on the subject in the analyzed period (2007–2014), and that iii) the hunters in the videos appear to be, in general, Brazilian urban upper-middle class residents, due to the filming period – mainly during the winter (June and July) and summer (November through January) school holidays – and the use of high cost equipment. El Bizri *et al.* (2015) show that in the videos' comments, hunting permission in other countries is one of the most mentioned arguments to support hunting regulations in Brazil.

In the same sense, using the database from an environmental surveillance system composed of several institutions, Sousa & Srбек-Araujo (2017) showed that most hunters in a complex of protected areas are sport hunters and not subsistence hunters (Linhares-Sooretama forest complex in the state of Espírito Santo). Although the study by Sousa & Srбек-Araujo (2017) was not focusing exclusively on rural areas, it corroborates the study conducted by El Bizri *et al.* (2015). Rosa *et al.* (2018) investigating the control of exotic wild pigs, showed that most hunters (locally called controllers) had a college degree (61% from 175) and some had relatively high income for Brazilian standard (21% with annual wages >US\$ 34,000). Forty percent of respondents were acting illegally. According to them, bureaucracy (46%) and lack of information about the authorization process (33%) were the main causes for such a pattern. Most respondents (83%) of the online questionnaires used by Rosa *et al.* (2018) were from South and Southeast regions of Brazil.

The studies of Mazzolli *et al.* (2002), Desbiez *et al.* (2011), El Bizri *et al.* (2015), Rosa *et al.* (2018) and Carvalho *et al.* (2019) present data that point to a modification of hunting activities in some areas of the Center-South region, including changes in target species and hunting gears. Desbiez *et al.* (2011) present data that show how rural residents in the central Pantanal changed the target species, management, and hunting techniques to adapt to the new realities in rural areas. In local

Table 2. Delimitation of the study area of the research found in the literature review that evaluates hunting or the hunter's profile, carried out in Brazil ($n = 63$) and in its Center-South region ($n = 18$).

Study area	Brazil (N = 63)	Only Central-South References (N = 18)
Entire territory of one or more states	6	4 (Chagas <i>et al.</i> 2015, El Bizri <i>et al.</i> 2015, Rosa <i>et al.</i> 2018/Carvalho <i>et al.</i> 2019)
Protected areas	22	9 (Chiarello 2000, Pianca 2004, Nobre 2007, Araújo <i>et al.</i> 2008, Peters <i>et al.</i> 2011, Sousa <i>et al.</i> 2017, Da Silva <i>et al.</i> 2018, Pereira-Ribeiro <i>et al.</i> 2018, Yves <i>et al.</i> 2018)
Rural and peri-rural areas	25	3 (Peres 2001, Mazzolli <i>et al.</i> 2002, Desbiez <i>et al.</i> 2011)
Urban and peri-urban areas	2	–
Protected and rural areas	4	1 (Cullen Jr. <i>et al.</i> 2000)
Coastal communities	1	1 (Hanazaki <i>et al.</i> 2009)
Indigenous lands	3	–

Table 3. Main characteristics (study reference, state of the Union where it was carried out, objectives, year of data collection and species investigated) of the studies found in the literature review that assess hunting or the hunter's profile in the Center-South region of Brazil.

