



Food or Extinction? Analysis of Differing Perceptions Among Residents and Conservation Experts of Columbids (Aves: Columbidae) Hunting in Sergipe, Northeastern Brazil

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Abstract

While hunting wild animals may be considered a problem for conserving native fauna, they can represent an essential part of the diet for some human communities, such as those living in rural areas. Therefore, regulations to combat overhunting should be designed to accommodate the needs of local communities dependent on hunting as a source of food and income in a sustainable way. We interviewed local residents in three communities and wildlife specialists in Sergipe, NE Brazil, where the hunting of columbids is common both for subsistence and leisure, about their perceptions of Columbidae hunting using a semi-structured questionnaire. Most residents defend hunting and make regular use of columbids, suggesting quota hunting as a way of reconciling the practice with the conservation of the species while also noting that columbid populations are decreasing. The wildlife and conservation specialists are opposed to hunting and propose improvement of the socioeconomic status of the residents to mitigate the hunting problem, while also noting that the national environmental agency (IBAMA) is understaffed and underfunded, and there is a lack of adequate reliable data on columbid populations to adequately assess the impact of hunting.

Keywords Aves: Columbidae · Doves and pigeons · Ethnozoology · Hunting · Food resource · Sustainable use · Wild meat · Municipality of Itabaiana, Sergipe · Northeastern Brazil

Highlights

- The hunting of columbids is defended by rural residents.
- Rural residents will consume columbids even if other protein resources are available.
- Rural residents suggest that hunting can be practiced in a controlled manner.
- Researchers and inspectors view hunting as a conservation problem.
- Socio-economic improvement may mitigate the problem of columbid hunting in the region.

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Introduction

Hunting wild animals is defined as capturing any animal species directly from nature for any purpose (Nasi et al., 2008). In Brazil, it is a crime (Linacre & Tobe, 2011) and identified as one of the main factors linked to the reduction of populations of wild fauna (Renctas – Rede Nacional de Combate ao Tráfico de Animais Silvestres, 2001; Silveira & Straube, 2008; Alves & Souto, 2010; Scariot, 2010). However, when undertaken for human consumption, hunting wild animals is both a conservation and a human subsistence issue (Bennett et al., 2002; Milner-Gulland et al., 2003). A matter of conservation because, if unregulated, hunting can have significant negative consequences on target species, ranging from a decrease in population density to local extinction and alteration of ecosystem processes and community structure (Antunes et al., 2016; Constantino, 2016; Cullen et al., 2001; Robinson & Bennett, 2000; Tabarelli et al., 2010). And an issue of human subsistence because the use of wild animals as a food resource is important for some communities, such as those living in tropical forests and rural areas, where

subsistence is traditionally more dependent on the exploitation of natural resources (Bragagnolo et al., 2017a, b; Gama et al., 2016; Robinson & Bennett, 2002).

Birds are among the most hunted groups of animals in the world (Renctas, 2001; Ferreira & Glock, 2004; Alves, 2012), and are hunted for various reasons, such as to be used as pets, food resources, and for trade (Bezerra et al., 2012; Nobrega et al., 2011; Oliveira et al., 2020). The Columbidae family (doves and pigeons; hereinafter columbids) is a valued food source and is consequently under considerable hunting pressure from hunting, especially illegal hunting (Alves et al., 2009; Fernandes-Ferreira et al., 2012; Schulz et al., 2019; Walker, 2007). In the State of Sergipe in the Northeast of Brazil, where columbid hunting is unregulated (Alves et al., 2009; Bezerra et al., 2011; Nobrega et al., 2011; Fernandes-Ferreira et al., 2012; Fernandes et al., 2012; Fernandes-Ferreira, 2014; Barbosa et al., 2014), a recent study in the interior found that hunters regularly kill hundreds of birds per hunt (Silva et al., 2021). The same study also reported that, according to hunters, some species are no longer easily found in the region due to overexploitation, notably the migratory species *Zenaida auriculata* (Des Murs, 1847), popularly known as the eared dove, which has been identified as one of the most exploited species of Columbidae (Barbosa et al., 2010; Bezerra et al., 2011; Nobrega et al., 2011). In this semi-arid region, it is the preferred food alternative in periods of drought and a popular snack in large urban centers (Souza et al., 2007) and since 1984 the *Centro Nacional de Pesquisa e Conservação de Aves Silvestres*; (CEMAVE—the National Center for Bird Conservation in Brazil), in partnership with other research institutions in the Northeast has undertaken several studies on *Z. auriculata* in order to guarantee and support adequate management strategies for its conservation (ibid.).

