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Traditional Knowledge on the use of Turtles in a Protected Area of the Amazon in Maranhão (Brazil): A Conservation Proposal

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Abstract

AbstractThe use of turtles for food or breeding is a traditional practice in the Baixada Maranhense Environmental Protection Area (EPA), which is composed of wetlands of high conservation value. However, species such as *Kinosternon scorpioides,* a semi-aquatic Amazon turtle, are threatened by direct harvesting and habitat loss. Local knowledge of biodiversity has been used to understand these practices and to control these problems as a theoretical basis in research on the use and management of natural resources and conservation. This work aimed to analyze the traditional knowledge of riverside communities on the biology, habitat, capture methods, forms of use, and conservation of turtles in the Baixada Maranhense. Data were collected through semi-structured interviews with inhabitants of riverside communities. Based on our results, turtle species are commonly caught in fishing activities (54.71 percent of the interviewees) or by burning (32.35 percent), a practice with great environmental impacts. 41.77 percent of respondents capture these animals for consumption and prefer the *K scorpioides*, which also has cultural and medicinal importance for the riverside communities. 89 percent of the interviewees report no knowledge of either the structure and function of an EPA or how resource management works, compromising the sustainability principles and operation of this Conservation Unit (C.U.). It is concluded that capture of turtles is one of the reasons for the decrease in natural stocks of *K scorpioides*. Strategies for management and conservation of the Baixada Maranhense EPA resources are proposed.

Keywords

environmental perception, traditional knowledge, conservation, turtles, *Kinosternon scorpioides*

Introduction

Turtle populations in many parts of the world are heavily impacted by human activities (Silva, Terán, and Jacaúna 2012; Teixeira 2018). The decline of such populations is a cause for alarm for researchers, conservationists, and those who care about turtles and the well-being of aquatic ecosystems. The main causes of this decline are the indiscriminate consumption of turtles and/or their eggs and the removal of turtles for the illegal pet trade (Rebêlo and Pezzuti 2000; Moll and Moll 2004).

The consumption of turtles is a centuries-old practice of indigenous peoples which was later extended to riverine communities. More recent turtle hunting groups overexploit the species, despite their feeding the animals in their habits (Luz et al. 2003; Rêgo 2012). Increased hunting pressure and the pollution of water bodies have negatively influenced body growth, the number of spawnings, and the average number of eggs per spawning, compromising natural stocks of turtles (Silva et al. 2012; Bohm 2013).

The Baixada Maranhense is an environmentally important region located in northern Maranhão state, Brazil. It is an ecosystem with transitional characteristics between the Amazonian vegetation, wetland, and savanna. Because of the recognized importance of the flooded grasslands region, the Maranhão state government established the Baixada Maranhense Environmental Protection Area (EPA) following Decree No. 11,900 dated June 11, 1991. It is a classification that follows the National System of Conservation Units, which determines areas of environmental importance and the official guidelines and procedures that allow federal, state, and municipal government spheres to create, implement and manage protected areas (Conservation Units).

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In 2000, the region was designated by the Ramsar Convention and The National Wetlands Committee (CNZU) as a Ramsar site, a wetland area of international importance that provides ecological services—such as meeting water and power needs—for biodiversity and human populations. In addition to regulating the water regime of large areas, Ramsar sites function as a source of biodiversity at all levels (Ramsar 2018).

The Baixada region is dominated by fields that flood during heavy rain, and is home to testudine species such as *Kinosternon scorpioides* (Pereira et al. 2007; Barreto, Ribeiro, and Nascimento 2011), *Phrynops geoffroanus* and *Rhinoclemmys punctularia*. These turtles inhabit the flooded grasslands and remain in the region throughout the rainy season.

K scorpioides is a semi-aquatic Amazon turtle belonging to the Kinosternidae family (Vanzolini, Ramos Costa, and Bit 1980; Iverson 2022). It is mainly found in the Eastern Amazon region and commonly known as muçuã or jurará (Rodrigues et al. 2017). It is widely distributed throughout the Neotropics, including Brazil, Peru, Ecuador, northern Colombia, Venezuela, the Guianas, Bolivia, and Argentina (Berry and Iverson 2011).

In Brazil, this turtle dwells in flooded grasslands, and therefore it is rare in the Western Amazon; instead, the highest concentration of this species is on Marajó Island and the Eastern Amazon (Rodrigues et al. 2017). Pereira et al. (2007) reported that this turtle is often found in fields and rivers in the Baixada Maranhense region.

Studies of turtles in the Eastern Amazon remain limited. Lack of data on the biology of the species in its natural habitat as well as the effects of environmental and ecological variables on the species' occurrence hinders the implementation of management actions and more efficient conservation policies (Barreto, Ribeiro, and Nascimento 2011).

In a study by Fagundes (2015) using species distribution models of turtle populations in the Amazon, the jurará is one of the species with the greatest potential loss of habitat due to current and predicted deforestation. It is known that habitat degradation and changes in wetlands are factors with a strong impact on jurará populations, as its uses terrestrial and aquatic habitats dynamically according to ecological niche and life stage (Berry and Iverson 2011). Considering the analysis by Fagundes et al. (2015) on the total area lost in relation to areas suitable for the species, *P geoffroanus*, *K scorpioides* and *R punctularia* are the most affected species.

