ETHNOBIOLOGY AND CONSERVATION

RESEARCH ARTICLE

Ethnobiology and Conservation, 12:25 (12 December 2023)
doi:10.15451/ec2023-12-12.25-1-19
ISSN 2238-4782 ethnobioconservation.com

A Bibliometric Analysis Concerning Local Ecological Knowledge on Elasmobranchs and Chimaeras

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ABSTRACT

The absence of historical data on endangered species poses a conservation and socio-environmental problem. Approximately one-third of all Elasmobranchs and Chimaeras are under some level of threat of extinction, with knowledge gaps for many species. This research aims to conduct a biliometric analysis of scientific production concerning Local Ecological Knowledge (LEK) of Elasmobranchs and Chimaeras. Searches on the subject were carried out at the SciELO, Scopus and Web of Science databases. The retrieved publications were assessed and sorted by a list of inclusion criteria, totaling 120 articles. The findings indicate that studies on LEK applied to Chondrichthyes assessments have recently gained relevance. The studies were published in a wide variety of journals and by researchers from different countries. Most research focused on marine ecosystems and interviewed professional fishers. Of the 179 Elasmobranchs species studied, most are large sharks with conspicuous diagnostic characters, such as *Galeocerdo cuvier*, *Isurus oxyrinchus* and *Sphyrna lewini*, mainly in publications focused on fisheries. Studies addressing ethnoknowledge as a historical data collection source are undoubtedly paramount, and the need for further investments in this research field in countries with scarce data addressing other actors, themes and scarcely studied taxa, is clear.

Keywords: Ethnoichthyology; Folk knowledge; Cartilaginous fish; Bibliographic review.

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SIGNIFICANCE STATEMENT

Chondrichthyes are a group of fish that chronically suffer from data absence, directly interfering with the understanding of their life history and conservation. We conducted searches in the main indexers of scientific articles regarding Local Ecological Knowledge focused on Elasmobranchs and Chimaeras. We found that the quantity of publications has grown in the last decade, with a significant number of studies conducted in Brazil. However, most of the identified publications had fishers as their primary source, focusing on aspects related to catch data and composition, especially those with conspicuous characteristics. We emphasize the importance of research involving other local actors, addressing topics related to biology, conservation, and the relationships established between humans and Chondrichthyes. The study provides a clearer picture of the knowledge gaps still faced in Elasmobranchs and Chimaeras research, where ethnoknowledge can offer an important contribution to the reconstitution of past information.

INTRODUCTION

Absence of historical data for threatened and fished species constitutes a large-scale environmental problem. In this regard, access to anecdotal, historical, and multicultural records has become a valuable tool in recovering the ecological history of several taxonomic groups, such as corals, groupers, cetaceans, and elasmobranchs (Ferretti et al. 2008; Fogliarini et al. 2022; Martínez-Candelas et al. 2020; McClenachan et al. 2012; Santos et al. 2022). This has altered societal perceptions of biological and ecological species aspects and may aid in future conservation decision-making (Ferretti et al. 2008; Fogliarini et al. 2022; McClenachan et al. 2012). In this context, Local Ecological Knowledge (LEK), comprising a set or system of theoretical and practical knowledge based on environmental observations and experimentations is an alternative source of information (Berkes et al. 2000; Ruddle 2000) and a way to access historical narratives (Burns et al. 2020; McClenachan et al. 2012).

Ethnoichthyology, "from the Greek 'ethno', race or people + 'ichthys', fish + 'logos', discourse, study" (Marques 2012) is the field that studies the Local Ecological Knowledge (LEK) associated with fishes and their many uses (Bahuchet 1992). Although this term has been employed by researchers since the late 1960s, this field of knowledge is still neglected by science (Albuquerque et al. 2021; McClenachan et al. 2012; Narchi et al. 2014). Despite this, research has revealed the potential of this field in contributing to the theoretical and practical advancement of biology and related areas, such as anthropology, during their implementation, providing an overview of interactions between fauna and different human groups (Albuquerque et al. 2021; Pinto et al. 2018; Ruddle 2000; Silvano and Valbo-Jørgensen 2008).

The class Chondrichthyes comprises sharks and rays (Subclass Elasmobranchii) and chimeras (Subclass Holocephali), an evolutionarily successful fish group (Dulvy et al. 2021; Stein et al. 2018). Representatives belonging to this class display a variety of body and behavioral patterns, are globally distributed throughout many aquatic environments, and play important ecological roles in maintaining ecosystems (Ebert et al. 2021; Ferretti et al. 2008; Sherman et al. 2023). Most sharks, rays and chimeras display intrinsic characteristics, such as slow growth rates, late sexual maturation, and low fecundity (Dulvy et al. 2017; Lucifora et al. 2022) which added to the chronic threats directed at this group, such as overfishing, habitat degradation and pollution, contributing to their decline (Dulvy et al. 2017; Lucifora et al. 2022). It is, in fact, currently estimated that about 33% of Chondrichthyes are at risk of extinction (Dulvy et al. 2021; Sherman et al. 2023; Stein et al. 2018).

Knowledge synthesis studies have been carried out focusing on Elasmobranchs and Chimaeras, highlighting a significant lack of data and the need for new techniques and methodologies to study the species belonging to this taxon (*e.g.,* Moura and Vianna 2020), emphasizing LEK research (Becerril-García et al. 2022; Cashion et al. 2019; Coelho et al. 2021; Jorgensen et al. 2022). Considering human and Chondrichthyes interactions, access to LEK information becomes a valuable source of historical data and reveals the importance of this taxon in human relationships (Bastari et al. 2022; Mojetta et al. 2018). Furthermore, access to these data reinforces their importance, especially in countries with limited research resources and investments, which is clearly demonstrated by knowledge gaps for several species (Blanco-Parra et al. 2022; Ruddle, 2000; Seidu et al. 2022).

Bibliometric research plays an important role in providing an overview of the state of knowledge of a certain subject, identifying patterns, trends, gaps and indicating directions for future studies (Albuquerque et al. 2013; Alves et al. 2018; Moura and Vianna 2020; Santos and Vianna 2017; Souza and Vianna 2020). To this end, a worldwide bibliometric analysis was conducted on LEK focused on Chondrichthyes species, aiming to answer the following questions: (i) what is the temporal trend concerning LEK publications focused on Chondrichthyes species?, (ii) where was this research been developed?, (iii) which are the most representative taxonomic groups reported in these surveys? and (iv) what topics have been addressed by these surveys?

MATERIAL AND METHODS

Data collection

Searches were carried out at the following databases: SciELO, which indexes articles published in regional Latin American journals (Souza and Vianna 2020); Scopus, which covers more than 16,000 publications (Martín-Martín et al. 2018; Vieira and Gomes 2009), and Web of Science, considered the most complete scientific literature database, indexing publications from 1945 to the present (Santos and Vianna 2017; Souza and Vianna 2020). The research period was set from 1945 to October 10, 2022.