One question still debated is how to address the overhunting of wild animals. Some argue that hunting is a major problem for successful conservation strategies and that the only way to protect wild species is to ban hunting altogether (Di Minin et al., 2021; Santos et al., 2011). However, in many contexts, the prohibition of hunting wild animals is regionally difficult and costly to enforce and can be challenged on ethical grounds (Adams & McShane, 1992; Ostrom et al., 1999). Others argue that the only hope of eliminating destructive patterns of resource use is to reduce rural poverty and improve levels of income, nutrition, healthcare, and education (Brandon & Wells, 1992) by promoting the wildlife trade. However, this approach can lead to rapid exploitation and deterioration of wildlife resources (Robinson & Redford, 1991).

There is a broad consensus among researchers and environmental inspectors that legalizing hunting in Brazil is not feasible (Fernandes-Ferreira & Alves, 2017; Fernandez et al., 2012) due to insufficient data in Brazil and more broadly in

Latin America to allow for wild fauna to be legally exploited as a source of food and income (Roper, 2006). On the other hand, rural and forest-dwelling communities argue that they need access to this resource to supplement their food and income to support their livelihoods (Bragagnolo et al., 2017a, b; Gama et al., 2016).

There are few studies explicitly designed to help policymakers and wildlife managers develop and implement strategies to combat unsustainable hunting, prevent species loss, and maintain long-term flows of wildlife that can be exploited as a source of food and income (Bennett et al., 2007; Robinson & Bennett, 2000). Exploring this type of approach can help optimize species conservation and the maintenance of wildlife as a provisioning ecosystem service that delivers food and income primarily to less affluent families. In this sense, our objective in this study is to investigate the perceptions of environmental researchers, inspectors from the *Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* (IBAMA—the Brazilian Institute of Environment and Renewable Natural Resources), and the residents of three rural areas in the municipality of Itabaiana (Sergipe, northeastern Brazil) about hunting columbids in order to gather data for the formulation of conservation and sustainable development strategies in the region. We hypothesized that since our resident informants hunt columbids, they would argue in favor of legalized hunting, while environmental researchers and IBAMA inspectors would argue. Finally, we expected that supporters' attitudes toward either the legalization or banning of columbid hunting in the region would converge in light of evidence that implementing a workable strategy for sustainable levels of hunting would result in improved socioeconomic circumstances for the local communities.

Methods

Study Area

Itabaiana municipality (Sergipe, Brazil) covers 337,295 km² comprising 1.53% of the semi-arid mesoregion of Sergipe, located in a transition zone between the Caatinga and the Atlantic Forest vegetational domains (Dantas & Ribeiro, 2010; IBGE, 2014, 2021). According to the most recent census, the population of the municipality is 86,967 inhabitants, with 67,709 residents in the urban area and 19,258 residents in the rural area (IBGE, 2010). The climate, according to the Köppen-Geiger classification, is As' – tropical with a dry summer (Alvares et al., 2013). Precipitation occurs between April and September, with a peak in May (175 mm), and the average annual temperature is 24 °C (Climate-data.org, 2021). Itabaiana has a highly diverse economy, ranging from the traditional agricultural activity based on family farming