The environmental observations of riverside communities are an important tool for obtaining ecological information about the turtles in terms of their behavior and areas of occurrence, as well as the state of stocks, the effectiveness of management practices, and cultural knowledge.

The study of environmental perception is fundamental to understanding the interrelationships between human populations and the environment in which they live, as well as their expectations, satisfactions and dissatisfactions, values and behaviors, and how each individual perceives, reacts and responds differently in the face of actions affecting the environment (Marchand and Vander Velden 2017; Fonseca et al. 2020). It is important to note that current conservation initiatives to protect turtle populations have not achieved satisfactory results in Brazil and especially in Maranhão, as they do not often include traditional communities or take into account their knowledge and values (Salera Junior 2005; Kennet, Danielsenn, and Silvius 2015).

Examining the way different cultures or groups might think about nature or conservation is crucial for implementing conservation actions. The lessons learned from examining the contexts, processes, models and ways of thinking about conservation can yield innovative ways of thinking about or planning conservation (Christie 2011; Bennett et al. 2017). Significant steps are needed within the scientific community to increase knowledge of interactions between human communities and the environment. Conservation actions must be multi and interdisciplinary; that is, they require an understanding of natural and social systems and a partnership between scientists and the community (Moon and Blackman 2014; Bennet et al. 2017).

Research on local needs and the attitudes of people living around protected areas provides support for the redirection of adopted policies and actions; people's positive perceptions of protected areas are a key indicator of protected area conservation success (Teixeira 2018; Allendorf 2020). ***In addition, knowledge of the relationship between inhabitants of EPAs and the turtle species in the region can contribute to the success of management and conservation projects involving such reptiles (Ataídes, Malvasio, and Parente 2010).

This study aimed to analyze the traditional knowledge of riverine communities regarding the biology, habitat, capture methods, use, and conservation of turtles in the Baixada Maranhense EPA, as well as aspects of the interaction between human populations and these reptiles, such as where these interactions happen, for what purpose and the importance of it for the communities. Our goal is to create strategies that involve these populations in the management and conservation of turtles.

Methodology

The study was developed with riverine communities located in the EPA of "Baixada Maranhense" (State of Maranhão-Brazil), created in 1991 by Decree No. 11,900 of June 11, 1991 and Ramsar Site, designated in the year of 2000 by the Ramsar Convention and the National Wetlands Committee (CNZU).

The research was carried out under the authorization of the Chico Mendes Institute of Biodiversity Conservation (ICMBio), through the System of Authorization and Information on Biodiversity (SISBIO), permit number 47635-4. All procedures were performed according to the ethical principles established by the National System of Ethics in Research (SISNEP) for recording research involving human beings. When answering the questionnaires, all the

interviewees were presented with the consent terms for the dissemination of the data obtained in this research.

The Baixada Maranhense region has the largest number of lacustrine basins in northeastern Brazil, which contribute to high fishing productivity, which is the main source of food and income for the local population. The choice of the study area is justified by its international environmental importance. It has transition characteristics between the eastern Amazon, swamp and tropical savannah, where flooded fields predominate during the months of January to July (rainy season), which have differentiated biodiversity and the occurrence of turtles such as jurará (Pereira et al. 2007; Figure 1). For this study, some regions were selected close to the main rivers that make up the Baixada, such as São Bento, Pinheiro and Viana.

Respondents were selected randomly or through snowball sampling (Vinuto 2014) among members of communities close to the camps, fishermen settlements, rural and urban workers, with their prior authorization. We participated in monthly meetings in fishing settlements that were invited to voluntarily respond to the interview. The fishermen who agreed to respond, in the end, indicated other people to be interviewed, who could contribute to the work, this methodology was adapted from Vinuto (2014). Among those chosen were fishermen, farmers, hunters, teachers, riverside dwellers, and other community members who participated in the monthly meetings of the fishermen's colonies.

A total of 170 semistructured questionnaires were applied, containing open and closed questions, addressing the socioeconomic profile, environmental perception, and traditional knowledge of the respondents.

The questions (Appendix 1) evaluated habitat knowledge and exploitation of jurará and other turtles in the area. The questions also referred to the frequency of consumption of meat and eggs, traditional knowledge about turtle populations, the ways in which these turtles are used, their cultural relevance, as well as positions on wildlife exploitation, the perception of environmental problems resulting from anthropic action in the EPA and strategies to reduce possible impacts.

The interview scripts were adapted from Pereira (2004) and prepared according to Ditt et al. (2003), using strategies that allowed testing the consistency of responses, such as supplementary questions and answers that depend on previous questions; in order to minimize the risk of obtaining information that does not reflect reality. Such a risk is to be expected from unknown informants discussing a sensitive subject, and

