ETHNOBIOLOGY AND CONSERVATION

REVIEW

Ethnobiology and Conservation, 14:02 (2025)
doi:10.15451/ec2025-09-14.02-1-14
ISSN 2238-4782 ethnobioconservation.com

Non-food uses of sharks in southern Bahia, Brazil

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ABSTRACT

Sharks are a highly threatened group, and the threats these animals face also affect the cultural ways artisanal fisher communities interact with them. Consequently, local knowledge arising from human interactions with these animals also becomes threatened, as well as the potential of fisheries management through ethnoconservation. In this sense, this study examines the dynamics of shark use by fishers in northeastern Brazil. In 2012, data was collected through semi-structured interviews about shark uses applied to 65 traditional fishers who use sharks differently. The ways fishers use these fish are changing mainly because fishers informed an overall reduction in shark catches. Thus, the analysis of their uses comprises a historical-anthropological record, as specific interactions are quickly disappearing. Therefore, the variety of utilitarian connections and changes in shark use patterns over time reveal both ecologic and cultural extinction threats of the traditional shark fisheries in this area. We suggest implementing anthropological and biological studies that aim to contribute to the maintenance of the livelihoods of populations that interact with sharks and seek to guarantee the sustainable exploitation of these animals.

Keywords: Ethnobiology; Local Ecological Knowledge; Elasmobranch Fishes; Conservation.

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SIGNIFICANCE STATEMENT

This study represents the first record of traditional knowledge and practices of artisanal fishers from Bahia, Brazil, regarding non-food shark uses. About one-third of elasmobranch species are threatened. Therefore, the development of conservation strategies that consider the human shark fishing dimension is paramount. However, until recently, ethnobiological research on shark knowledge, practices, feelings, beliefs, and uses by fishers did not consider this adequately. In this sense, little information on the traditional uses of these fish, especially concerning non-food items, is available. The interviewed fishers point to a sharp decrease in shark catches in recent decades. This research, therefore, describes traditional practices and the knowledge of these social actors, some of which, although yet to be described in the scientific literature, are already locally extinct. This represents a case study on the role of biodiversity threats concerning the erosion of traditional knowledge and practices.

INTRODUCTION

Sharks are cartilaginous fish belonging to the Elasmobranchii subclass, comprising about 536 species (Dulvy et al. 2021). As these animals display numerous adaptive specializations developed throughout over 420 million years of evolution, these fish are noteworthy as one of the top food chain predators in their environments (Roff et al. 2018; Sandin et al. 2022). Most species exhibit K-strategist characteristics, such as late sexual maturity, slow growth, low fecundity, and reduced reproductive rates, and are, therefore, naturally susceptible to overfishing, with a limited capacity for population recovery (Heupel et al. 2014; Pacoureau et al. 2023). However, despite their high vulnerability, shark catches, directed or not, occur in all oceans by artisanal and industrial fisheries, resulting in world catch estimates ranging between 63 and 262 million individuals caught annually (Worm et al. 2013). Worm et al. (2013) suggest that 6.4% to 7.9% of existing sharks worldwide are killed every year, compromising their populations, as they cannot support such exploitation levels. In fact, over one third of all shark species are currently at risk of extinction (Dulvy et al. 2021).

Most studies concerning fisheries resources focus on food use. However, fish are also used on a smaller scale for medicinal and magical-religious purposes and as curiosities or aquaria organisms (Dias et al. 2011, 2017; Mota et al. 2020; Pinto et al. 2015). When the target comprises elasmobranchs, such as sharks, ethnozoological research has focused on the use of these vertebrates mainly as food for humans (Custódio Nascimento et al. 2023), mostly concerning their meat and fins.The available assessments generally address the harm caused by such impacts on the food and nutritional security of socially vulnerable coastal populations in poor and developing countries (Barbosa-Filho et al. 2019; Bornatowski et al. 2018; Dulvy et al. 2017).