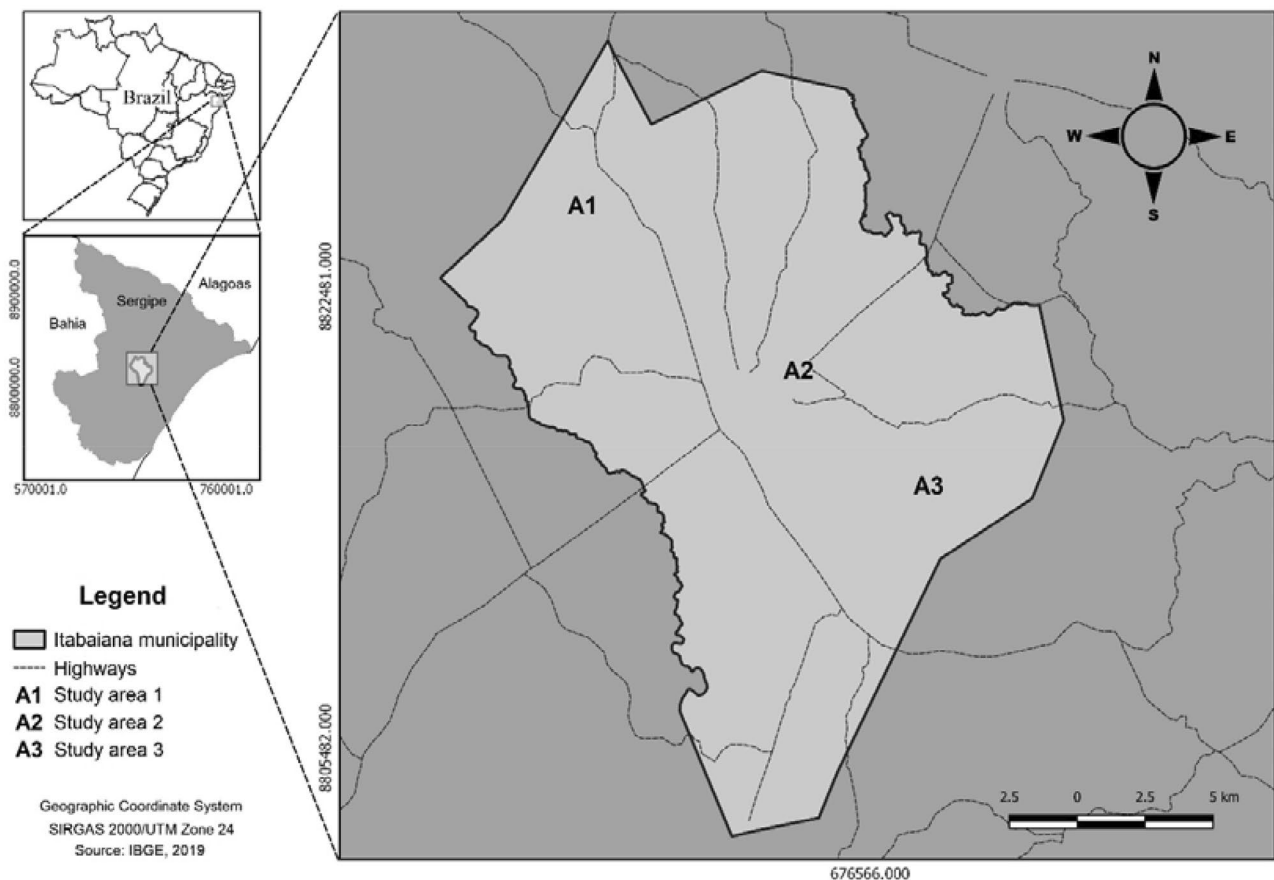


Fig. 1 Location of the rural areas sampled (A1 = Tabuleiro do Chico; A2 = Açude da Marcela; A3 = Bom Jardim) in the municipality of Itabaiana, Sergipe, Brazil

to the typically urban activities that form one of the largest centers in terms of commerce and the provision of services in the region (Carvalho & Costa, 2009). Its popular local market is held twice a week and is one of the most important in the state (Carvalho & Costa, 2009).

We conducted our study in three rural areas with high hunting pressure (Silva et al., 2021), located at an average distance of 7.3 km from the urban center of Itabaiana (Fig. 1). The communities, in general, are composed of a small number of households distributed as follows: Area 1 (A1; Tabuleiro do Chico) = 59 households; Area 2 (A2; Açude da Marcela) = 53 households; Area 3 (A3; Bom Jardim) = 343 households. The main economic activity is agriculture, based mainly on horticulture.