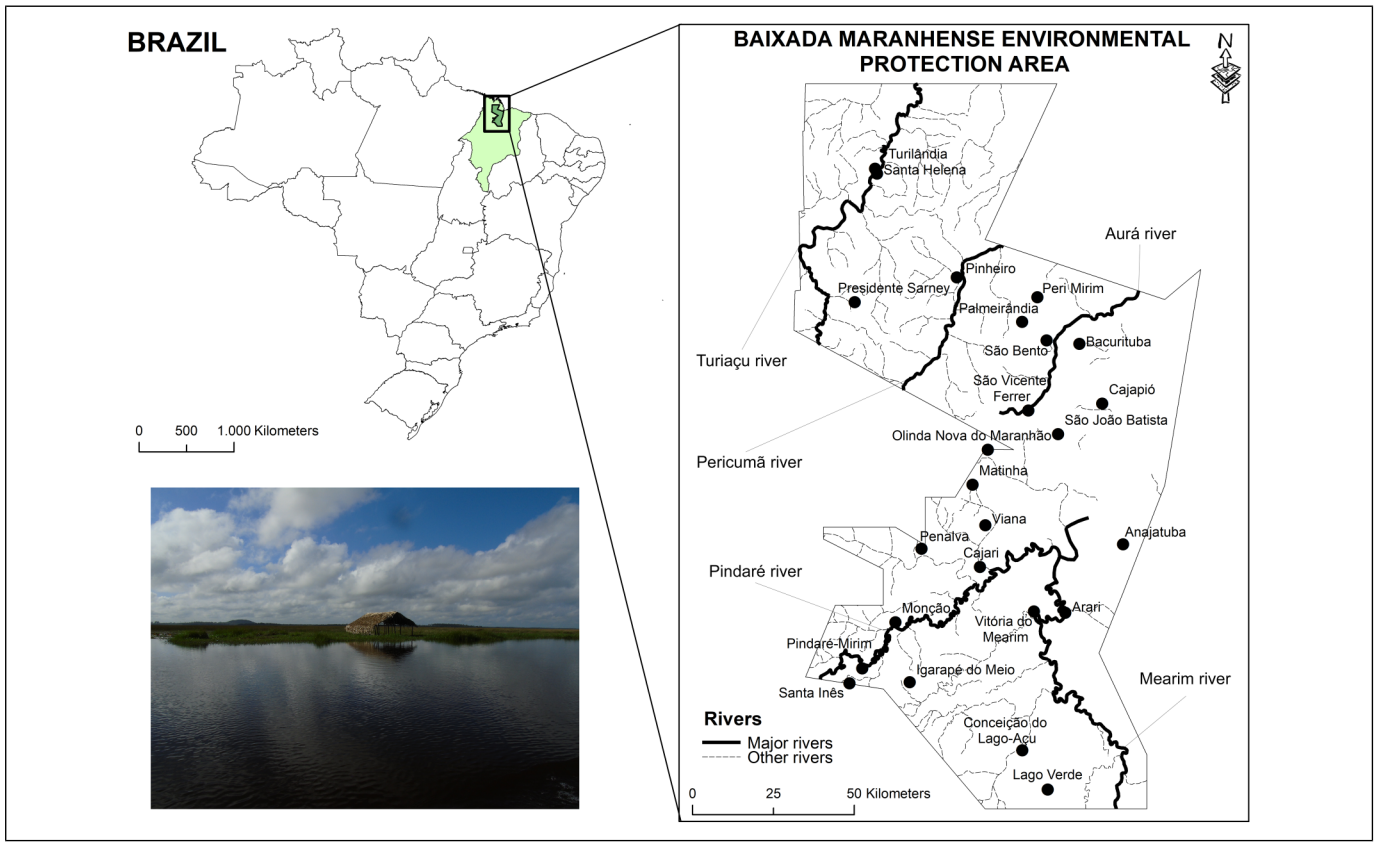

Figure 1. Map of Brazil (to the right) with emphasis on the state of Maranhão and the Baixada Maranhense Environmental Protection Area (EPA). Photo (right below) representing the flooded fields. On the left, EPA of the Baixada Maranhense highlighting the cities and main rivers. Source: Research data, 2022.

it should be noted that the capture, sale, and consumption of wildlife is illegal in Brazil.

The standard interview procedure was suggested in a study by Minayo 2008), according to which researchers should consider the following during interviews: Initial conversation—check if the potential respondent is able to provide information and create a relaxed atmosphere; mention the area of interest of the research; present institutional credentials; explain the reasons for the survey; justify the choice of the respondent; guarantee anonymity and confidentiality—ensure the informants that the data obtained will be used only for academic purposes.

The interviews were carried out individually or in groups of two or three people, in which the facilitators (research authors) encouraged the participants to expand on answers to the questions and allowed additional discussions (Smith et al. 2017). Detailed information from the discussions was categorized, tabulated in spreadsheets and analyzed by a descriptive statistical analysis tool in Microsoft Excel 2013. Additional statements from respondents during the process were also considered to be responses and used in the results (Pinto et al. 2016).

Results and Discussion

Social profile of riverside dwellers

The age of interviewees ranged between 21 and 63 years (average of 43.7 years), with 31 percent aged between 46 and 50 years, showing that the interviewees were experienced and had lived in the locality for several years. This data was a reference for the subject in question, as the experience consolidates practices and knowledge in the interaction of man with the environment. Socio-demographic data, including population parameters such as age and gender, are considered to be key factors for explaining environmental attitudes (Gifford and Sussman 2012). All survey respondents claimed to be part of riverside communities, so they develop some activity related to the countryside. According to the answers regarding their occupations, they were divided into categories by livelihood: farmers, fishermen, hunters, and others.