The searches were carried out in the "Topics" section, which covers titles, abstracts, and keywords. The choice of keywords and Boolean operators followed Moura and Vianna (2020), where two search fields joined by the "AND" operator were used in the article searches. The symbols "*" and "$" contemplate variations of up to one letter, and the second, of more than one letter. The symbols "$" and "*" were used

to guarantee the variety of spellings that the compiled terms may present. The first search field refers to the knowledge area, comprising the string "ethno*" OR "ecological knowledge" OR "local knowledge" OR "traditional knowledge" OR "fish* knowledge" OR "folk knowledge" OR "interview". The second concerns Chondrichthyes, set as "chondricht*" OR "elasmobran*" OR "shark$" OR "ray$" OR "stingray$" OR "skate$" OR "holocepha*" OR "chimaerifor*" OR "chimaera$". All keywords were also translated into Portuguese and Spanish. A third search parameter comprising the keywords "ethnology" OR "x-ray", joined by the operators "NOT" or "AND NOT", was added in order to exclude publications from unrelated topics.

For the SciELO database, the keywords applied to the three search fields were used separately (*i.e.,* "ethno* AND shark*" AND NOT "ethnology"), due to the simplicity of the platform's search algorithm and the size of the database, which does not retrieve publications when applying complex word combinations (Souza and Vianna 2020).

Data analysis

Article inclusion criteria were set as follows: (i) interviews as one of the applied methodologies; (ii) focus on one or more Elasmobranchs and Chimaeras species, describing their taxonomic level (order, family, genus and/or species); and (iii) availability in Portuguese, English or Spanish.

After screening, the retrieved articles were compiled in a database and were classified according to title, author(s), publication year, journal, database, language, study area, presence/absence of protected area, human group(s) (Table 1), ecosystem (freshwater, estuarine, marine), taxonomy (order, family, genus, and species), focus on Chondrichthyes, conservation status (IUCN), and addressed topic(s) (Table 2). The titles, abstracts, methodologies, and results sections were evaluated for data retrieval. Only data obtained from interview methodology results were considered.

Taxonomic corrections for family, genus, and species were applied according to the Eschmeyer Catalog of Fishes (last updated on 11 January 2023), Gomes et al. (2019) for orders occurring in Brazil, and Nelson et al. (2016) for orders with no records in Brazil. Furthermore, regarding preliminary taxonomic identification of species (confer, "cf."), the species mentioned by the authors were considered in our study. For groupings of species with two epithets, separated by the symbol "/", only the genus was considered.

The data were compiled in a spreadsheet editor program, synthesized, and presented in the form of graphs generated by the R software (R Core Team, 2023), using the "ggplot2" and "piedonut" packages. The distribution map of total publications by country was generated using the Quantum GIS Software (QGIS 3.10.11), with the shapefile format obtained from Eurostat (2023). The species taxonomy graph was generated in Microsoft Excel. A weighting was performed to enable comparative analysis for the determination of human groups, ecosystems, themes, sub-themes, and taxonomic groups, assigning a greater proportional weight according to the number of human groups, ecosystems, themes, subthemes, and taxonomic groups studied in each evaluated article.

Table 1. Description of human groups referred to in Local Ecological Knowledge publications concerning the Class Chondrichthyes retrieved by this systematic review.

Human group	Description
Fishers	Subsistence and recreational fishers; boat owners; fishing associations; fish farmers; fish processors
Community	Members of local and/or traditional communities (*i.e.*, fishing - except fishers-, coastal, riverside, indigenous); workers (*i.e.*, farmers and rubber tappers)
Traders	Merchants (*i.e.*, ice companies, middlepersons, pharmacies, restaurants, rooters, and establishment employees)
Divers	Recreational divers, professionals, and guides.
Researchers	College students and researchers
Government Agents	State agents
Health Agents	Health agents
Others	Religious persons; photographers; tourists; NGOs; conservationists; sick persons; volunteers; hunter/gatherers (of animals other than fish)

Table 2. Topics addressed in Local Ecological Knowledge publications concerning the Class Chondrichthyes retrieved by this systematic review.

Topics	Subtopics	
Biology	1. Diet	4. Habitat
	2. Reproduction	5. Taxonomy
	3. Behavior	6. Others
Fisheries	1. Fishing apparatus	5. Fishing impacts
	2. Fleet	6. Economy
	3. Fishers	7. Others
	4. Legislation	
Human Relationships	1. Food	4. Craftsmanship
	2. Medicinal	5. Others
	3. Religious	
Conservation	1. Legislation	2. Environmental changes

RESULTS

Bibliometrics

A total of 120 articles on LEK concerning Chondrichthyes species were retrieved from the three searched databases from 1945 to 2022. Article publication years were restricted from 1996 to 2022 (Figure 1; Additional File 1). The number of publications per year from 1996 to 2010 remained low, not exceeding three articles in 2007. Articles were published only 1996, 2000, 2007 and 2009, with gaps between 1997 and 1999, between 2001 and 2006 and 2008. From 2011 onwards, the number of publications increased, surpassing three publications per year, except in 2012, 2013 and 2015. A substantial increase in the number of publications is noted from 2016 onwards, with a peak of 19 articles observed in 2021.

Articles retrieved from the Scopus database covered most publications (n= 110; 92%), followed by the Web of Science, (n= 78; 65%), and SciELO (n= 3; 3%) databases. However, redundancies between the searched databases were noted, with three articles retrieved by all three databases, and 65 (54%) retrieved both in Scopus and Web of Science databases.

The retrieved articles were published in 56 different journals (Table 3). The *Aquatic Conservation and Marine and Freshwater Ecosystems* journal published the largest number of articles (n= 14; 12%), followed by *Marine Policy* (n= 12; 10%), and *Biological Conservation* (n= 6; 6%). It is noteworthy that, of the total number of journals observed in our review, only five focus on relationships between humans and other elements of nature, namely *Journal of Ethnobiology and Ethnomedicine* (n= 5), *Ethnobiology and Conservation* (n= 3), *Ethnobiology Letters* (n= 2), *Conservation and Society* and *Ecology and Society* (both with only one article). In addition, of the total number of retrieved articles, most (n= 117; 98%) were published in English, with only two (2%) articles published in Spanish and one (1%) in Portuguese.

Geographic distribution

The retrieved articles were developed in 57 different countries (Figure 2), with Brazil ranking first (n= 27 articles; 22.5%), followed by Mexico (n= 9; 7.5%), Italy (n= 8; 6.7%) and Fiji (n= 7; 5.8%). The marine environment was the most addressed among the different aquatic environments, with 104 (87%) publications, followed by estuarine environments (n= 27; 23%), and freshwater (n= 13; 11%). Twenty of the studies (16%) were carried out in protected areas.