Reference	State*	Objective	Year of data collection	Taxa/group studied
Chiarello 2000	Espírito Santo	It reports the incidence of illegal hunting, in reserves and forest fragments in the region, and discusses how this factor may be affecting fauna.	1994/1996	Game mammals and birds
Cullen Jr. et al. 2000	São Paulo	It assesses the susceptibility of species to hunting by comparing the abundance of species between fragments of similar size, but with different hunting pressures.	1996	Game mammals and birds
Peres 2001	Three states	Examine the probability of medium and large birds and mammals to persist in forest fragments of the Amazon of varying sizes.	1987/2000	Medium to large game mammals and birds
Mazzolli et al. 2002	Santa Catarina	Contribute to understand human-predator interactions, establishing a relationship between losses in livestock production and farming methods in southern Brazil.	1993/1995	<i>Jaguar (Puma concolor)</i>
Pianca 2004	São Paulo	Quantify the frequency of hunting and the occurrence of medium and large mammals, and evaluate the differences in the frequencies of mammals in areas with different intensities of hunting pressure and inspection.	2003	Medium to large mammals
Nobre 2007	São Paulo	To know the current demographic condition of the wild species that are the target of hunting, the characteristics of the hunting activities practiced and the possible sustainable limits of hunting for subsistence in the do Mar State Park.	2002/2005	Mammals and medium to large birds
Araújo et al. 2008	Rio de Janeiro	Estimate the abundance, density and population size of game mammals and analyze evidence of poaching in two UCs in RJ.	2003/2005	Game mammals
Hanazaki et al. 2009	São Paulo	Analyze the use of terrestrial fauna by the caiçaras of the Brazilian Atlantic Forest.	1998/2000	Game species – mammals, birds, and reptiles
Desbiez et al. 2011	Mato Grosso do Sul	Investigate and understand hunting practices in the Pantanal river plain.	2004/2005	<i>Pecari tajacu</i> , <i>Tayassu pecari</i> and <i>Sus scrofa</i>
Peters et al. 2011	Rio Grande do Sul	Report hunting and persecution records applied to mastofauna, in a sustainable use protection unit (Environmental Protection Area) in the pampa gaúcho.	2009	Mammals
Chagas et al. 2015	Sixteen states	Characterize poaching and fishing at the national level, collecting data from the environmental police.	2013/2014	Game species – mammals, birds, reptiles, and fish
El Bizri et al. 2015	Brazil	Use an online resource (YouTube™) to detect the occurrence of sport hunting, measure the impacts of the activity on game species and biomes, evaluate the opinions of Internet users about the activity and discuss the need for political interventions on the topic in the country.	2014	Game species
Sousa & Srbek-Araujo, 2017	Espírito Santo	Characterize hunting activities in a mosaic of protected areas, compare hunting records between areas and evaluate the species most affected by the activity.	2010/2013	Game species (Mammals, birds, and reptiles)
Da Silva et al. 2018	Paraná	Investigate if species occupancy declined over time and if species occupancy or detectability are spatially associated with illegal hunting and other factors in a National Protected area.	2009/2013	Terrestrial large mammals
Pereira-Ribeiro et al. 2018	Espírito Santo	To analyze the population of <i>Penelope superciliaris</i> in a protected area (density, population size and activity) and well as the occupancy and detectability of the species related with six covariates, including poaching intensity.	2013/2014	Rusty-margined guan (<i>Penelope superciliaris</i>)
Rosa et al. 2018	Brazil	To characterize the profile of wild pig controllers in Brazil, to understand their methods and motivations, estimate the number of wild pigs killed per person per year, and evaluate current regulations.	2014/2015	Wild pig (<i>Sus scrofa</i>)
Yves et al. 2018	Minas Gerais	To describe the occurrence of illegal hunting on <i>Caiman latirostris</i> in a Protected Areas and implications for its conservation.	Not mentioned	<i>Caiman latirostris</i>
Carvalho et al. 2019	Brazil	To argue that feral pigs control, if based on non-selective methods, can have deleterious effects on wild populations, especially those that are already threatened.	2017/2018	Feral pigs (<i>Sus scrofa</i>)

Hunting Culture in Central-South Brazil

Table 4. Evidence found in studies from the literature review (n = 9) on hunters' profile, motives and hunting characteristics in the Center-South region of Brazil.