Data Collection and Analysis

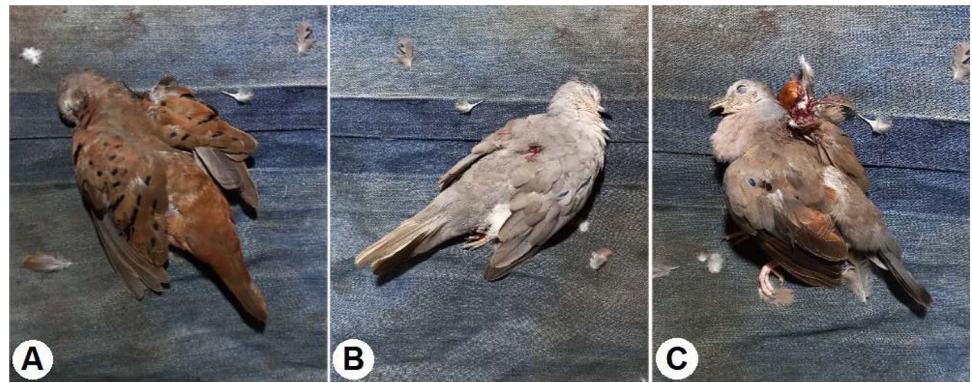
We collected data from February to May 2022 through a semi-structured questionnaire, composed of objective and subjective questions, to participants in each rural area (Supplementary material) (Albuquerque et al., 2021). To obtain

as much information as possible, we decided to administer the questionnaire to every resident over the age of 18 who chose to participate in our research¹ (Albuquerque et al., 2021) in their own homes. The responses were recorded in writing verbatim by Cleverton da Silva. We also interviewed IBAMA inspectors and researchers who work in the region via email with a Google Forms[®] link containing the questionnaire (Supplementary material) (Faleiros et al., 2016). We adjusted the language in the questionnaire as necessary to facilitate interviewees' understanding of the questions.

We identified the columbids mentioned by the interviewees with the checklist/interview technique (Medeiros et al., 2010), using photographs of species already recorded in Sergipe. The species were listed with local and scientific names,

¹ All participants were informed about the objectives and implications of this research contained in the Free and Informed Consent Term, in compliance with resolution 466/12 of the National Health Council through the Research Ethics Committee (Brasil, 2012). This research was approved and authorized by the Ethics Committee in Research with Human Beings of the Federal University of Sergipe (CAAE 47838821.9.0000.5546).

Fig. 2 Pigeons most consumed by rural residents of the municipality of Itabaiana, Sergipe. Photos provided by local hunters. **A** *Columbina talpacoti*, **B** *Columbina picui*, **C** *Columbina minuta*



according to the recent list of the Brazilian Committee of Ornithological Records (Pacheco et al., 2021).

We analyzed data referring to open questions, following Bardin (1977), through observation of thematic categorical content. This approach corresponds to qualitative data methods, which are initially configured by identification in the texts, grouping the informants' answers to the subjective questions according to the specific theme. In addition, we used discourse analysis to allow the organization and interpretation of information (ibid.). We initially inserted data into a Microsoft Excel spreadsheet. Responses to closed questions were counted, and their percentages analyzed.

Results

A total of 258 participants were interviewed: seven IBAMA inspectors², 28 ornithological, conservation, wildlife management, and hunting experts, and 223 rural residents (A1 - 44; A2 - 30; A3 - 149).

Most (N = 146; 65.4%) responded in the affirmative when asked whether they consume or have consumed pigeons/doves and indicated the plain-breasted ground-dove (*Columbina minuta* Linnaeus, 1766), the Picuí ground-dove (*Columbina picui* Temminck, 1813), and the ruddy ground-dove (*Columbina talpacoti* Temminck, 1811) as the most commonly consumed species (Fig. 2). Regarding the reasons for consuming these birds, most (N = 128; 87.6%) cited the taste of the meat ("Because the meat is delicious" (Resident 27)), while the others claimed subsistence necessity (N = 18; 12.3%) ("Boy, I get some to eat because, from time to time, we don't have enough money for beef or chicken..." (Resident 110)).