Human groups

The most interviewed human groups were fishers, with 97 (56%) publications, followed by community members and traders, with 19 (11%) publications each, and divers with 15 (9%) publications. Although the "Others" category was noted in a high number of publications (n= 12; 7%) compared to other categories, such as Researchers (n= 6; 3%), Government (n= 2; 1%) and Health agents (n= 2; 1%), the groups that fit into this category present values equal to and/or lower than those concerning the Government and Health agent categories.

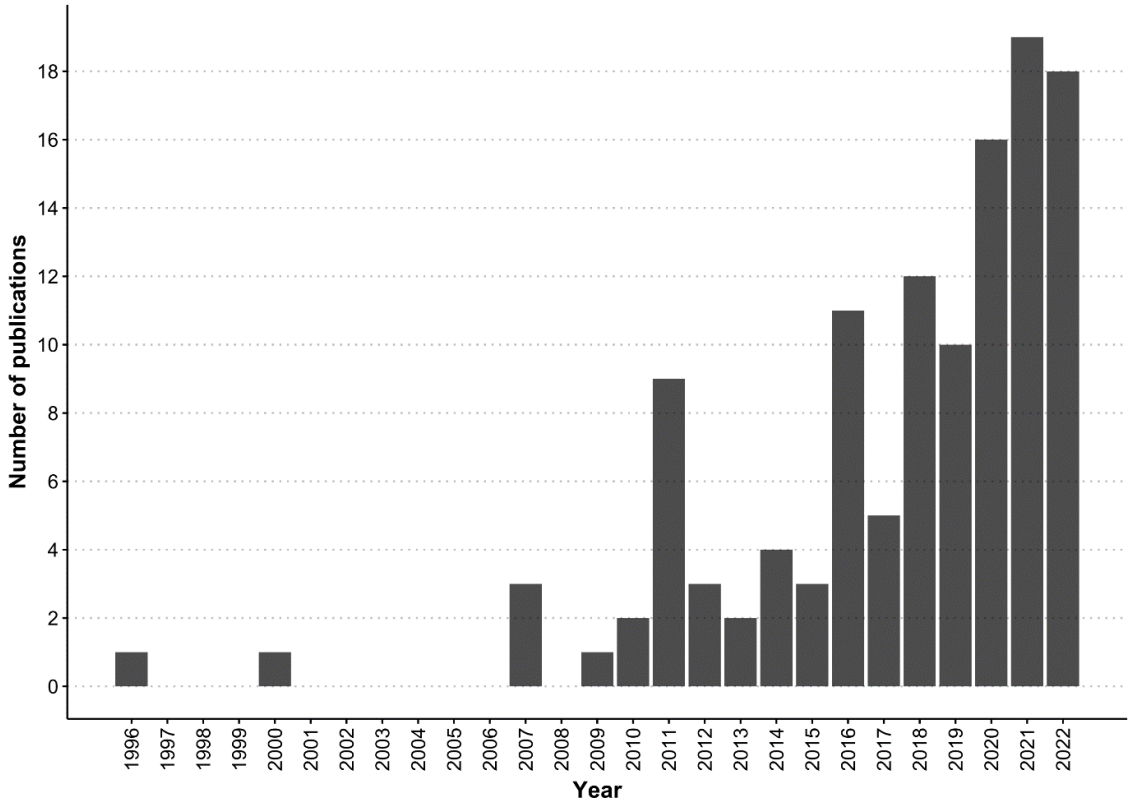

Figure 1. Annual distribution of publications on Local Ecological Knowledge, concerning Elasmobranchs and Chimaeras, species worldwide from 1996 to 2022.

Table 3. Top 10 journals in relation to the total number of published articles, on Local Ecological Knowledge, concerning Elasmobranchs and Chimaeras species retrieved by this systematic review.

Journal	**Total**	%
Aquatic Conservation: Marine and Freshwater Ecosystems	14	12
Marine Policy	12	10
Biological Conservation	6	6
Endangered Species Research	5	5
Journal of Ethnobiology and Ethnomedicine *	5	5
Ocean and Coastal Management	5	5
PLoS ONE	5	5
Frontiers in Marine Science	4	5
Conservation Science and Practice	3	4
Ethnobiology and Conservation *	3	4

Legend: The symbol "*" indicates journals related specifically to relationships between humans and other elements of nature.

Species

A total of 179 species included in the Elasmobranchii were mentioned by the retrieved articles (Table 4). Out of the 120 publications found, the majority (n= 93; 77.5%) focused on Elasmobranchs. The three most studied species were *Galeocerdo cuvier* (tiger shark) in 24 (20%) publications, *Isurus*

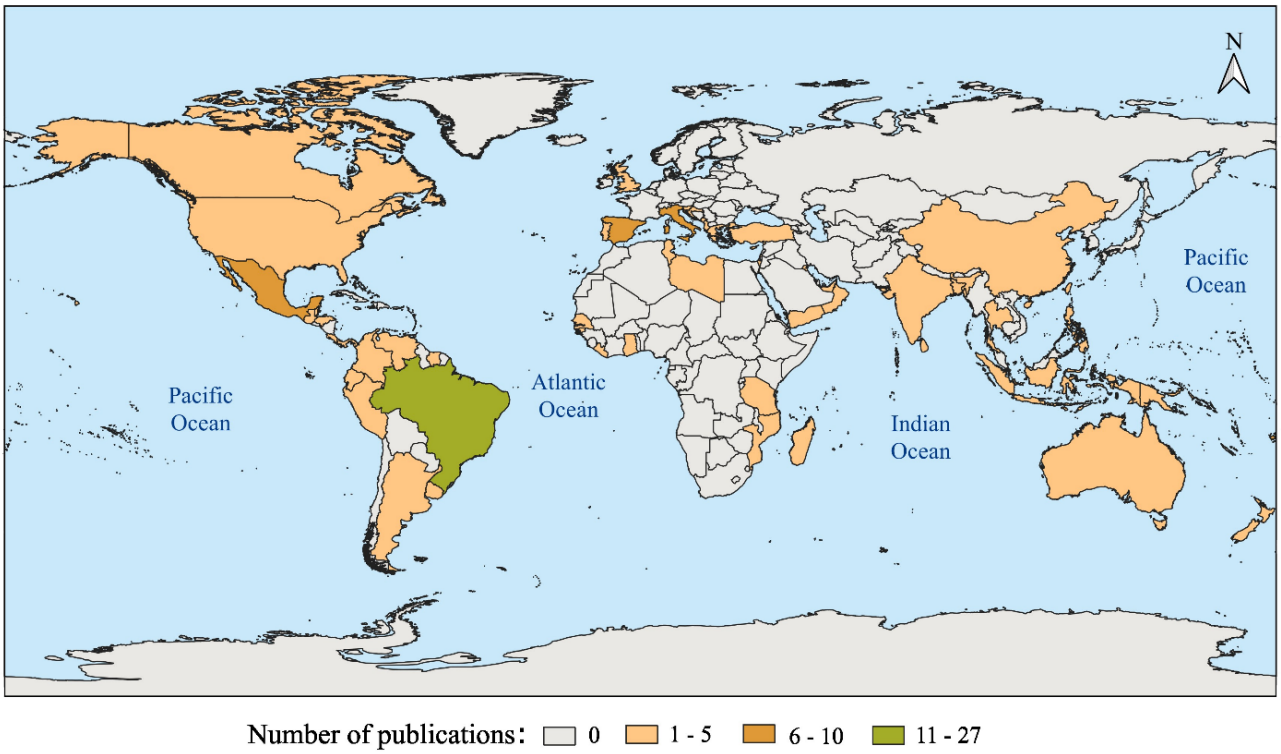

Figure 2. Geographical distribution of publications concerning, Local Ecological Knowledge, on Elasmobranchs and Chimaeras by country retrieved by this systematic review.