The results indicate that 59 percent of respondents have more than one occupation in addition to fishing, usually to supplement their income, while the other 40 percent are only fishermen, and have been performing this role for more than 20 years. This information is very important for obtaining data on the capture and hunting of *K scorpioides* and other turtles in the field, as well as data on the animals' natural stocks, as fishermen are in direct contact with the habitat of these animals. According to De Carvalho et al. (2016), although it cannot be assumed that the time spent fishing is the same as the time spent collecting turtles, this information is useful for drafting actions aimed at the conservation of these species.

With respect to educational level, 48 percent of respondents had only attended elementary school. This data confirms the results of the study by Ataídes et al. (2010), which found a low level of education among community dwellers in the Parque Nacional do Araguaia (Araguaia National Park) in Tocantins where most of those surveyed had not completed primary education (62 percent).

Education is considered among the most important factors driving knowledge and learning processes, and thereby, influencing the attitude toward environment and resources conservation. By contrast, wealth-related variables such as occupation and income can strongly affect human needs and their effect on attitudes can be directly related to the unregulated use of resources (Bragagnolo et al. 2016). Education is a key driver of better employment opportunities and a means to generate alternative livelihood strategies, thereby diminishing direct dependency on natural resources (Kideghesho et al. 2007).

Environmental Perception of Riverside Dwellers

In terms of the environmental perception of local people, the majority (72 percent) had known about jurará turtle for over 21 years. In their discourse, respondents said they had known about other turtles in the region such as the *P geoffroanus* and *R punctularia* for the same period of time, as they share habitat with *K scorpioides*. The species were identified through images and descriptions of their main characteristics during interviews.

When asked about collecting jurará, 58 percent of respondents said they accidentally collected the turtles when fishing. However, 67 percent stated that the greatest collection occurred during the dry season from July to January, which suggests that this activity is carried out not only by fishermen but by anyone who has access to the fields.

This calls attention to the fact that it is in this period when the fields are totally or partially dry, that female turtles perform the spawning, coinciding with the reproductive period of the species (Ferrara et al. 2017; Rodrigues et al. 2017). This is a very important and delicate time for reproduction as it is the period of development and birth of new individuals, a fact reinforced by Ataídes et al. (2010), who stated that the reduction in the number of females in one species can lead to the reduction of its stock, hence reducing the population of the entire species. In the rainy season when the turtles are at the lakes' bottom and in flooded fields, captures are greatly reduced, due to water dispersion. Pereira et al. (2007) confirm the fact that turtles are easier to collect and sell in the dry season.

For Lacava and Balestra (2019), jurará represents a protein and economic source for riverside communities. Due to the economic conditions of the Baixada Maranhense, and to the lack of conservation strategies for the species, such as raising awareness among the population, or protecting the nests and breeding areas; many fishermen are encouraged to collect this animal, either for their own consumption or for sale, especially in the dry season, when fish are scarce.

According to the fishermen, collection in the rainy season is accidental, with 54 percent of respondents saying they collected

jurará using nets (gill), with the rest mentioning other forms of collection such as corrals and traps. Most riverine dwellers (43 percent) usually collect about six to ten turtles accidentally during fishing, most frequently jurará (Figure 2).

In the dry season the animal seeks self-protection in dry vegetation or buries itself in the ground. During this period 12 percent of respondents used manual means to collect turtles: an iron rod called *chucho*, used to beat the ground. The sound emitted on striking the carapace allows identification of the animal buried. In addition, 32 percent said they collected *K scorpioides* using the burning method, consisting of setting fire to vegetation, notably the "cotton" (*Ipomoea carnea*) which is very common in the region and the preferred hiding place of the jurará. When the animal flees the fire, it is vulnerable to manual capture. It is also customary for riverside dwellers to use burning practices for soil preparation and planting fast-growing crops such as maize, beans, and cassava. This action causes damage to several wildlife species, significantly affecting the loss of turtle eggs at a very important time for reproduction. The intensity of the fire can impact the population of jurará Burnings are often carried out during the dry season, which is also the spawning season of the jurará (Pereira et al. 2007).

It has been reported that fishermen are the main collectors of turtles (Ataídes et al. (2010) and Teixeira (2018)). However, 23 percent of respondents mentioned the existence of 'hunters', who mainly hunt wild animals, including turtles such as *K scorpioides* and *P geoffroanus*, snakes such as *Bothrops jararaca*, and birds such as *Jacana jacana* and *Porphyrio martinica*. When asked about capture methods, these hunters were reported to use fire as the main technique for capturing turtles, especially in the dry season. According to one participant, "They burn the forest and wait in silence for the animals to come out of the fire to capture them."

Regarding the destination of the animals collected, 41 percent of respondents stated that turtles are used for their own consumption, although the collection was mostly accidental, turtles are easily caught in fishing gear, especially during the rainy season, a fact that makes them vulnerable to accidental capture during fishing activities. Species such as *K scorpioides* go through a type of "hibernation" at a time of year (dry period) when they bury themselves in the soil (Vogt 2008). This estivation moment is a dormancy period that some groups of vertebrates and invertebrates adopt in response to high ambient temperatures and/or danger of dehydration. During this period, turtles are most commonly captured by hunters who use burning as a method.

In 32 percent of reported cases, the jurará are sold alive, by the dozen, adults, and sub-adults and threaded, like crabs. They are marketed mainly from May to August, when the females are in the reproductive period (egg/ova production), since during this period these animals are in search of food, mating partners, or spawning grounds; move in flooded fields, between rivers and streams and are easily caught in fishing traps (Pereira 2007; Medeiros 2016).