In other hand, many studies have demonstrated the utilitarian versatility of sharks, whether they are captured by small-scale or industrial fisheries (Lack and Sant 2009; Musick 2005). Their uses range from, for example, their teeth employed as weapons by Central Pacific cultures (Drew et al. 2013) to cartilage raw material used in cancer drugs, even though their effectiveness is not scientifically proven (Ostrander et al. 2004). In traditional communities, these fish have also been historically used for therapeutic and religious purposes, through consumption or topical use (Custódio Nascimento et al. 2023; Valerio-Vargas and Espinoza 2019).

Nevertheless, efforts aimed at the conservation of sharks have highlighted the successful experiences of generating work and income with the non-lethal use of such animals in ecotourism diving (Gonzáles-Mantilla et al. 2021; Torres et al. 2017). This example demonstrates that to achieve long-term sustainable use of a particular faunal resource, it is essential to analyze and understand, under an ecological perspective, the mechanisms and motivations that guide the human connections with these resources, including men's knowledge, use and management of them (Lucrezi et al. 2023). In this sense, despite their utilitarian versatility and the increase in the number of studies on the human dimension of shark fishing in recent years (Custódio Nascimento et al. 2023), studies focusing on the traditional non-food uses of these fish are still scarce. Furthermore, little is known about the cultural changes resulting from decreased shark catches by certain human groups and the consequences of the loss of certain utilitarian connections between fishers and these animals.

To achieve the sustainable use of a particular faunal resource, it is essential to understand the mechanisms that drive the human connections with these resources, including human uses and knowledge on the specific resource (Barbosa-Filho et al. 2021; Ostrovski et al. 2021). Concerning fishing, due to the inherent complexity of socio-ecological systems, management should focus not only on the resolution of issues relating to the resources themselves but also on the interaction with human populations who make use of them (Brandão et al. 2021; Hilborn and Ovando 2014; Kroodsma et al. 2018). In this context, sci-

ence recognizes the legitimacy of traditional forms of management of exploited resources (Ferreira-Júnior et al. 2022; Johannes et al. 2000; Ruddle and Davis 2011) and suggests that these comprise one of the pillars of a new conservationism. This is particularly true in developing countries, where conventional paradigms applied to fishery management are inadequate due to the peculiarities of small-scale fisheries and a systemic lack of historical series of fisheries and biology data (Begon et al. 2006; Ladislau et al. 2020). In addition, these countries seem to have a lower capacity for shark fishing management (Sherman et al. 2023; Yulianto et al. 2018).

The intrinsic characteristics of local knowledge, such as intergenerationality, orality, and empiricism (Marques 2001), explain why this sphere possesses a dynamic character. It is, thus, influenced by environmental changes in a given region, among other factors, which, in turn, can threaten the cultural memory of human populations and their knowledge concerning the environment they inhabit over generations (Pauly 1995; Soga and Gaston 2018; Santos et al. 2022). In recent years, literature reviews have reported numerous success stories in the application of Local Ecological Knowledge (LEK) as an auxiliary tool in the construction of fisheries management (see d'Armengol et al. 2018; Seixas et al. 2019; Sobczak et al. 2013). On the other hand, LEK, a relevant and modern component of the conservation toolkit, is undergoing increasing loss in indigenous communities worldwide (Aswani et al. 2018; Turvey et al. 2018). This loss represents a complex and multidimensional phenomenon, which usually goes hand in hand with the cultural, social, and economic changes to which globalization and contact with Western cultural norms subject local human groups worldwide (Kodirekkala 2016; Tang and Gavin 2016). The global biodiversity crisis is also an important factor in LEK erosion, as it culminates in the progressive degradation of ecosystems and the weakening of relations between local communities and the different components of the natural world (Aswani et al. 2018). Thus, scientists have dedicated themselves to investigating the current serious risks of LEK erosion.

This study describes several non-food sharks used by small-scale fishers specialized in catching these fish in southern Bahia, Brazil. Some of these utilitarian connections are recorded herein for the first time, even though they are already regionally extinct. Thus, this study comprises a historical-anthropological record of the cultural practices of traditional fishers in Northeastern Brazil, as some of this knowledge and practices are condemned to extinction. Furthermore, from the perspective of a diachronic and intergenerational analysis of the patterns of these uses, this study aims to contribute to shark conservation through the development of participatory strategies that also enable the cultural reproduction of these coastal human groups in the long term.