oxyrinchus (shortfin mako) and *Sphyrna lewini* (scalloped hammerhead), comprising 23 (19%) publications each. A total of 11 orders, 44 families and 87 genera Elasmobranchii were studied (Figure 3). The most studied order was Carcharhiniformes, with 70 articles (corresponding to 45.8% of the elasmobranchs studied). The most studied family was Carcharhinidae (n= 60; 30.8% of the elasmobranchs), and

Table 4. List of the 10 Elasmobranchs species most cited by publications addressing, Local Ecological Knowledge, retrieved by this systematic review. Classification according to the IUCN Threat Status Categories (2022). CR: Critically endangered; EN: Endangered; VU: Vulnerable; DD: Data Deficient.

Species	Mentions	IUCN
Galeocerdo cuvier (tiger shark)	24	NT
Isurus oxyrinchus (shortfin mako)	23	EN
Sphyrna lewini (scalloped hammerhead)	23	CR
Carcharhinus leucas (bull shark)	20	VU
Rhincodon typus (whale shark)	19	EM
Prionace glauca (blue shark)	18	NT
Carcharhinus limbatus (blacktip shark)	17	VU
Ginglymostoma cirratum (nurse shark)	15	VU
Carcharhinus falciformis (silky shark)	12	VU
Pristis pristis (common sawfish)	12	CR

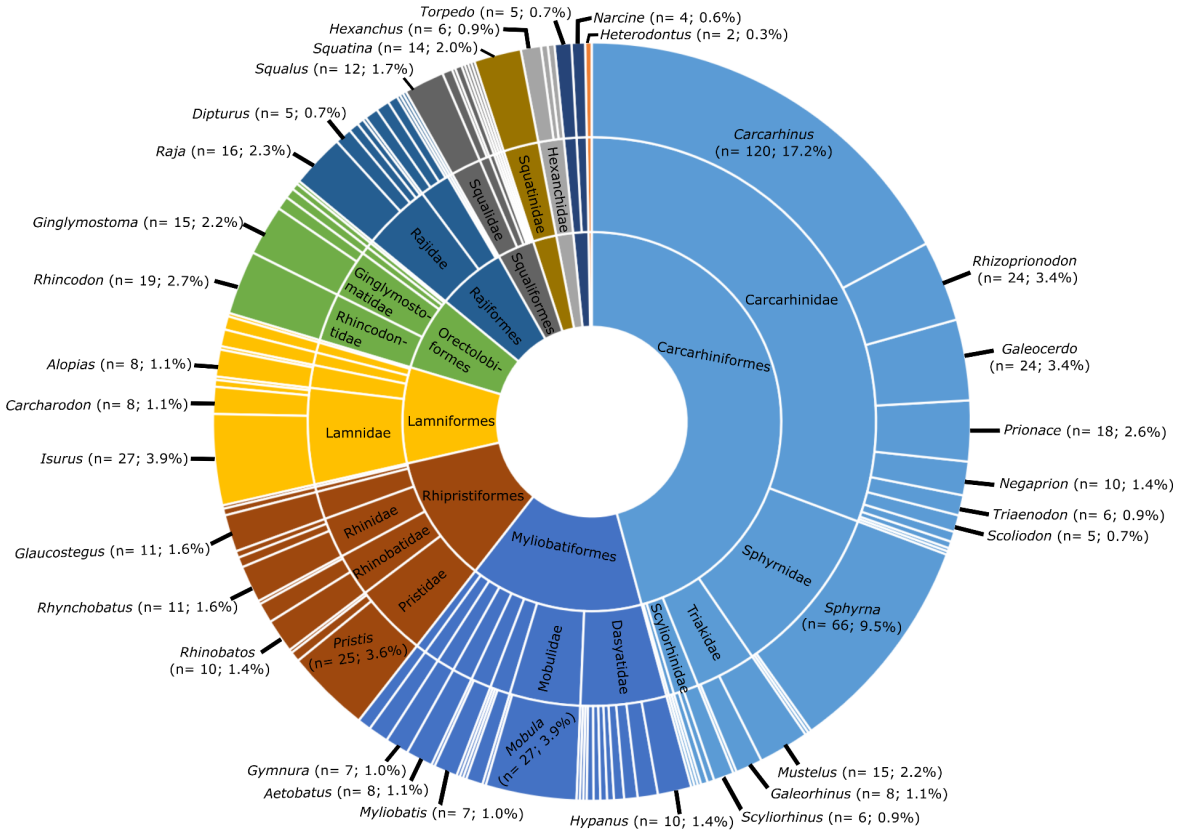

Figure 3. Orders, families, and genera mentioned by publications addressing, Local Ecological Knowledge, on Elasmobranchs retrieved by this systematic review.

the most cited genera, *Carcharhinus* and *Sphyrna*, both mentioned in 46 articles (corresponding to 17.2% and 9.5% of studied taxa). A total of 51 articles restricted information to the genera level, 16 to family and three to order. No articles mentioned the Holocephali subclass.

The 10 most cited species are included in three threat categories — Vulnerable (VU), Endangered (EN) and Critically endangered (CR) —, except for *Galeocerdo cuvier*, which is considered Near Threatened (NT) (Table 4). In the overall picture, of the 179 species mentioned in the articles, 126 (70%) are included in some threat category (Figure 5). No Extinct (EX) and Extinct in the Wild (EW) species were mentioned, and only *Potamotrygon boesemani* is not categorized by the IUCN due to lack of data.

Thematic areas

The retrieved publications addressed different topics within four main themes, namely Biology, Conservation, Fisheries and Human Relations (Figure 5). Both themes and subtopics presented results classified in more than one category. The most discussed topic was Fishing, with 88 (30%) publications. Data on fishing gear was the most mentioned among the subtopics related to this area, noted in 78 (30%) publications, followed by economy, 49 (19%) and fisheries impacts, 34 (13%).