In total, 67 percent of respondents denied collecting and consuming turtle eggs. When collected, eggs are not intended for sale or for food, but for breeding, demonstrating that their consumption is not common in the region. This is a positive finding, as keeping these eggs in incubation may lead to reproduction, although if it is not for conservation purposes and the hatchlings are not released back into the environment, these practices may not be effective. Still, this contradicts studies of the riverine communities of the Amazon, which find that the consumption of turtle eggs is as common as eating meat (Ferrara et al. 2017; Figure 3).

The following are testimonials of Baixada Maranhense riverine dwellers regarding consumption of the jurará:

> I like to breed *jurará* in the backyard, they are tame. Fisherman, 45.
>
> I collect the eggs when I find them to see if they were born elsewhere. Fisherman, 51.
>
> I've never found eggs. They are very hard to find. Fisherman, 39.
>
> I've found eggs. I took them home to see if they produce young. They are too small to eat Riparian dweller, 41.

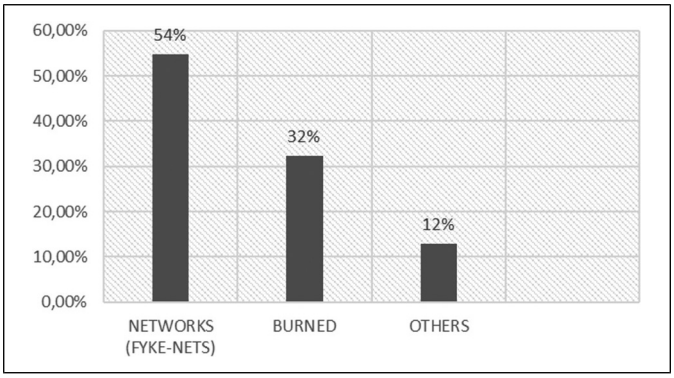

Figure 2. Turtles capture methods in the riverine region of the Baixada Maranhense. Source: Research data, 2017.

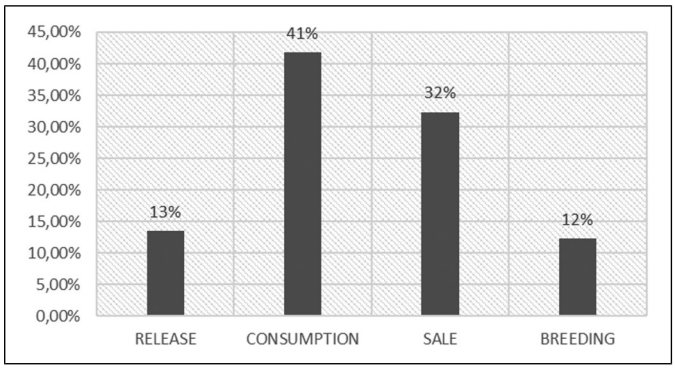

Figure 3. Destination of turtles collected by riverine communities in the Baixada Maranhense. Source: Research data, 2017.

It can be seen that the riverside dwellers have a strong relationship with these animals, which ranges from observation in the field to raising them in their homes for food, marketing, or just as a pet. Similar data were observed by Mittermeier et al. (2004) and De Carvalho et al. (2016) which stated that the indiscriminate collection of eggs and uncontrolled hunting of adult animals, especially in the nesting period, may reduce the number of female individuals of these species and, consequently, their natural stocks.

Many riverine dwellers reported collecting other species of turtles common to the region during fishing, such as *P geoffroanus* and *R punctularia*. Yet these species are not commonly consumed by riverine communities of the Baixada Maranhense. Preference for the consumption of *Podocnemis expansa* in communities around Parque Nacional do Araguaia (Araguaia National Park) (Tocantins) has been reported (Ataides et al. 2010). Several factors—such as the animal's size, taste, or cultural factors—can influence the food preference of residents of traditional communities. Interviewees declared that the consumption of jurará is a traditional custom among riverside dwellers, in addition to considering the meat of this animal to be tastier.

Similarly, bushmeat has been reported to be preferred to livestock by rural residents in northeast Brazil due to its preferred taste rather than dietary necessity (Barboza et al. 2016). Other studies point to how cultural drivers are key factors in shaping diet preferences and food-related behaviors of urban dwellers, cautioning about the increasing demand for bush-meat in Amazonian towns (Morsello et al., 2015). This situation is especially recognizable in the Brazilian Amazon, where several species such as the giant river turtle (*P expansa*) have been transformed from a subsistence food for riverine people into a delicacy for high-income people (Schneider et al., 2011).

Jurará has a greater cultural value in relation to other species of turtles. Also, reports of riverine inhabitants confirm that this is the most abundant turtle species in the region, the easiest to capture and also the tastiest. These preferences can be based on the most abundant food in the local environment and on economic and cultural factors (Fonseca et al. 2020).