Rural residents were also asked whether the disappearance of pigeons/doves from the region would impact their lives. The majority said "Yes" (N = 150, 67.2%), of whom 94% (N = 141) said their food supply would be impacted

("It would be bad, because we would be without them to eat" (Resident 10)), while for 6% (N = 9), missing their vocalizations would impair their enjoyment of their environment ("Life would be sadder, wouldn't it? Their singing makes us happy" (Resident 3)). Some respondents (N = 73; 32.7%) conceded that the absence of pigeons/doves would not impact their lives as they do not depend exclusively on this type of food resource ("No! Because we can eat other things" (Resident 201)).

When asked if they would stop eating doves/pigeons and eat only the meat of domestically raised animals (e.g., beef, chicken, pork), the majority of rural residents (N = 125; 56%) responded that they would not stop because dove/pigeon meat is tasty, while they found beef and chicken unpalatable ("Because dove meat is delicious. Chicken and beef are nauseating" (Resident 7)), or that it adds variety to their diet: ("Because sometimes it's good to eat something different" (Resident 18)). Others (N = 21; 9.4%) said that they would stop eating pigeon/doves for beef and chicken only if they had the financial means to do so ("I would leave, right! But to eat only beef and chicken, we need money. Beef is expensive" (Resident 50); "I did. I also like beef and chicken, but we can't always afford to buy them" (Resident 67). Seventy-seven (34.5%) residents said that they do not consume pigeon/dove meat.

Most rural residents (N = 142; 63.6%) were in favor of hunting doves/pigeons because they perceive these birds as natural and abundant resources in the wild: "Doves are a good of nature. Why can't we hunt for food?" (Resident 53); "There are too many doves. These animals never end" (Resident 11). Those who were not in favor of hunting (N = 81; 36.3%) claimed that these birds are overexploited: "It really should be prohibited. People hunt too much" (Resident 114). On the other hand, we found a solid consensus among researchers (academics) and IBAMA inspectors about the necessity for a prohibition of this practice, due to the lack of data on this group of birds: "There are very few studies on this group of birds, including population studies that indicate whether hunting is indicated or not and how it could be done" (Researcher 16); "There is not much data on population estimates, especially for migratory species" (Inspector 4).

² All of the inspectors assigned to the region.

As most rural residents were in favor of hunting, we invited them to suggest a strategy through which hunting could be continued out without causing substantial damage to the populations of the target species, to which their responses were generally centered on some form of controlled hunt, for example: “Only a certain number of kills should be allowed in each hunt” (Resident 5). We then asked the participants who opposed hunting (IBAMA inspectors and researchers: $N=35$) to suggest mitigating measures for the region. Socioeconomic improvements were suggested ($N=26$; 74.2%) (“Improve socioeconomic conditions. The government could present alternative practices to communities that depend more on hunting, such as the availability of a social card to facilitate the purchase of food” (Researcher 5)), and more investments in inspection and environmental education programs ($N=9$; 25.7%) (“Before any action, the inspection must be effective, so it must receive the due investment. However, we know that, in addition, there must be a partnership with the communities that live with the species. This partnership can be made with the bridge of environmental education” (Researcher 1); “Reduce poverty, through the generation of employment and income” (Inspector 3); “Investments to strengthen inspection and environmental education actions for young people and adolescents” (Inspector 1)).

Finally, we asked the IBAMA inspectors if there had been any arrests of pigeon/dove hunters in the region, and were told that there are very few due to the small number of inspectors in the region: “The small number of inspectors in the region makes our work less efficient” (Inspector 3). According to the five of inspectors who responded to our question as to what punishments were meted out to the few hunters who are caught, they are fined for environmental crime and, in some cases, for illegal possession of a firearm (“Hunters face prosecution for environmental crime and some for carrying a firearm” (Inspector 1)). Two inspectors did not respond.