MATERIAL AND METHODS

Study area

The study area comprises 175 km of coastline (14°24'31"S and 39°00'57"W to 15°49'09"S and 38°53'46" W) and includes the cities of Canavieiras, Una e Ilhéus. The continental shelf width of the state of Bahia is highly variable (8 - 246 km), presenting two well-defined sections, the first to the north of Ilhéus and the second to the south. The region north of Ilhéus has a narrow and steep bathymetric gradient, with practically parallel and relatively uniform isobaths in the platform relative to the shoreline. In contrast, the region to the south reaches a significant width at Canavieiras, extending 100 km in length (Bittencourt et al. 2000) to form the Royal Charlotte Bank.

Since the marine fishery in the region occurs primarily in reef formations and unconsolidated substrates, it presents essentially artisanal characteristics, and the fishers involved in the activity mainly use lines with hooks and nets (Barbosa-Filho and Cetra 2007; Erler et al. 2015). However, despite the high socioeconomic relevance of this fishing activity, the actual number of fishers in the region is not accurately known, partly due to the inherent informality of artisanal fisheries and the lack of initiatives to account for its contingent. There are three fisher associations, locally dubbed "fisher colonies" (Colônia de Pescadores), in this stretch of coastline: the Z-20, in Canavieiras, and Z-19 and Z-34, in Ilhéus, the latter with an estimated number of 6,000 fishers (Braga and Schiavetti 2013). There are at least 13 marine landing sites and communities (Figure 1) in the study area. Seven are located in Ilhéus (Ponta do Ramo, Praia de Mamoã, Ponta da Tulha, São Miguel, Pontal, Jairí, and Acuípe), one in Una (Pedras de Una), and five in Canavieiras (Vila de Atalaia, Porto do Areal, Centro, Barra Velha and Poxim da Praia).

Data collection

A request was made to the Ethics Committee for Researches involving Humans of the State University of Santa Cruz via the Brazilian Platform website, which was approved under no. 25275. Thus, a "Free and Informed Consent Term" was presented to each respondent before each interview, according to the National Health Council Resolution (196/1996), which rules the ethical aspects of research involving human

beings. It was read to the respondents and distributed among those who participated in the research. The study's aims were explained at the beginning of all interviews, and each fisher was asked if he/she wished to participate. In September and October 2011, 14 fishers were found casually at the Z-34 Fisher Colony (8), Ilhéus, and Z-20 (6) in Canavieiras. Open interviews were then used as the central data-generating methodology (Posey 1987) on shark fishing, including data on the uses of these fish in the region.

From March to October 2012, 65 male fishers from the cities of Canavieiras (38), Una (2), and Ilhéus (25) on the southern coast of Bahia were interviewed by means of a semi-structured form. The interviewees were chosen through a network of specialists (Marques 2001) with over 15 years of experience in shark captures. A questionnaire containing 175 questions was used, of which 35 (20%) were addressed concerning shark uses. The interviews were recorded using a digital audio recorder, and the total recording time was 70 hours and 40 minutes, with an average interview time of one hour and five minutes for each participant.

Data analysis

The data analysis was conducted using a qualitative approach, the union model of several individual competencies (Werner 1969), which considers all information shared by the informants. The quantitative approach made use of statistical descriptive techniques (percentages). Controls were carried out through tests to check response consistency and validity (Marques 2001). Repetition interviews were used in synchronic situations when the same question was asked to different people during quite close moments. Diachronic interviews (questions made with the same informant at different times) were also used. More precisely, to contemplate control from a synchronic perspective, the interviews were concentrated in a specific community until all specialists living there were interviewed. Only after completion did data collection begin in another community. Furthermore, the researcher previously visited specialist fishers from a given community, prioritizing, scheduling interviews for the same day or on subsequent days, whenever possible. In turn, the diachronic tests to check the consistency of the interviewees' responses took place as follows: 20% (n=13) of the fisher sample specializing in shark fishing were interviewed twice. Because the researcher who applied the form was from Ilhéus, only fishers from that municipality participated in this test. Therefore, in March 2012, all 13 fishers were interviewed. At the end of the study with new interviewees, in October 2012, these same fishers were interviewed again. Thus, around seven months passed between the two interviews with these participants concerning the response consistency and validation test.