Reference	Survey type	Number of interviewees	Gender	Age (years)	Occupation/income	Education	Region	Type of hunting	Hunters motive	Hunting characteristics (efforts, evidence, equipment)
Pianca 2004	In-person surveys	19	Male	40 to 82	Household workers, landowners, squatters, retirees and unemployed Without income; From less than one minimum wage (US\$50.00) ¹ to more than one	–	Serra de Paranapiacaba, São Paulo	Part conducted subsistence hunting and part do not hunt anymore	–	Four hunting techniques were registered: at point, waiting, with dogs and trapping. Machete and shotgun are used. The “sty” is a technique in which a gun is set up to fire automatically when an animal passes by. Shelters built in the forest are used as refuge.
Nobre 2007	In-person surveys	41	Male	–	–	–	–	Subsistence hunting	–	Interviewees hunted on average once a month (54%) and returned on the same day (58%). Walked an average of 7.5km each time (49%).
Hanazaki <i>et al.</i> 2009	In-person surveys	116	Usually male	–	–	–	São Paulo state (Icapara, Pedrinhas and São Paulo Bagre)	Subsistence hunting	Food and medicine	From urbanized to rural communities. Hunting activities decreased. Most hunting used artisanal trap called “mundéu” and ragged fish nets with the help of dogs. Hunting activities were suspended during periods of reproduction and pregnancy of the animals.
Desbiez <i>et al.</i> 2011	In-person surveys	97	–	–	–	–	Central Pantanal	–	Mainly for meat but also property defense and leisure	Hunting was carried out on horseback (100%), with dogs (84%) and using lasso, knife or gun. Ranch workers catch young male feral pigs and castrate, mark and then release them. Castrated males heal, gain weight and are killed later. if one is not located, then a female may be killed. On average, 2.6 to 3.3 feral pigs were killed per month. Most hunters claimed they prefer hunting during the wet season (67%).
El Bizri <i>et al.</i> 2015	–	–	–	–	Possibly people with high income	–	Brazil, mainly Cerrado biome (27.6%)	Sport hunting	–	Hunting was conducted mainly in July and December. Hunters are possibly urban residents who travel to rural areas to hunt. 70.9% of the videos demonstrated the use of shotguns.
Sousa & Srbeek-Araujo, 2017	–	–	–	–	–	–	–	–	–	Hunters use firearms, handmade firearms, non-lethal traps, hunting supplies (hunting tools or utensils such as knives, ammunition, flashlights, backpacks, hammocks, firearm silencers, and whistles to attract animals), hunting gear, tree stands and baits.

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Reference	Survey type	Number of interviewees	Gender	Age (years)	Occupation/ income	Education	Region	Type of hunting	Hunters motive	Hunting characteristics (efforts, evidence, equipment)
Da Silva <i>et al.</i> 2018	–	–	–	–	–	–	–	–	–	Hunting in the area is usually conducted using platforms, trails and/ or camps and is associated with palm tree extraction.
Rosa <i>et al.</i> 2018	Online and in-person surveys	172	–	–	Most with high income (21% received more than US\$2,850.00 a month); only 3% earned minimum wage (US\$270.00) ²	Most had high levels of education (99% college or high school degrees)	In-person: Minas Gerais and Rio Grande do Sul; Online: most (83%) from southern and southeastern Brazil	Sport hunting (40% of ilegal hunters)	Primarily for propriety defense, then trophy or sport hunting and meat consumption	Main technique used was active hunting (74.6%), hunting and trapping (17.9%) and trapping (7.0%). Most active hunting used dogs (86.6%) and also firearms, knives and archery. Traps included corrals, small cages, trench traps, and snares. Most hunters captured few individuals a month, only 16.8% harvested >30 pigs/year.
Yves <i>et al.</i> 2018	–	–	–	–	–	–	–	–	–	Animals captured presented injuries across almost the entire mentonian region of the lower jaw possibly caused by hooks used in hunting activities.

*Chiarello 2000, Cullen Jr. et al. 2000, Peres 2001, Mazzolli et al. 2002, Araújo et al. 2008, Peters et al. 2011, Chagas et al. 2015, Pereira-Ribeiro et al. 2018 and Carvalho et al. 2019 did not present evidences on hunting culture, hunting characteristics or hunters' profile.

¹ Based on current currency: US\$1 = R\$4,80.

² Based on current currency: US\$1 = R\$3,25.

Table 5. Species targeted by the eighteen studies found in the literature reviewed for the Central-South region of Brazil. *The names of the species were kept as found in the studies, without updating their taxonomy.