Discussion

Our results confirmed our initial hypotheses that rural residents be hunt columbids as an important food resource, and that researchers and IBAMA inspectors opposed unregulated hunting in the region due to lack of data on its impact on the bird populations. Most of our resident informants defended hunting of columbids as part of their diet, even preferring their meat to that of domesticated animals, while we found agreement among the researchers and the hunting inspectors we interviewed that columbid hunting is a conservation problem and that it should at the very least be regulated in light of the lack of the demographic studies for those species and the reduced number in inspections in the region. Both inspectors and researchers recognize that combating

columbid hunting in the region is complicated by problems arising from the low socioeconomic status of the residents and the fact that hunting was also carried out as a leisure activity, not only to secure a protein source. Rural participant indicated that even if they could afford other sources of meat (beef, chicken, or pork), they would continue to hunt columbids.

Our third hypothesis that suggestions from our three groups of interviewees of strategies for the legalization or banning of columbid hunting in the region would be similar, and focus on improvements in the socioeconomic status of the communities proved not to be the case. Most of our rural resident participants indicated that even if they were able to afford other animal meat, they would continue to hunt pigeons/doves, due to their personal preference for the taste of these birds, and as a leisure activity. Nevertheless, at the same time, they did suggest that hunting should be regulated with sustainable quotas established in order to reconcile hunting activity with species conservation. The researchers and inspectors, on the other hand, maintained that improvements of socioeconomic circumstances, combined with effective inspections and environmental education, could reduce or even end columbid hunting in the region.

Several similar studies carried out in Northeast Brazil indicate that the Columbidae family is among the groups of birds most exploited by rural populations as a food resource (Alves et al., 2009; Bezerra et al., 2011; Nobrega et al., 2011; Fernandes-Ferreira et al., 2012; Fernandes-Ferreira, 2014; Barbosa et al., 2014) corresponding with our results that the columbids most consumed by rural residents are precisely the most abundant and the most hunted species in the studied region (Silva et al., 2021; Silva et al., unpublished data). The fact that our rural informants reported that they consume pigeons/doves more for the pleasure of their taste than out of necessity reflects on the links between poverty and hunting of wild animals found by Duffy et al. (2015) in their review of political and academic literature on hunting and illegal use of wild animals, which highlights several studies in Northeast Brazil that found people hunt illegally because they lack financial resources and alternative livelihood strategies (Alves et al., 2009, 2012; Barbosa et al., 2014; Nobrega et al., 2011). It is not uncommon in rural communities in the Northeast, for example, to hunt to “earn a penny” and buy rice, beans, and other basic foods (Bragagnolo et al., 2019). Nevertheless, several studies (Alves et al., 2009, 2012; Barboza et al., 2016; Santos, 2019) find that illegal hunting is more linked to cultural preferences for wild meat, as we observed in the present study, and to entertainment activities rather than subsistence.

Wilderness, including the fauna, provides important ecosystem services that benefit human communities (Millennium Ecosystem Assessment, 2005), including food (Michel et al., 2020). The meat of pigeons/doves is appreciated in

several Brazilian regions (Alves et al., 2012; Barbosa et al., 2014; Bezerra et al., 2011; Cajaiba et al., 2015; Fernandes-Ferreira et al., 2012; Lucena & Freire, 2012; Mendonça et al., 2015; Nobrega et al., 2011; Silva et al., 2021; Souza et al., 2022), which puts their populations under significant pressure from hunting. However, it is important to note that the benefits provided by this group of birds are not limited to providing food. Some rural participants reported their pleasure in their singing, a non-material benefit we refer to as a cultural service (Chan et al., 2012). Cox and Gaston (2016) argue that relationships between humans and birds have the potential to impact people's physical and mental social comfort and happiness. Other studies have shown, for example, that urban environments are more appreciated if birdsong can be heard (Hedblom et al., 2014). Some bird calls are commonly associated with relieving stress (Ratcliffe et al., 2013), anxiety, and depression currently exacerbated by the impacts of climate felt throughout the world (Clayton et al., 2013). Cox and Gaston (2018) advocate designing landscapes to promote human-nature relationships to mitigate biodiversity loss and provide people with feelings of connection with nature.