When asked about their knowledge of Law 5,197/1967, which requires the protection of wildlife, 81 percent of respondents said they knew the law and were aware of the ban on wildlife poaching. It was also observed that 73 percent considered the jurará to be a wild animal, but 84 percent said they consumed or consumed the animal on a monthly basis (42 percent) (Table 1). This is a worrisome result, as it indicates environmental crimes and also interferes significantly with the natural stocks of these turtles. Ataídes et al. (2010) and Faria and Malvasio (2018), when interviewing fishermen and residents of Araguaia National Park and the Ecological Corridor Araguaia Bananal in Tocantins, respectively, also noted the contradiction between the percentage of respondents who were aware of the ban on wildlife poaching, but still consumed turtles regularly.

Table 1. Frequency of Consumption of *Kinosternon scorpioides* by Riparian Dwellers of the Baixada Maranhense.

Frequency	No São Bento	No Pinheiro	%
More than 3 times per week	13	8	12
Once a week	22	15	22
More than twice a smonth	41	31	42
A few times a year	19	21	24
Total	95	75	100

Source: Research data, 2017.

In Brazil, subsistence hunting is not technically illegal and is allowed on Indigenous Lands and poor rural areas as a means to ensure the rights of indigenous populations (traditional hunting) and to improve the food security of rural people living in poverty. However, there is evidence that subsistence hunting is increasingly being coupled with commercial hunting as an alternative income source. For example, van Vliet et al. (2015) used questionnaires to reveal how urban hunters in the Amazon hunt for both subsistence and trade.

This resonates with other studies where it has been shown that participants simultaneously consider the illegal extraction of resources to be both a benefit and a problem (see Allendorf et al. 2007). Even while having a positive attitude towards a protected area, individuals may continue to extract resources illegally from the park because they are unaware of the negative impacts of their behaviors, or they lack any feasible alternatives (Thapa Karki and Hubacek 2015).

Around 36 percent of respondents said that eating jurará meat could lead to becoming sick, as the animal is considered "remoso" (a colloquial term meaning harmful to health). On the other hand, 23 percent considered it an aphrodisiac and another 22 percent indicated that they have used it as a medicine for the liver, and reported that "burning the shell is good for asthma." Pereira (2004) reported that the jurará is considered a "remoso" animal, for individuals suffering from inflammation. The medicinal use of turtles is also described by Faria and Malvasio (2018) and Fonseca et al. (2020), including its use in treatments for rheumatism, injury, thrombosis, and asthma.

When asked about natural stocks of jurará, 75 percent of respondents said the population of this species has decreased over the years. Among the causes pointed out for this decline are the consumption and illegal trade of these turtles (24 percent), followed by burning (22 percent), either for agriculture or poaching. Landfill impacts, lack of government enforcement of wildlife protection Law No. 5,197/1967, the breeding of animals for production such as buffalo, and deforestation of mangroves in the region were also mentioned.

The main environmental impacts perceived by residents of the Baixada Maranhense EPA were deforestation, fires, destruction of mangrove forests and fields, poaching, and urban waste. All these actions directly influence the survival of chelonian populations and other native species. Some of these problems were also reported in other Brazilian PAs, such as the

National Park of Araguaia in Tocantins and Mamirauá Sustainable Development Reserve in the State of Amazonas, Brazil where several examples of anthropogenic disturbances were observed, including deforestation associated with agriculture and cattle ranching and the destruction of mangroves (De Carvalho et al. 2016 and Castello et al. 2017).

According to riverside dwellers of the Baixada Maranhense region, buffalo are also responsible for the environmental degradation in the area. Buffalo was introduced in this locality about 40 years ago, and over the years has had severe environmental impacts. Buffaloes exert several impacts on the aquatic fauna (Costa-Neto et al. 2002). Buffaloes trample fields and wetlands, they remove the subsoil, destroying fishes' and other animals' nests and larvae, and overall disrupting the alluvial-rural ecosystem (Silva 2003).

Nearly all interviewees (89 percent) reported a lack of knowledge about the purpose of a Conservation Unit (Brazilian classification system for areas important for conservation) and also about the fact that Baixada Maranhense is an EPA. Consequently, they report that they are unaware of their rights and duties as an integral part of a CU, and the rules that govern these units, emphasizing the need for projects that advise and raise awareness among these populations on the use and protection of natural resources.

Conservation Strategies

In Figure 4, we present some suggestions for the conservation of the environment and the turtles of the Baixada Maranhense, described by riverine dwellers in interviews:

Some respondents (23 percent) highlighted the importance of environmental awareness, accomplished through environmental education projects involving Baixada Maranhense communities. Evaluating the perceptions about negative aspects in the region as well as suggestions for improvement is important. This reveals the main issues experienced by the population, placing the riverside dwellers as the main subject, exposing their vision and ideas for changes inserted in their own social context. This can aid in the implementation of conservation measures by environmental agencies with the help of the community and minimize the aforementioned problems. Conducting awareness programs and encouraging formal and nonformal environmental education are strategies that help in biodiversity conservation.

Increasing technical skills and income opportunities for local people has therefore often been suggested as a way to increase positive attitudes toward the environment. Participants did not report of among the solutions proposed during the interviews, sustainable management of natural resources, such as turtles. This suggests a lack of knowledge of the communities used in this study about this alternative form of riparian conservation. Current levels of surveillance by public agencies do not prevent the sale and consumption of turtles and other wildlife. The absence of these mechanisms could lead to an increase in negative attitudes toward Conservation Unit management (lack of support), illegal behaviors, and social conflicts (Bragagnolo et al. 2016). Some of these negative effects can be ameliorated through co-management, giving more authority to local communities and increasing the sense of ownership to protect their resources.