Class	Family	Species	Observation
Mammalia	Didelphidae	<i>Didelphis sp.</i> <i>Didelphis aurita</i>	
	Dasypodidae	<i>Dasypus Novemcinctus</i> <i>Dasypus septemcinctus/Dasypus hybridus</i>	
	Chlamyphoridae	<i>Euphractus sexcinctus</i> <i>Cabassous tatouay</i> <i>Priodontes maximus</i>	
	Bradypodidae	<i>Bradypus variegatu</i> <i>Brachyteles arachnoides</i>	
	Myrmecophagidae	<i>Tamadua tetradactyla</i> <i>Myrmecophaga tridactyla</i>	

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Class	Family	Species	Observation
	Trichechidae	<i>Trichechus inunguis</i>	
	Atelidae	<i>Alouatta sp.</i> <i>Allouata fusca</i> <i>Alouatta guariba</i> <i>Lagothrix lagotricha</i> <i>Ateles sp.</i>	
	Cebidae	<i>Cebus apella</i> <i>Cebus nigritus</i>	
	Leporidae	<i>Sylvilagus brasiliensis</i> <i>Lepus europaeus</i>	*exotic
	Caviidae	<i>Cavia sp.</i> <i>Cavia aperea</i> <i>Hydrochoerus hydrochaeris</i> <i>Kerodon rupestris</i>	
	Ctenomyidae	<i>Ctenomys torquatus</i>	
	Cuniculidae	<i>Agouti paca/Cuniculus paca</i>	
	Dasyproctidae	<i>Dasyprocta sp.</i> <i>Dasyprocta leporina</i> <i>Dasyprocta azarae</i>	
	Sciuridae	<i>Sciurus aestuans</i>	
	Canidae	<i>Cerdocyon thous</i> <i>Lycalopex gymnocercus</i>	
	Mephitidae	<i>Conepatus chinga</i>	
	Mustelidae	<i>Galictis sp.</i> <i>Eira Barbara</i> <i>Lutra longicaudis</i>	
	Procyonidae	<i>Procyon cancrivorus</i> <i>Nasua nasua</i>	

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Class	Family	Species	Observation
	Felidae	<i>Panthera onca</i> <i>Puma concolor</i> <i>Puma yagouaroundi</i> <i>Leopardus sp.</i> <i>Leopardus pardalis</i> <i>Leopardus geoffroyi</i>	
	Tapiriidae	<i>Tapyrus terrestris</i>	
	Cervidae	<i>Mazama sp.</i> <i>Mazama americana</i> <i>Mazama nana</i>	
	Tayassuidae	<i>Pecari tajacu</i> <i>Tayassu pecari</i>	
	Suidae	<i>Sus scrofa</i>	*exotic/domesticated
	Bovidae	<i>Bubalus bubalis</i>	*domestic
Aves	Rheidae	<i>Rhea americana</i>	
	Tinamidae	<i>Tymnus solitarius</i> <i>Crypturellus sp.</i> <i>Crypturellus noctivagus</i> <i>Crypturellus variegatus</i> <i>Crypturellus soui</i> <i>Nothura maculosa</i>	
	Anatidae	<i>Cairina moschata</i>	
	Cracidae	<i>Penelope sp.</i> <i>Penelope obscura</i> <i>Penelope superciliaris</i> <i>Aburria jacutinga</i> <i>Ortalis sp.</i> <i>Crax sp.</i> <i>Crax blumenbachii</i> <i>Mitu sp.</i> <i>Mitu tuberosa</i>	
	Odontophoridae	<i>Odontophorus capueira</i>	

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Class	Family	Species	Observation
	Ardeidae	<i>Nyctanassa violacea</i>	
	Aramidae	<i>Aramus guarauna</i>	
	Charadriidae	<i>Vanellus chilensis</i>	
	Falconidae	<i>Caracara plancus</i>	
	Psittacidae	<i>Amazona brasiliensis</i>	
	Turdidae	<i>Turdus albicollis</i> <i>Turdus rufiventris</i> <i>Turdus amaurochalinus</i> <i>Platycichla flavipes</i>	
	Thraupidae	<i>Sporophila angolensis</i> , <i>Sporophila caerulea</i>	
Reptilia	Crocodylidae	<i>Caiman latirostris</i>	
	Teiidae	<i>Salvator merianae</i> <i>Tupinambis sp.</i>	
	Alligatoridae	<i>Paleosuchus sp.</i>	
	Podocnemididae	<i>Peltocephalus dumerilianus</i>	

ranches, the *monteiro* hog replaced the former traditional game species (*i.e.*, armadillos and peccaries) with piglets' castration followed by release and adult culling. The study also presents data on hunting efforts, as well as on the importance of *Monteiro* hog meat and fat to local economy, culture, and food security. Two reasons justify the change in the hunting system portrayed by Desbiez *et al.* (2011): i) the legal hunting ban of native game species; and ii) the relatively high cost-benefit of *monteiro* hog hunting, as they have a higher reproductive rate and larger body size, with more meat and fat than the local traditional game species. In such a case, the changes in land use and coverage coincide to the new sociocultural and ecological conjuncture.