Bushmeat is consumed in all regions of Brazil (Winck et al., 2022), and according to a recent study (Winck et al., 2022), is a relevant factor in the formation of observed patterns of emerging zoonoses. However, research on the contribution of bushmeat to human health and nutrition remains limited (Ingram et al., 2021; Torres et al., 2022; Van Vliet et al., 2017; Winck et al., 2022). For Torres et al. (2022), this research gap is problematic because reliable evidence is essential for informed debates about the ethical and health implications of policies that promote the sustainable use of wildlife. The threat of zoonoses such as leprosy, Chagas disease, ornithosis, and leptospirosis illustrates the public health hazards associated with handling and feeding wild birds and mammals (Gruber, 2017).

Although most urban Brazilian populations oppose hunting wild animals, (Marchini & Crawshaw, 2015), rural populations are traditionally more dependent on the exploitation of natural resources for their subsistence, including hunting wild animals (Bragagnolo et al., 2017a, b; Gama et al., 2016). Nevertheless, studies on hunting and trade in wild animals in different regions of the Brazilian Northeast indicate that the commercialization of these animals (alive and/or slaughtered) is evident in urban centers (Silva et al., 2021) where they are bought by urban residents (Santos, 2017), revealing something of a moral contradiction on their part. For professionals specializing in wildlife conservation, such as the IBAMA inspectors and the researchers we interviewed in our study, hunting is a challenge to conservation efforts in Brazil (Fernandes-Ferreira & Alves, 2017; Fernandez et al., 2012). They argue that in Brazil and more broadly in Latin America there are insufficient data available for

wild fauna to be legally exploited as a source of food and income (Roper, 2006). They also claim that addressing an issue such as hunting in Brazil is extremely complex due to its geographic extent and existing cultural megadiversity (Bragagnolo et al., 2019).

Despite the lack of data on the impacts of the hunting of pigeons/doves in Brazil, the fact that most rural residents favor of the exploitation of these birds suggests that regulated hunting is a practical and sustainable conservation strategy alternative to either unregulated legal hunting or a total ban (Robinson & Bennett, 2000). Advocates of recreational hunting argue that it can provide subsistence (meat) and advance conservation concerns, for example by preventing the conversion of natural habitats into pasture lands and the consequent loss of biodiversity (Di Minin et al., 2021). However, it is important to note that recreational hunting can also drastically contribute to the population reduction of target species in the face of increasing human pressure on biodiversity (ibid.).

Efforts to change behaviors in pursuit of a conservation goal can be challenging, especially if rooted in traditional or cultural practices, as in the case of pigeon hunting in Northeast Brazil. Failure to consider ingrained social and cultural motivations can result in conservation policies that are misaligned or conflict with stakeholder needs (Swan & Conrad, 2014). Thus, values alignment can be critical to the success of conservation programs, and merely strengthening inspection regulations and capacity is not sufficient (Bezerra et al., 2012).

Bragagnolo et al. (2019) point to the potential role of socioeconomic improvements in reducing hunting pressure in rural Brazil through the alleviation of poverty and provision of alternatives for income generation, as in some successful projects in Africa. However, it has been noted that the success of these projects depends almost exclusively on site-specific institutional, ecological, and developmental conditions (Adams et al., 2004; Sanderson & Redford, 2004). In Brazil, a viable starting point would be the promotion of projects to integrate household income through activities that add value to rural products (e.g., honey production, organic food, craft production) (Lindsey et al., 2013). Another option aimed at alleviating poverty and reducing bushmeat hunting is the adoption of a local business-based approach, such as the Community Markets for Conservation (COMACO), developed with local communities around national parks in Zambia (Lewis et al., 2011), which creates rural trade networks and trains target households (people with less food security and poachers of wild animals) in sustainable agricultural practices, rewarding them with premium prices for their products. Another way to reduce hunting pressure, according to Bragagnolo et al. (2019), is to remove some of the financial incentives for hunting and trading wild animals by modifying supply chains. There

is good evidence in other parts of the world that breeding in captivity can reduce the demand for wild captured birds (Jepson & Ladle, 2005, 2009). This option could have potential for the main species of Columbidae hunted in the study region, given the relative ease of adaptation of these birds to captivity.