One potential approach is closely linking the community to well-designed wildlife management programs (Campos-Silva and Peres, 2016). There have been several successful examples of sustainable use and population recovery of aquatic

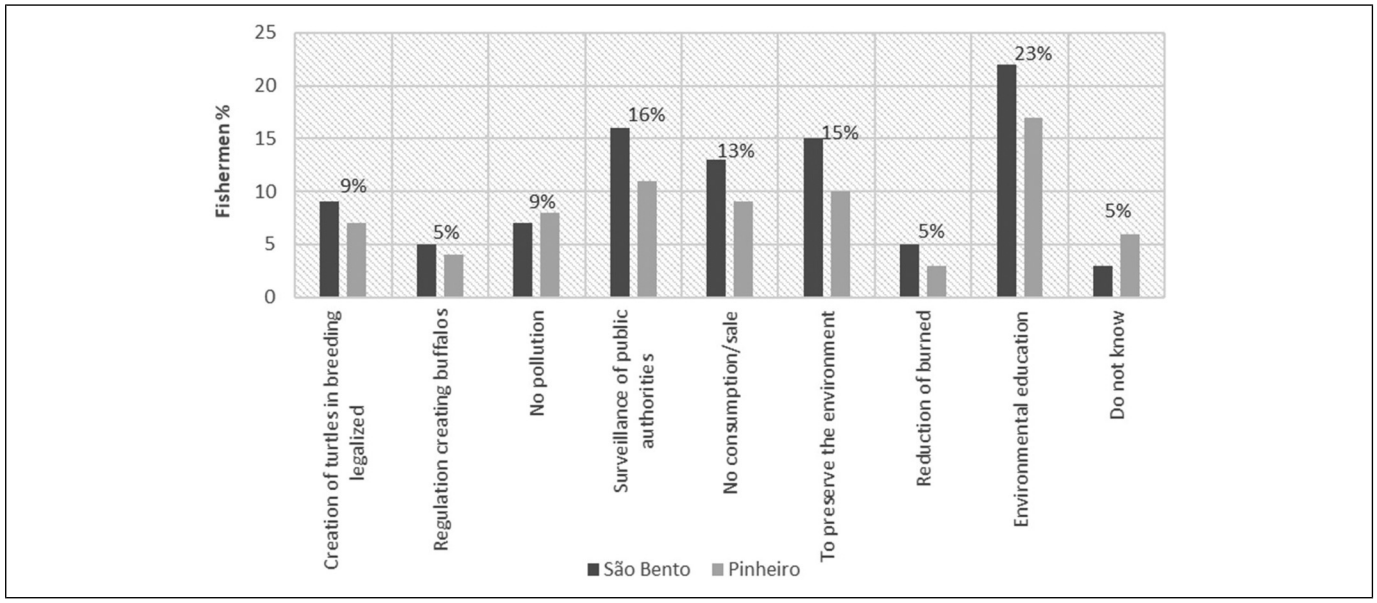

Figure 4. Suggestions from riverside dwellers for environmental and turtle conservation in two regions of the Baixada Maranhense source: Research data, 2017.

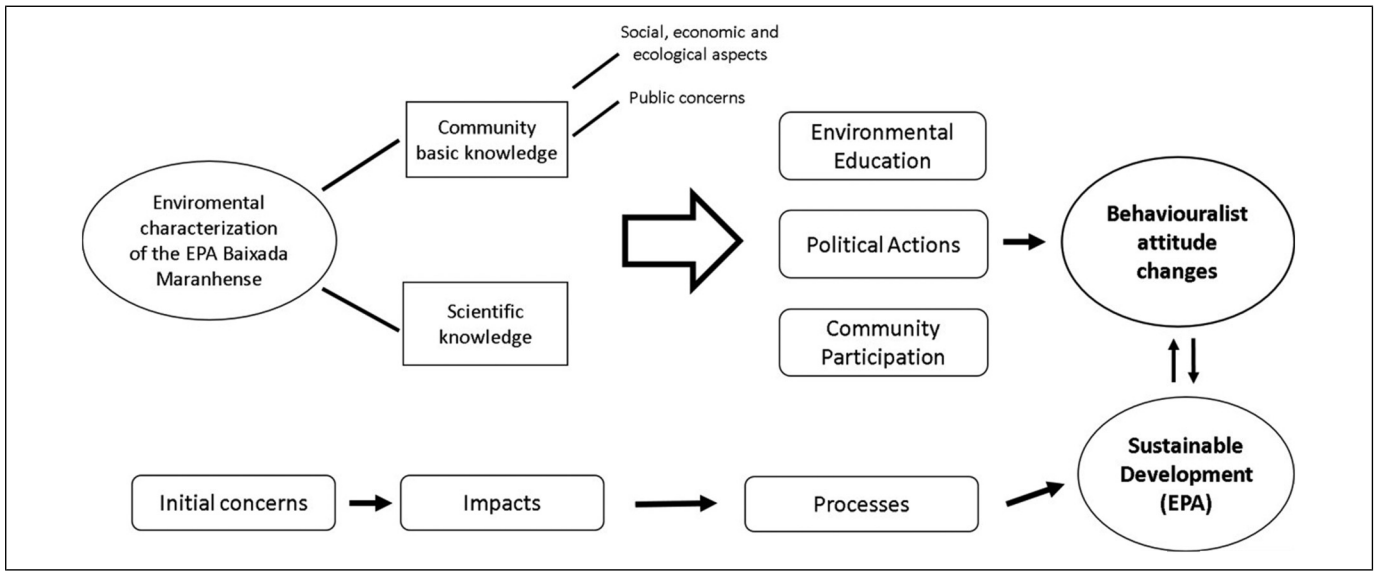

Figure 5. Action plan for conservation of the Baixada Maranhense Environmental Protection Area (EPA).