Although we did not search directly for studies about human-wildlife coexistence, Mazzolli *et al.* (2002) and Desbiez *et al.* (2011) present data that deal with the high rate of negative interactions between landowners and wild carnivores culminating in these species hunting. The study by Mazzolli *et al.* (2002) is old and restricted to the eastern Santa Catarina state in southern Brazil. However, it characterizes the

interactions between landowners and pumas (*Puma concolor*) and carnivore hunting as a retaliation for economic losses. The authors showed that the number of jaguar attacks on livestock was high. However, a large portion of the attacks could have been avoided if there was an adequate livestock management. Moreover, in some cases, the monetary loss, even when it is relatively low (Mazzolli *et al.* 2002). Desbiez *et al.* (2011) suggests that carnivores are commonly killed by rural residents in Brazilian Pantanal as a retaliation to their livestock depredation. On the other hand, for exotic species, Rosa *et al.* (2018) shows that the main motivations to hunt exotic wild hogs in Brazil were: damage to agriculture (140/172 respondents, approx. 81.2%), sport hunting (68.4%) and meat consumption (63.2%). Yet, accordingly to the respondents, meat consumption was the final destination for the carcasses and almost half of the respondents (42.4%) reported only one individual killed per month. These studies show evidence that at least a part of hunting in rural areas is highly motivated by conflicts in agricultural landscapes, what has been largely studied by

Table 6. Methods and main results of the six studies found in the literature review that contribute to discuss hunting and the hunter's profile in the Center-South region of Brazil.

Reference	Method	Main results
Mazzolli <i>et al.</i> 2002	Vestiges and interviews to assess predation in rural properties (15 props from 40 to 2500 ha)	37 traces of predation were found. In the study, predations are characterized by period of the day in which the attack occurs, species attacked, and economic losses are estimated. The authors estimate the relevance of losses from attacks in relation to other types of losses and suggest actions that can be taken to reduce predation.
Desbiez <i>et al.</i> 2011	Exploratory survey, semi-structured interviews, and skull collection	Exotic wild pigs are the main hunting target, replacing the historic hunting of native wild pigs. Hunting and animal handling techniques for later hunting have also been modified to suit changes in hunting.
El Bizri <i>et al.</i> 2015	Youtube video evaluation	They found 383 videos related to sport hunting with over 15 million views. The videos were mainly in regions of the Cerrado, showing activities of hunting pacas (<i>Cuniculus paca</i>), armadillos and other species, carried out mainly in the months of January and July and sports hunting clothes, possibly indicating hunters of upper-middle class. The opinion of most internet users was in favor of hunting.
Sousa & Srбек-Araujo, 2017	Database of agencies responsible for inspection	Characterizes hunting activities in the region. They found 693 records about 15 species. It shows an increase in the number of hunting events found over time, related to the inspection effort. It presents hunting as a significant threat to the fauna of the region.
Rosa <i>et al.</i> 2018	Structured questionnaire conducted online and in person to pig controllers, including both hunters and non-hunters.	2,389 killings of pigs reported (average of 17.2 pigs/respondent/year, with male and female pigs killed in the same proportion), mainly conducted by volunteers. 40% of respondents were acting illegally. Main reason for pig control was defend third-party properties. Farmers suffered most of the impacts.
Carvalho <i>et al.</i> 2019	Data on animals rescued by an NGO after having been caught in illegal snares set to capture feral pigs	Authors show evidence of four animals which suffered injuries from being caught in illegal snares set to capture feral pigs, of which three died from it.

human-wildlife coexistence researchers (Marchini 2014). Consequently, we can assume that the greater the agricultural expansion, the more intense the hunting activities will be.