Information on biology aspects of mentioned species ranked as the second most cited topic, comprising 80 (27%) publications. Species habitat was the most discussed subtopic, present in 42 (27%) publications, followed by ethnotaxonomy (n= 37; 23%), food (n= 24; 15%), and behavior (n= 21; 13%). Regarding conservation, 67 (23%) articles were identified, with environmental changes comprising the most discussed sub-theme, reported in 60 (74%) publications, followed by management and legislation (n= 21; 26%). Other human relationships, excluding fishing, were addressed in 60 (20%) publications, with human food being the most cited subtopic, (n= 42; 42%) articles, followed by other subtopics (n= 19; 19%), and medicinal uses (n= 16; 16%).

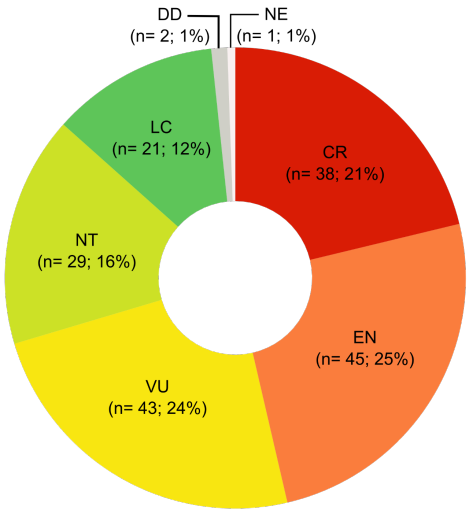

Figure 4. Percentage of total species found through Local Ecological Knowledge for Elasmobranchs, by IUCN threat category, retrieved in this bibliometric review. Legend: NE - Not Evaluated; DD - Data Deficient; LC - Least Concern; NT - Near Threatened; VU - Vulnerable; EN - Endangered; CR - Critically Endangered.

The results indicate that studies employing LEK to investigate sharks and rays has only gained relevance very recently. These surveys have been published in a wide variety of journals and were conducted in different countries. The studies mostly focus on the marine environment and the interviewed public generally comprises professional fishers. Many species are cited, but most are large sharks with conspicuous diagnostic characters, with a recurring fishing theme.

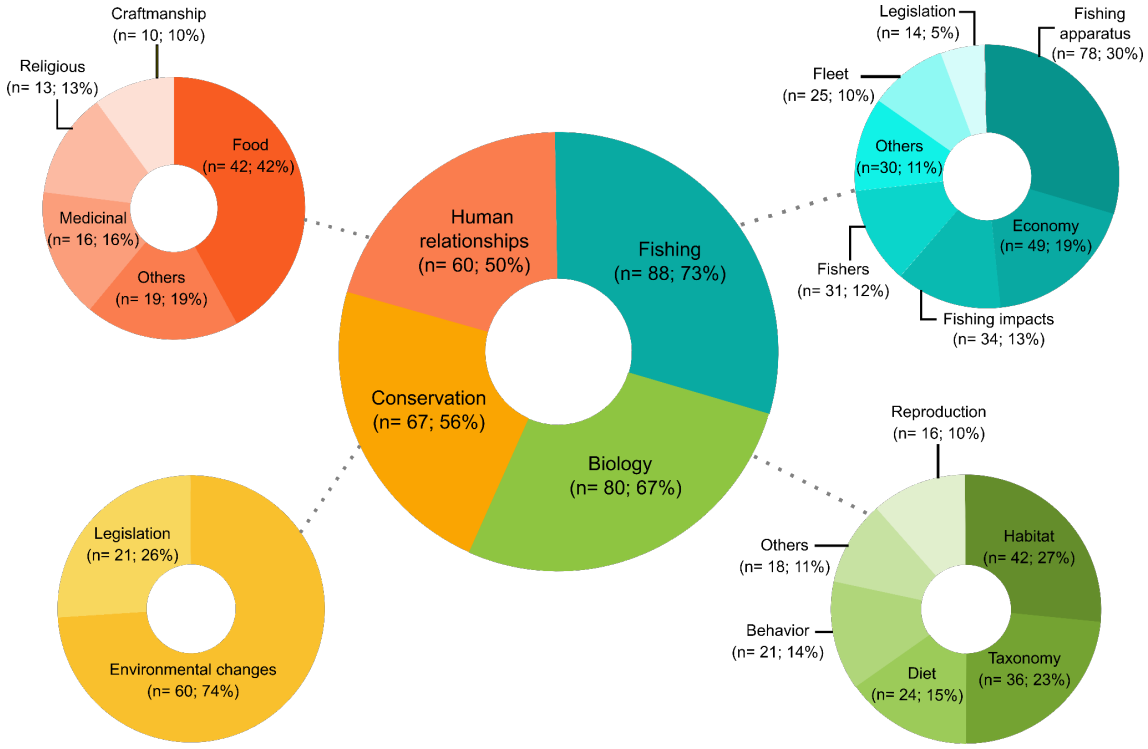

Figure 5. Topics addressed by publications, on Local Ecological Knowledge, on Elasmobranchs retrieved by this systematic review.

DISCUSSION

Bibliometrics

The biliometric analysis carried out herein indicates a slow but steady increase in publications focused on LEK regarding Chondrichthyes, restricted, however, only to the Elasmobranchii Subclass, in comparison to the general scientific production observed for this group (Oliveira et al. 2023). This increase was noted mainly in the last decade, a reflection on the increasing number of articles published in the ethnozoology field (Albuquerque et al. 2013; Alves et al. 2018), and consequently in its subareas, such as ethnoichthyology, which has been accompanying this growth (Ladislau et al. 2021; Lyra-Neves et al. 2015).

Compared to other ethnobiology areas, ethnozoology and its sub-area ethnoichthyology are recent study fields. The term ethnoichthyology was employed for the first time in 1967 (Morril 1967). The field was then finally established in the 1990s, when a significant increase in the number of publications focused on ethnobiology was noted, mainly concerning ethnozoology, added to research training diversification on the subject (Alves et al. 2018; Aswani et al. 2018; Marques 2012). However, according to our data, the increasing assessments in the ethnoichthyology field focusing on Chondrichthyes is even more recent, taking place only after 2016.

Despite the number of articles retrieved in this review, it is important to emphasize that this research does not consider all existing publications, as the applied methods and criteria to search for publications on LEK focusing on Chondrichthyes are limited. Furthermore, although an overlap was noted for the Web of Science and Scopus databases, both do not cover a variety of journals, especially those related to multidisciplinary areas and/or to society (Halevi et al. 2017; Martín-Martín et al. 2018), restricting most publications to the English language (Halevi et al. 2017; Martín-Martín et al. 2018; Smith et al. 2021). In addition, many ethnozoology articles were published in journals with low impact factors or not indexed and related to other biology fields (Gutiérrez-Santillán et al. 2019; Lyra-Neves et al. 2015), making article retrieval difficult when applying the search criteria employed herein.