Study limitations

The application of an essentially qualitative methodology for the data analysis alongside with the option made to interview a restricted number of experts in shark fishing in a specific region of the Brazilian coast limits the possibilities of making generalizations based on the results. Given this context, we emphasize the need for the study findings to be used sparingly.

RESULTS AND DISCUSSION

Over time, fishers in southern Bahia have used sharks in different ways, mainly for their own consumption and commercial purposes, as well as for zootherapeutic, decorative-aesthetic, and recreational uses. Shark byproducts used to this end are meat, liver, jaws, teeth, cartilage, and gills. Records on the symbolic utilization of shark images, especially for developing visual and graphic art forms, such as photographs, public areas paintings, sculptures, and even fisher tattoos, are also noted. These forms of use and byproducts are in accordance, with some specificities, to those observed in other studies that focus on the use and trade of sharks worldwide (Lack and Sant 2009, 2012; Musick 2005; Okes and Sant 2019; Vannunccini 1999). Furthermore, the multitude of utilitarian connections verified in the analyzed context demonstrates the place that these animals occupy in the cultural imagination of these fishers. In fact, human-shark interactions are always multidimensional, commonly involve emotional issues and contemplate a multitude of ecological aspects, as well as social and economic elements (Macdonald and Escalle 2023; Neves et al. 2022).

Commercialization of the jaws, teeth, and cartilage

Regionally, these byproducts are circumstantially sold by artisans to tourists who use these pieces in interior decorations or as curious souvenirs, like large jaws. In Brazil, the souvenir trade has grown recently, causing increased fishing pressure (Alves 2012; Gurjão and Lotufo 2018) and threats to marine biodiversity (Amaral and Jablonki 2005). Accordingly, two-thirds (n = 44) of the respondents indicated they had already removed jaws from sharks, pointing out that the removal process was laborious and dangerous, demanding attention and sometimes causing hand injuries.

A quarter (n=22) of the respondents answered they had already sold jaws (Figure 2). The sale price ranged

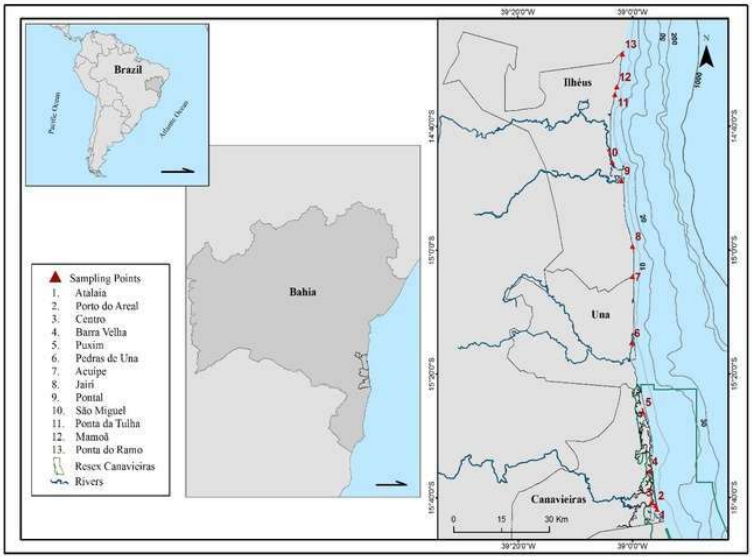

Figure 1. Fishing communities in the study area where interviews were conducted with local fishers in Bahia, Brazil.

between R$ 50.00 (U$ 8.86) and R$ 400.00 (U$ 70.91), with a mean of R$ 150.00 (U$ 26.59), which indicates the possibility of obtaining good profits by selling jaws to tourists (mostly foreigners). Tourist curiosity has been identified as the driving force behind shark jaw sales in other regions worldwide (Dent and Clarke 2015; Musick 2005; Vannuccini 1999).