megafauna in the Amazon adopting a community-based approach. For instance, the recovery of the giant Arapaima which was almost extinct in many Amazon floodplains and the associated increase in many other overexploited freshwater species with natural and economic value (Arantes and Freitas, 2016).

According to the data collected and observed during the interviews, the suggestions and traditional knowledge of the riverside communities of the Baixada Maranhense, together with scientific data on the chelonian species and on the region, the following action plan is proposed:

1. Generate a database on the traditional knowledges of communities combined with biological and ecological data to develop an initial management plan and a threat assessment. Obtain data on flora and fauna (birds, mammals, reptiles, amphibians and fish) to establish the predominant ecological relationships between the environment, the species found, and jurará. (Sayre et al., 2003; Luz et al., 2011; Lacava and Balestra, 2019).
2. Establish a permanent Environmental Education Program in the region: to provide knowledge and value of the EPA to local communities; to disseminate scientific knowledge in an appropriate language, to be simple and accessible to the focal communities; to enhance their culture. This will enable the participation of different social groups in the management process and decision-making directed to environmental sustainability, integrating them to the co-management process. Promote the integration of socio-environmental education actions with formal education, involving public school students and teachers.
3. Establish environmental and human resource management actions of the Baixada Maranhense EPA together with public agencies: it seeks to mobilize the participants knowledge and experience to prepare a diagnosis of the Conservation Unit jointly and consensually. Proposing a strategy of action to overcome identified problems—weaknesses and threats—taking advantage of existing strengths and opportunities (Luz et al., 2011; Lacava and Balestra, 2019; Figure 5)

The proposed suggestions are the result of a progressive and cumulative process of collecting information through field observations, traditional knowledge of riverside dwellers in the region, community suggestions, and existing scientific data on the area. The management of an EPA, rather than an empirical experience, must be the result of the accumulation and the information analysis about the interaction of the knowledge produced by the actors involved (Silva, 2010; De Carvalho et al., 2016). It must include: local people integration into the discussions and elaboration of a Management Plan; debate on the importance of conservation linked to the existing activities; ecotourism development and handicraft commercialization as economic alternatives.

Conclusions

The traditional communities of Baixada Maranhense have extensive knowledge of the *K scorpioides* and their habitat, as well as the importance of this species for local culture and use. Local knowledge about the jurará and other turtles complements the information available in the literature. These data reinforce the importance of associating traditional knowledge with scientific knowledge on the population ecology of a species and socioeconomic studies of the region for an effective conservation process.

Empirical knowledge of the riverside dwellers indicates that natural stocks of *K scorpioides* are declining. The fishing/

poaching of these turtles is seen as one of the main reasons for this reduction. This study verifies the major importance of this turtle for the inhabitants of the Baixada Maranhense EPA, which highlights the need for the involvement of local people in conservation and management projects.

The species is known by all and highly appreciated in regional cuisine. In addition to food use, jurará is used for medicinal purposes and as an aphrodisiac item, facts that highlight the species' cultural importance for Baixada Maranhense communities. However, these uses encourage illegal trade. Turtle harvesting increases in the dry season, when fish reproduction slows down. Despite the indiscriminate harvest of jurará, most riverside communities have a significantly reduced knowledge about the stocks in nature, and indicate public agencies as responsible for the conservation of this resource, disregarding the consequences of their own harmful practices.

The advance of urbanization in the municipalities of Baixada Maranhense in Maranhão has seen buildings gradually advance over the fields, affecting the habitats of turtles and other wildlife. This further affects the strong dependency relationship between the riverine dwellers and the fields, from which they derive the necessary resources for their survival.

This research showed the need for projects in the Baixada Maranhense region to make the population aware of issues related to environmental conservation and, consequently, to exploited species such as turtles and other wildlife of the EPA. It is important to highlight the need for environmental education in schools at all levels, as students will be the largest disseminators of information on environmental issues in the future.

Studies of turtles in Maranhão are still scarce, and this lack of information hinders the implementation of conservation actions. Given the economic and social importance these creatures have in the Baixada Maranhense region, this conservation strategy should ensure the effective protection of these turtles and the sustainable use of this resource.

Our findings suggest there is a need for management and conservation strategies not for only *K scorpioides*, but also for the other turtles found in the Baixada Maranhense EPA region. These strategies should combine ecological studies with effective community participation. The results of this research will be used to inform public agencies such as the Brazilian Environmental Institute (IBAMA), the State Secretariat of Environment (SEMA) and the ICMBio about the need to participate in the suggested action strategies and on the importance of an effective control in the use of EPA resources. The inspection should provide for a reduction in the consumption and trade of turtles and other wildlife.

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