Discussion

Over the last decade, the number of published research related to hunting in Brazil has almost doubled compared to the prior decade (Fernandes-Ferreira & Alves 2017). Nevertheless, the few dozens of publications found in this review of the scientific literature are far from being enough to produce a “state of the art” report of hunting activities in the country, especially considering its size and its mega socio and biodiversity (Joly *et al.* 2018). For the Center-South region this assessment is even harder. Our research shows that the studies carried out in the north and northeast regions of Brazil are proportionally higher than that of the Center-South region. In addition, most studies in this region focused on exotic species. Therefore, it was not possible to fully assess whether there was a change in hunting culture in the Center-South region as a whole and whether there was a relationship between changes in land use (*i.e.*, agricultural expansion and rural exodus). Nonetheless, in assessing the available literature we present few but consistent evidence of change in hunting culture, which can be seen as an early sign for proactive management. Actions over early signs of change may reduce management costs, when compared to costs of responsive management.

The studies found suggest a possible trade on the hunted species (from native to exotic) as well as on the hunters' profile (from rural to urban). As a result, hunting techniques seem to be changing (from light to heavy firearms and archery) whereas subsistence hunting appears to have, at least relatively, declined. Culling predators in retaliation to livestock damage appears to continue. The possible impacts of such changes are still mostly unknown and should be prioritized in future studies. Our study indicates that apparently a portion of the urban population, mirrored in the populations of countries considered developed, as is the case in the United States and Australia, where sport hunting is allowed (Arnett, & Southwick 2015), may be considering hunting (even illegal) as a new hobby (Tomas *et al.* 2018, Bragagnolo *et al.* 2019). These results contrast with findings from studies on hunting in other regions of Brazil, in which much of the activity is still carried out for subsistence by rural populations (Alves *et al.* 2009, Barboza 2009, Barbosa *et al.* 2010, Alves & Souto 2011, Alves *et al.* 2012), indicating a possible regional trend.

It is important to consider that aspects related to studies' nature and design and the researchers' topics of interest may bias our conclusion. The absence of studies on hunting for subsistence in this region is not direct evidence of decrease in this type of hunting. Studies on sport hunting may be gaining prominence in this region in detriment of those focused on subsistence hunting. On the other hand, in a broad perspective, there is large evidence that many factors have triggered the lack of interest of the great majority of young people from rural

and traditional communities in the Center-South in illegal hunting. These include migration to cities, access to technologies and interest in the modern and urban life, access to education and preservationist discourses, disconnection from the rural environment, and an increasing law enforcement in some regions (Diegues & Viana 2004, Islas 2015, Govindin, & Miller 2015). Considering these observations, further researches should delve deeper into the influence of socioeconomic factors and cultural shifts in the hunting culture in different urban and rural landscapes in the Center-South region, thereby shedding more light on the evolving dynamics of human-wildlife coexistence to support management efforts.

Wildlife management is about the decision-making process on the following alternatives of human intervention on nature: biological conservation (*i.e.*, reverse population decline), control (*i.e.*, reverse population explosion), sustainable use (*i.e.*, reach the maximum sustainable yield), and monitoring (*i.e.*, keeping an eye on it to detect relevant changes as soon as possible) (Caughley & Sinclair 1994, Verdade *et al.* 2014b). Despite wildlife many negative impacts on agricultural landscapes, wildlife management is fundamental for wildlife conservation outside National Parks and other conservation areas (Verdade *et al.* 2014a, 2016, 2022). However, in agricultural landscapes the most relevant demand for wildlife management is likely related to human-wildlife coexistence, including hunting regulations and mitigation on wildlife damage on livestock and agriculture (Marchini 2014). In such a context, monitoring programs including both ecological and societal dimensions should be prioritized by government agencies responsible for wildlife management as they feed the decision-making process of such a system with technical data (Verdade *et al.* 2014b). A first step for the success of such monitoring program is guaranteeing confidentiality and professional secrecy devices for biologists (Verdade & Seixas 2013) or other government staff carrying out such monitoring. Together with land use change, hunters' profile and culture are fundamental human dimensions for such a program.

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Conflicts of Interest

The author(s) declare(s) that they have no conflict of interest related to the publication of this manuscript.

Ethics

The authors ensure that this research is in conform to national and institutional laws and requirements and confirm that approval by the pertinent committee has been obtained (Process CAAE: 48061315.6.0000.5404).

Data Availability

The datasets generated during and/or analyzed during the current study are available at: <https://doi.org/10.48331/scielodata.CPNT4G>

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