In fact, some elasmobranchs specie are the target of a lucrative international trade in their body parts, a fact that results in unsustainable mortality rates for several species (Campana and Ferreti 2016). In New Zealand, for example, the jaw of the tiger shark *Galeocerdo cuvier* (Péron and Lesueur, 1822) can cost U$ 499.00, and of the white shark *Carcharodon carcharias* (Linnaeus, 1758), U$ 12.500,00 (Duffy 2004). In some parts of the world, white shark jaws and teeth can be worth up to 50 thousand dollars, a fact that causes the intentional killing of specimens that, in other contexts, could be released by fishers (Fergusson et al. 2009).

Only 10.8% (n = 7) of the respondents reported selling "ossos do meio" (the middle bones = backbone cartilage) and shark teeth for the artisanal manufacturing of bodily adornments, such as necklaces, earrings, and bracelets, among others. Four fishers from the Acuípe community in Ilhéus usually sell these byproducts to Tupinambá Indians who live nearby.

Shark liver oil marketing

About a third (33.8%, n = 22) of respondents reported having extracted liver oil from sharks. Liver oil has been extracted for over 25 years, mainly at the Vila de Atalaia community, located in Canavieiras, where the indigenous populations put livers in large pans or paint containers and cook them under fire until they turn into oil. Fishers used to sell shark liver oil to muleteers, farmers, and riding pet owners, who use this byproduct for ethnoveterinary reasons, both for the prevention and treatment of animal hide problems. Although some studies have superficially mentioned the use of shark oil by traditional Brazilian fishers (Alves and Rosa 2006; Silva et al. 2004; Szpilman 2004), this is probably the first record of its marketing for use in ethnoveterinary practices. The estimated price for an oil gallon containing 20 liters of shark liver oil is around R$50.00 (U$8.86). The informants indicated, however, that this marketing has also become extinct due to the abrupt shortage of shark catches, especially larger specimens. For this reason, local pet owners began using industrial veterinary products, coconut oil, or lubricating oil for the same purpose.

Zootherapeutic uses

The medicinal use of animal resources is a widespread practice that involves hundreds of species used in several traditional medical systems worldwide (Alves and Rosa 2013, Castillo and Ladio 2019, Martinez 2013; Van Vliet et al. 2017). Among the animal taxa used as medicinal resources, fish deserve special attention due to their strong representation in zootherapeutic practices (Alves and Rosa 2013, El-Deir et al. 2012, Pinto et al. 2018).

The high Brazilian biological and cultural diversity is reflected in a wealth of knowledge and traditional practices, including using animal parts for medicinal purposes (Alves et al. 2013). Among South Bahia fish-

Figure 2. Jaws sold in Canavieiras, Bahia, Brazil. Source: Márcio L. V. Barbosa-Filho. Year: 2012.

ers, several therapeutic shark products used for both human and animals health (ethnoveterinary) are reported, as follows:

Human uses

Medicinal shark use has been previously recorded in fisher populations in other Brazilian regions (Alves and Rosa 2006, 2007; Costa-Neto and Marques 2000; Pinto et al. 2015). In the present study, 76.9% (n = 50) of the respondents knew about the therapeutic use of shark parts, and 38.5% (n = 25) mentioned liver oil. Another 26.2% (n = 17) reported using fins, and 18.5% (n = 12) of cartilage.

Eight fishers said they had received small doses of liver oil from their parents, specifically by ingesting small amounts as a vitaminic complex or used to "clean" the blood. Elasmobranch liver oil contains important vitamins and can heal rickets and stimulate growth (Ogawa et al. 1973). Because of this, scientific studies were carried out in Brazil in the past to evaluate the viability of its industrial production (Cardoso 1943; Ogawa et al. 1973, 1974). This oil may also be topically applied to the skin according to the local culture to heal wounds or fungal infections. In addition, four fishers indicated its purgative action. These informants reported the shark oil's effectiveness for all pointed out indications.