The number of publications retrieved in this systematic review certainly reflects environmental and sociocultural issues that have taken place over the last few years in several countries, leading to LEK losses, either due to the difficulty in interacting with LEK resources, abundance decreases, or departure of people from professions and/or communities (Alves and Nishida 2003; Pinto et al. 2018; Svanberg and Locker 2020). Furthermore, the inherent difficulty in obtaining quality data due to the lack of trust established between interviewees and researchers must also be considered (Alves and Souto 2011). This mistrust situation can be aggravated by legislations that restrict and apply penalties to those who use Chondrichthyes resources, especially endangered species (*e.g.*, Lyra-Neves et al. 2015), which is the case of most Elasmobranchs and Chimaeras species.

Geographic distribution

Research on LEK concerning Elasmobranchs has been carried out in several countries displaying multiple sociocultural and economic realities. Several factors may contribute to lesser or greater research in the ethnoichthyology field, such as the faunal diversity and variety of social actors that use these resources (Alves et al. 2018; Nunes et al. 2021), the absence or scarcity of past fisheries and species biology data (Jorgensen et al. 2022; Santana-Morales et al. 2020; Skubel et al. 2019), and public investment in higher education and research institutions (Albuquerque et al. 2013; Alves and Souto 2011; Alves et al. 2018; Shiffman et al. 2020). In this regard, Becerril-García et al. (2022) carried out interviews with specialists on the future perspectives of Chondrichthyes research and demonstrated that, for 90% of the interviewees, the main factor that affects the progress of scientific production in Latin America compared to the global context is lack of funding. However, despite fitting into all these factors, Brazil ranked first concerning publications focused on elasmobranch ethnoknowledge, corroborating the country's international recognition for scientific ethnozoology and elasmobranch production (Alves et al. 2018; Lyra-Neves et al. 2015; Shiffman et al. 2020) and demonstrating that Brazilian researchers use ethnoichthyology as a low-cost tool to retrieve fisheries data based on traditional knowledge, as a way to compensate for the absence of official historical series, the low funding and baseline data.

Despite what was observed for Brazil, and although research in ethnoichthyology is being developed in other countries, publications are still scarce, and several authors increasingly emphasized the need to intensify studies in this area, given the importance of fishing and fish in various forms of cultural manifestations, the absence of historical data associated to their use and the significant knowledge gaps on species biology and ecology. This has been noted for some American countries, except for Brazil (Alves et al. 2018; Aswani et al. 2018), as well Europe (Alves et al. 2018; Ferretti et al. 2008; Svanberg and Locker 2020); Africa (Aswani et al. 2018; Seidu et al. 2022), Asia (Alves et al. 2018; Haque et al. 2021) and Oceania (Alves et al. 2018). It is also important to note the

increasing number of publications and countries, most considered "developed", which have been producing research focused on other knowledge areas concerning elasmobranchs (Oliveira et al. 2023).

Our results when evaluating ethnoichthyology in a broad manner indicate that most research was carried out in marine ecosystems, as reported by Ladislau et al. (2021). This reflects the number of Elasmobranchs and Chimaeras species that occur in these environments, as most species are exclusively marine, although part of part of their life cycles may take place in estuarine environments (Ebert et al. 2021; Gomes et al. 2019), with the exception of some stingrays (Potamotrygonidae), restricted to freshwater (Lucifora et al. 2022; Rosa et al. 2008), *Carcharhinus leucas* (Heupel and Simpfendorfer 2007) and *Pristis pristis* (López-Angarita et al. 2021; Whitty et al. 2017), which can be found in estuarine and eventually freshwater environments. However, few of the articles retrieved here focused on freshwater environments. According to Junqueira et al. (2020), research in this area is costly, requires long travel times (sometimes with access only by waterways) and present difficulties in communication and in material transport. This makes the low knowledge production on freshwater elasmobranchs worrying, due to late sexual maturation, low fertility, high endemism, and territorial restrictions (Abell et al. 2008; Dulvy et al. 2017; Lucifora et al. 2019, 2022). Furthermore, general elasmobranch threats (overfishing, habitat loss, urbanization, pollution, among others) are more significant for freshwater elasmobranchs, mainly tropical and subtropical species (Barrowclift et al. 2023; Lucifora et al. 2019). This accounts for most data deficient elasmobranchs as classified by the IUCN occurring in freshwater (Dulvy et al. 2017).

Although few articles have been conducted in protected areas, studies indicate that these areas are important for elasmobranch conservation (Jorgensen et al. 2022; Shiffman et al. 2020), and may favor ethnozoology studies (Alves et al. 2018). Certain conservation unit types, however, such as Marine Protected Areas, are under fishing restrictions (Jorgensen et al. 2022; Sabadin et al. 2022), which may be associated to conflicts of interest between conservation and exploitation, directly influencing the willingness of fishers to collaborate in interviews and, consequently, making research difficult (Alves and Souto 2011).

Human groups

Fishers were the most approached group concerning elasmobranch research. In fact, the traditional empirical knowledge of this group has been applied for years to obtain and complement biological and ecological data, in addition to accessing temporal abundance trends and serving as a basis for management strategies (Bastari et al. 2022; Giglio and Bornatowski 2016; Sáenz-Arroyo and Revollo-Fernández 2016; Santos et al. 2022; Silvano and Valbo-Jorgensen 2008), as fisher knowledge is a result of the proximity and regularity of fish interactions (García-Quijano and Pitchon 2010; Marques 2012; Pinto et al. 2018). As noted by Ladislau et al. (2021), although fisher knowledge is paramount in ethnoichthyology studies, other actors should be included in this line of research, in order to access the knowledge and perceptions of other actors who interact with ichthyofauna as much as fishers (Pinto et al. 2018; Skubel et al. 2019). Several examples illustrate how other social groups can contribute to a better understanding of the dynamics that encompass people-fish relationships. For example, Nunes et al. (2021), in Brazil, indicate that women who work in fish processing may possess knowledge on fish diet and reproduction aspects. In another study, Lopes et al. (2021) demonstrated temporal changes in the stocks of several fish species by interviewing family nuclei in fishing communities in São Paulo, Rio de Janeiro and Santa Catarina (Brazil) and divers interviewed by Blanco-Parra et al. (2022) in Mexico, demonstrated elasmobranch abundance declines.

Species

Several biology and morphology aspects explain why some elasmobranch species were mentioned more than others, such as (i) wide geographic distribution, (ii) importance in fish fishery (*e.g., Galeocerdo cuvier, Isurus oxyrinchus, Sphyrna lewini*), (iii) habitat diversity, *i.e.,* estuaries, rivers and lakes (*Carcharhinus leucas* and *Pristis pristis*), (iv) large body size, ranging in total length from 2.4 m (*Ginglymostoma cirratum*) up to 20 m (*Rhincodon typus*), (v) conspicuous morphological features such as rostrum (*P. pristis*), cephalofoil (*S. lewini*), barbells (*G. cirratum*), dorsal mottling patterns (*G. cuvier*, *R. typus*, *C. limbatus*) and (vi) the sum of several traits (e.g., *G. cuvier*, *I. oxyrinchus*, *S. lewini*) (Ebert et al. 2021; Gomes et al. 2019; Oliveira et al. 2023; Shiffman et al. 2020).