Hunting bans have typically been used as an emergency measure, e.g., as a response to threatened species extinction or a disease outbreaks. However, bans should be accompanied by public education efforts, and when applicable, by adequate mitigation programs, also considering local social and economic conditions (Koh et al., 2021). Some argue that simple bans can produce adverse conservation outcomes (Weber et al., 2015), discouraging sustainable exploitation (Biggs et al., 2013), exacerbating poaching, attracting organized crime ('t Sas-Rolfes, 2000), or leading to food insecurity and economic insecurity (Booth et al., 2021).

That said, hunting quotas to sustain local wildlife populations, as suggested by our rural participants in this study, have been widely practiced in Africa to prevent overexploitation and population decline of favored (Booth et al., 2020; Fukushima et al., 2021). However, it is essential that any quotas are based on robust data and methods, managed properly and operated transparently to avoid abuse or overexploitation in practice (Bennett et al., 2021; Fukushima et al., 2021). Thus, it is important to bear in mind that responses in our interviews with researchers and IBAMA inspectors highlighted the lack of data on the Columbidae family in Brazil.

As we have noted, IBAMA, the main body responsible for the inspection and management of wildlife in Brazil, has only seven inspectors to deal with all types of environmental crimes throughout the state of Sergipe, which has an estimated population of 2,338,474 people (IBGE, 2021), and is understaffed and underfunded across the country as a whole (Brant & Machado, 2021). For example, from 2005 to 2010, IBAMA received less than 2% of approximately US\$314 million in fines it imposed for crimes against wildlife across the country (Bennett, 2012). Poor governance sends a message that wildlife crimes can be committed with impunity (Gordon et al., 2009). The IBAMA inspectors we interviewed understand the problem of columbidae hunting in the region and they act accordingly, curbing and imposing fines on hunters caught in hunting illegally, but are fully aware that their work has a negligible impact. They also understand that more personnel would be an insufficient solution without simultaneous major improvements to the socioeconomic status of households and communities involved in hunting.

The researchers we interviewed all point to the lack of population studies of columbid species in the region as one of the biggest problems in designing strategies for its sustainable conservation. Both they and the IBAMA researchers agreed that hunting is a problematic activity in the

region, but its real impact on columbid populations remains unknown. Therefore, there was a suggestion that studies of this nature should be carried out, so that subsidies are provided to the competent authorities for making more assertive decisions. However, it is important to highlight the reports of some of the residents about the decline of some species they had already detected over the years (Silva et al., 2021), which they attributed to the over-exploitation, but also to other reasons that may be contributing to their decline, such as the use of pesticides on crops (Dibartolomeis et al., 2019; Li et al., 2020), climate change (Ay et al., 2014; Li et al., 2022), and increased urbanization (Aronson et al., 2014; Isaksson, 2018). Thus, long-term studies that evaluate all these possibilities should be conducted in the region in order that decision-making about columbid hunting is informed with accurate data.

Conclusion

Our results demonstrate that the hunting of columbids is a cultural, leisure, and subsistence activity rooted in the rural communities studied in the municipality of Itabaiana, Sergipe. Despite being aware of this activity and its deleterious potential for columbid populations, neither the IBAMA inspectors nor the researchers we interviewed are able to abolish or even reduce hunting of these birds in the region due to lack of personnel or research data. Thus, actions by public agencies that combine conservation with sustainable exploitation, in addition to environmental education actions are important to combat indiscriminate hunting of columbids locally. Studies that evaluate the dynamics of columbid populations in the region, as well as the impacts caused by hunting and other human activities, are necessary for the long-term conservation of the native species of doves and pigeons of Itabaiana.

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Authors' Contributions C. Silva, J. Ruiz-Esparza and A.S. Ribeiro conceived the project, designed the research, and revised the manuscript; C. Silva collected and analyzed data; C.S. Azevedo analyzed data, drafted and revised the manuscript.

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Availability of Data and Materials Data will be made available on request.

Declarations

Ethical Approval The study objectives and implications were explained to each participant and consent was given by signing a Free and Informed Consent Term. Participants also consent to the use of their images by signing Image Authorization term. The National Health Council through the Research Ethics Committee (Resolution 466/12) requests both documents. The Human Research Ethics Committee of the Federal University of Sergipe (CAAE 47838821.9.0000.5546) authorized this research.

Competing Interests The authors declare that they have no conflict of interest.

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