However, the medicinal use of liver oil is no longer a practice in the study area and is disappearing globally. Accordingly, FAO statistics indicate that the world production of this product decreased from about 500 tons in 1976 to just four tonnes in 1997 (Musick 2005). However, globally, shark fishing aimed at generating raw materials for the cosmetic and health supplement industries still represents a real and current threat to these fish (Neves et al. 2022).

Ethnoveterinary uses

Over time, traditional medicine has been one of the few alternatives for breeders to treat their animals, mainly in developing countries, where conventional medicines are commonly financially inaccessible (Alves and Rosa 2007). Souto et al. (2013) recorded that at least 98 wild animal species, of which 95% are used in worldwide traditional veterinary medicine. However, products derived from sharks for this purpose have yet to be recorded in the literature. Thus, these findings comprise the first for this type of shark use. In the region, 18.5% (n = 12) of the respondents indicated using shark liver oil to treat diseases on dog hides, like scabies or screwworms, either by swallowing or topical application. A number of fishers indicated that shark liver oil is utilized to treat diseases or wounds in mount animals, indicating that it can heal wounds caused by screwworms or by hide rubbing against the saddle. Interestingly, three respondents reported that shark liver oil was also helpful in preventing recurrent vampire bat bites in horses. According to these respondents, bats bite the horses and then return to lick the blood from the same body part for several consecutive days. Therefore, the oil is placed on the wound to assist both in healing and to prevent bite recurrence since the taste of shark oil would be unappealing for the bats.

However, shark liver oil has been substituted by

industrial products, so this practice is now considered extinct. Despite this fact, this is Brazil's first record of ethnoveterinary use of shark products.

Aesthetic-decorative use

In regional fishing community cultures, shark byproducts in interior decoration and employed in necklaces used by the fishers are common. When certain fishers use these parts decoratively, the object takes on a sentimental, subjective, and superstitious value, culminating in fishers often vehemently refusing to sell it. Such behavior is mainly observed among fishers who have retired from open-sea fishing. This artisanal use was reported by 95.4% (n = 62) of the interviewed fishers. They all reported using shark jaws, while 18.5% (n = 12) referred to the cartilage and 6.1% (n = 4) to the teeth. The jaw is commonly used to decorate the walls of fisher homes, small retailing shops, and even Fisher Associations (Figure 3). Câmara (1911) had already cited the existence of a "cação anequin" (probably *Isurus* sp.) from the Bahia coast, whose teeth were sharp, and jaws were used as a garnish for children and enslaved black women. However, traditional shark teeth used by Brazilian native populations refer to the invasion age of this land by the Portuguese, when indigenous peoples used this byproduct for making arrow tips (Salvador 1918).

According to 72.3% (n = 47) of the informants, shark parts are also used to manufacture body ornaments. The main cited artifacts in this regard were necklaces, bracelets, and rings (6.7%), and the parts reported as used to this end were young shark cartilage and adult teeth. However, only four fishers reported having made some jewelry using shark parts.

Playful uses

Playful uses occur in several ways, and the animal may be either alive or dead, captured or released, in whole or in parts. The main playful use involves a stingray species known in South Bahia as the lesser numbfish, *Narcine brasiliensis* (Olfers, 1831), which produces electrical discharges (Bigelow and Schroeder 1953). This is performed as an initiation fishing ritual. When a specimen is caught, the novice fisher, who is still unaware of its electrical capacity, receives the order from the fishing boat master to handle the animal when it is still alive. This fisher, who knows that the electric discharge is generated between the fish's eyes, clearly instructs the novice to hold the fish by its head. Thus, fishers have fun when the novice fisher receives the shock. Most informants reported that they had already been victims of this game, and others had been responsible for inflicting it on other fishers. At the same time, some expressed pride in never having fallen victim to this prank.

However, this region's most striking and unpredictable playful use of sharks involves the whale shark *Rhincodon typus* (Smith, 1828). Although there is little information concerning the presence of this species in Brazil (Barbosa-Filho et al. 2016), at least 50 respondents (75.5%) have already seen this fish, and eight (12.1%) mentioned that they had already surfed or had seen fishing mates surf on whale sharks.