Carcharhiniformes is the largest shark order, comprising 10 families and about 291 species (Ebert et al. 2021; Gomes et al. 2019), which explains the higher number of citations for this order in the retrieved articles. However, even though the Carcharhinidae family and Carcharhinus and Sphyrna genera were the most cited, they are not the most numerous species among sharks (Ebert et al. 2021; Gomes et al. 2019). They include however, taxa with wide geographic distributions, close to the coast, are found in different environments, are large and display striking morphological characteristics (Ebert et al. 2021; Gomes et

al. 2019; Oliveira et al. 2023). Furthermore, the variety and intensity of the ways in which elasmobranchs interact with humans also comprise a crucial factor in generating knowledge on this group. In addition to fishing, these species can also interact with people during recreational activities (Blanco-Parra et al. 2022; Cisneros-Montemayor et al. 2020) through injuries and accidents (Chapman and McPhee 2016; Silva et al. 2020; Katzer et al. 2022), by feeding (Davidson et al. 2016; Giglio et al. 2018) and through culture and/or religion expressions (Grant et al. 2021; Leeney and Poncelet 2015; Stacey et al. 2012; Torrente et al. 2018; Valerio-Vargas and Espinoza 2019). New knowledge and perceptions about species are, in fact, formed from these different forms of interaction.

Among the species mentioned in the publications retrieved by this systematic review, 126 (70%) are included in endangered categories (VU, EN, CR). If we consider that the two species classified as Data Deficient (DD) also mentioned in the publications are in fact threatened (Dulvy et al. 2021), the number of endangered species increases to 128 (72%). Therefore, ethnoichthyology also comprises a valuable way to generate data to support assessments on extinction threats in elasmobranchs, as about 33% of all Elasmobranchs and Chimaeras species are included in some threat category, according to IUCN assessments (Dulvy et al. 2021, Leduc et al. 2021; Oliveira et al. 2023). Only *Potamotrygon boesemani* is not categorized, probably due to its small occurrence area (Rosa et al. 2008), which, coupled to logistical factors, can restrict biology and ecology assessments for this species.

Despite the high number of publications retrieved herein and the reported diversity of fishing gear and fishing modes, no Chimaeras species were mentioned. One research effort has been, in fact, carried out by Baremore et al. (2021) with fishers from Mexico, Belize, Guatemala and Honduras, using photographs and popular names (Additional File 1) to gather data on *Neoharriotta carri* (Dwarf sicklefin chimera). The main reason for the absence of mentions for these members is probably related to biological aspects, such as low frequency and deep-water occurrence (Didier et al. 2012). Holocephalans, however, are known to interact with fishing, although infrequently, and species can be grouped upon landing along with shark species, due to generalizations concerning their external morphology, termed generically as dogfish or cação, as shark meat is called in many countries, or even discarded, losing this information (Di Dario et al. 2011; Didier et al. 2012; Santana-Morales et al. 2020).

Thematic areas

Ethnoichthyology is a multidisciplinary knowledge area (Alves et al. 2018; Marques 2012; Narchi et al. 2014) focusing on various topics. The first forms of interaction between people and elasmobranchs were and still are through fishing by groups that live close to aquatic environments (Lopes et al. 2016; Mojetta et al. 2018; Pinto et al. 2018). This justifies the predominance of fishing as the most addressed topic, as it comprises a primary and regular source of interaction (Berkes et al. 2000; García-Quijano and Pitchon 2010). In addition, fishing demonstrates its importance and produces knowledge not only through labor activity, but also through traditional people identity and culture maintenance (Skubel et al. 2019).

Contrary to what was observed by Ladislau et al. (2021) on ethnoichthyology research on teleosts, biology-related aspects were the second major topic most discussed in the retrieved publications (n= 80; 27%). Research on fish biology LEK has been compared with "conventional science" data for years (e.g., Albuquerque et al. 2021; Silvano and Begossi, 2012). Based on these studies, the scientific community currently recognizes the importance of their contribution to the generation and complementation of data concerning food (Begossi et al. 2016; Freitas et al. 2021; Silva et al. 2021), reproduction (Giglio and Bornatowski 2016; Irigoyen and Trobbiani 2016; Serra-Pereira et al. 2014), habitat (Begossi et al. 2016; López-Angarita et al. 2021; Rasalato et al. 2010), behavior (Barbato et al. 2021; Barbosa-Filho et al. 2014) and temporal trends concerning size, abundance and distribution variations (Bastari et al. 2022; Fogliarini et al. 2021; Giglio and Bornatowski 2016; Santos et al. 2022; Seidu et al. 2022), among others (Pinto et al. 2018; Ruddle, 2000), corroborating the relevance of employing ethnoichthyology in academic research.

Elasmobranch use as human food is noteworthy among the themes addressed by human-elasmobranch relationships in the retrieved publications. In fact, sharks and rays are a dietary component in several coastal and/or developing countries, mainly due to the guarantee of food security in its broad spectrum, which includes protein provision, with fish considered a healthy food and generating income from commercialization, allowing for the purchase of other food inputs and the settlement of other expenses (Davidson et al. 2016; Dulvy et al. 2017; Giglio et al. 2018; Skubel et al. 2019). In addition to the value of these animals as a food and income source, elasmobranchs are also important in therapeutic and religious uses, through their consumption and/or topical use of animal parts or by-products. For example, teeth or parts of sharks are used as a medical tool and for cultural

purposes, as noted by Rasalato et al. (2010) for Fiji and Leeney and Poncelet (2015) for Guinea-Bissau, while the head of Pristis pristis is used in the prevention of headaches, baldness and its teeth to obtain calcium and in the preparation of energy drinks in Costa Rica (Valerio-Vargas and Espinoza 2019). Several species of sharks and rays are employed by fishing communities due to their antiasthmatic and anti-inflammatory potential, and for cholesterol control, among others (e.g., Tocantins, Brazil, Begossi and Braga 1992; Península de Paria, Venezuela, Fariña-Pestano et al. 2011). In contrast, records of permanent or periodic restrictions on the consumption of these animals are associated to health maintenance, for example, for injured people, pregnant women and women in the puerperium, among other conditions (Begossi et al. 2004; Grant et al. 2021; Ramires et al. 2012). These uses highlight the sociocultural relevance of elasmobranchs for coastal and riverside communities, who also use these animals for tourism (Cisneros-Montemayor et al. 2020), for ethnic group identification through totem poles and/or scarification (Grant et al. 2021; Torrente et al. 2018), and in crafts and tools (Rasalato et al. 2010; Valerio-Vargas and Espinoza 2019).