Indirect uses

Vargas-Clavijo (2009) argues that the particular importance of a given animal for a society depends on how it is conceived and represented within this social group. Its symbolism and semantic value fit directly into the interests, knowledge, and meanings it may present to an individual or the community. Thus, the high physical and symbolic importance of sharks in this cultural system can be evidenced by the informants' use of these fish in artistic expressions of visual, graphic, or even plastic art. In this context, it is important to note that one fisher creates shark sculptures and displays them on city streets. Others hire painters to decorate the walls of their shops with images of these fish, while one respondent had framed photographs in which he poses beside large specimens exposed in his living room as trophies (Figure 4).

This shark use has not been influenced by aspects that may have hindered the maintenance and reproduction of other uses. A factor that could have contributed to this scenario is the historical symbolism that shark images have in the human collective unconscious (Clarke et al. 2005).

CONCLUSION

The data at this moment compiled on shark uses demonstrate these fishes socioeconomic and cultural relevance for the studied fishing communities. Their use extends beyond mere subsistence to include various traditional and cultural dimensions. However, the diversity in utilitarian connections and the observed changes in usage patterns over time indicate serious threats to both the ecological and cultural aspects of traditional shark fisheries. However, the variety of utilitarian connections and changes in its usage patterns over time reveal the threats of extinction, both ecologically and culturally, of the traditional shark fishery in this region. They also portray a historical record of fishing practices carried out by traditional fishers from Bahia since certain types of use and the knowledge involved are already extinct. In this context, we emphasize the need for this information to contribute

Figure 3. Tiger shark (*Galeocerdo cuvier*) jay that adorns a wall of the Z-20 Fishing Colony in Canavieiras, Bahia, Brazil. Source: Márcio L. V. Barbosa-Filho. Year: 2012.

to the management and conservation efforts of this relevant zoological group in line with the maintenance of food security, ways of life, and culture of coastal human groups that have been making diverse use of these fish over time. Involving local communities in conservation efforts is crucial, as they hold valuable traditional knowledge and have a vested interest in the sustainable use of shark resources.

Finally, our data serves as a historical record of the fishing practices employed by traditional fishers from Bahia. This record is crucial as it documents practices and knowledge that have already become extinct. Preserving this historical knowledge is important for understanding the evolution of fishing practices and the cultural history of the region.

ACKNOWLEDGMENT

The authors would like to thank the Conselho Nacional de Pesquisa (CNPQ) for the Master's fellowship (132919/2011-7) granted to M. Barbosa Filho and the Zoology Postgraduate Program (UESC) for logistical support. A special thank you goes to Fábio Hazin (*in memoriam*) for reviewing, giving valuable ideas, and helping in the translation of this manuscript; to Christine Del Vechio Koike for reading, proposing improvements, and helping in the translation of this text, and to all fishers who took part in this study, whether by indicating specialists or providing interviews. RAHD acknowledges FAPERJ (Process numbers E-26/201.270/2021 and E-26/210.300/2022) and CNPq (Process number 308811/2021–6) for financial support. The implementation of the Projeto Pesquisa Marinha e Pesqueira is a compensatory measure established by the Conduct Adjustment Agreement under the responsibility of the PRIO company, conducted by the Federal Public Ministry—MPF/RJ.

Figure 4. Framed photographs of hammerhead sharks (*Sphyrna* sp.) used in the house decoration of a fisher from Ilhéus, Bahia, Brazil. Source: Márcio L. V. Barbosa-Filho. Year: 2012.

DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived the idea: MLVBF.
Experiments: MLVBF.
Data analysis: GBGS, MLVBF, RAHD, RRNA, SS.
Wrote the first draft of the manuscript: EMCN, MLVBF.
Review and final manuscript preparation: EMCN, GBGS, MLVBF, RAHD, RRNA, SS.
Supervision: EMCN.

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Received: 09 December 2023
Accepted: 11 September 2024
Published: 01 January 2025
Available: 25 September 2024

Editor: Ulysses Albuquerque