The importance of the human dimension in elasmobranchs conservation is of recognized importance in academia (Booth et al. 2019; Oliveira et al. 2023; Ostrovski et al. 2021; Skubel et al. 2019). However, as noted, few studies aim to investigate the knowledge and perception of actors who interact directly with these animals. Furthermore, what makes this issue more sensitive is the problem of non-inclusion of local actors and their respective contributions in decision-making processes (Johannes et al. 2008; Ostrovski et al. 2021; Pinto et al. 2018; Renck et al. 2023; Skubel et al. 2019), in addition to establishing a simple and objective dialogue on the subject.

Elasmobranch conservation is a topic of different opinions. For example, there are those who relate conservation successes to country development levels by employing development indices (Lucifora et al. 2019) and the "emotional affinity" of people towards these animals, thus influencing management and fisheries resources management (Skubel et al. 2019; Ostrovski et al. 2021). In addition, behavioral and cultural changes may also take place, ignoring the history of exploitation between countries as a strategy to reduce or end elasmobranch capture (Booth et al. 2019; Lucifora et al. 2019). Counterbalancing these ideals that tend to homogenize and generalize issues associated with elasmobranch conservation to society, some coastal communities present cultural and/or religious expressions that aid in species conservation. For example, *Prionace glauca* is called the shark god (Temago-Purotu or Ma'o-purotu in Tahitian) by Anaa Atoll inhabitants (French Polynesia) and, as a sacred element of this culture, it should not be fished or consumed (Torrente et al. 2018). For the Bajo people (eastern Indonesia), *Rhincodon typus* captures are prohibited due to laws established by the community's ancestors, as the species is thought to be guarded by a protective spirit which helps fishers in times of adversity (Stacey et al. 2012). These examples reinforce the fact that Chondrichthyan conservation requires a comprehensive approach at the local level considering sociocultural, economic, and environmental factors and involving the main actors affected by the management process (Becerril-García et al. 2022; Ostrovski et al. 2021; Pinto et al. 2018; Renck et al. 2023; Seidu et al. 2022). In this regard, as noted by Diegues (2000), the adoption of generalized management and resource use models are not adequate and effective, as they neglect local particularities. Thus, it is crucial to integrate popular knowledge and the active participation of all involved, in order to make the management process inclusive, participatory, and understandable (Albuquerque et al. 2021; Alves and Nishida 2003; Johannes et al. 2008; Silvano and Valbo-Jørgensen 2008), also comprising a mobilization and social empowerment tool (Alves and Nishida 2003). This will, in turn, contribute to conservation effectiveness, strictly associated with fisheries sustainability, reflecting aquatic environment health and benefitting local economies and cultures.

CONCLUSION

This review demonstrates an increasing trend in the scientific production on LEK directed to Elasmobranchii species in the last decade. Surveys were carried out mostly in Brazil, in marine environments and outside conservation units. This highlights the need to direct research efforts to other countries and freshwater environments, mainly due to the lack of historical information on the biology, ecology and relationships between fish and people, in addition to the threat status of many members of this taxonomic group.

The mention of many endangered species (such *Isurus oxyrinchus*, *Sphyrna lewini*, *Carcharhinus leucas*) highlights research efforts in gathering information in this regard and reinforces the current threat state of many Elasmobranchs and Chimaeras species. In addition, the lack of any Holocephali mentions indicates the importance of exploring other ethnographic methodologies, diversifying interviewed actors, and other less researched taxa like freshwater stingrays, which are potentially more subject to the threats Chondrichthyes are exposed to.

The interdisciplinary ethnoichthyology character was demonstrated herein by the varied actors and top-

ics addressed in the retrieved publications. However, other human groups (such as divers, fish processors, health agents, among others) should be included in this type of research. This will allow for further Chondrichthyes knowledge access and information on interactions and issues on rarely addressed topics, such as conservation, which is strictly associated with fishing resource sustainability and maintenance and local cultures that effectively interact with Chondrichthyes.

ACKNOWLEDGMENT

The authors would like to thank Laboratory of Technological and Fisheries Biology (BioTecPesca) students for their collaboration. Thanks are also due to Prof. Dr. Vinicius Fortes Farjalla (VFF) for methodology suggestions, Msc. Aléxia Antonia Lessa da Costa (AALC) who helped with the R script, and Dr. Rachel Ann Hauser-Davis (RAHD) for translating the manuscript.

FUNDING

MV acknowledges Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro – FAPERJ (Process number E-26/200.934/2022) and Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq (Process number 302398/2022-8) and Fundo Brasileiro para a Biodiversidade – FUNBIO 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.

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 declare no conflicts of interest.

CONTRIBUTION STATEMENT

Conceived of the presented idea: MCN, MV.
Carried out the experiment: MCN.
Carried out the data analysis: MCN, SRS.
Wrote the first draft of the manuscript: MCN.
Review and final write of the manuscript: MCN, SRS, MV.
Supervision: MV.

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Received: 02 August 2023
Accepted: 25 November 2023
Published: 12 December 2023

Editor: Rômulo Alves

Additional Files

Add File 1. List of articles included in the Bibliometric review.

Code	Author(s)	Title	Year	Journal	DOI
A001	Pierini SV, Warrell DA, Paulo A, Theakston RDG	High incidence of bites and stings by snakes and other animals among rubber tappers and Amazonian Indians of the Juruá Valley, Acre State, Brazil	1996	Toxicon	10.1016/0041-0101(95)00125-5
A002	Costa-Neto EM	Food avoidances and preferences among fishermen communities from the county of Conde, State of Bahia, Brazil	2000	Revista de Nutrição	10.1590/S1415-52732000000200006
A003	Dalla Rosa L, Secchi ER	Killer whale (Orcinus orca) interactions with the tuna and swordfish longline fishery off southern and south-eastern Brazil: A comparison with shark interactions	2007	Journal of the Marine Biological Association of the United Kingdom	10.1017/S0025315407054306
A004	Jonahson M, Harding S	Occurrence of whale sharks (Rhincodon typus) in Madagascar	2007	Fisheries Research	10.1016/j.fishres.2006.11.023
A005	Carlson JK, Osborne J, Schmidt TW	Monitoring the recovery of smalltooth sawfish, Pristis pectinata, using standardized relative indices of abundance	2007	Biological Conservation	10.1016/j.biocon.2006.11.013
A006	Psomadakis PN, Maio N, Vacchi M	The chondrichthyan biodiversity in the Gulf of Naples (SW Italy, Tyrrhenian Sea): An historical overview	2009	Cybium	-
A007	Garrone-Neto D, Haddad-Junior V	Stingrays in rivers in southeastern Brazil: Occurrence localities and impact on the population	2010	Revista da Sociedade Brasileira de Medicina Tropical	10.1590/s0037-86822010000100018

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Code	Author(s)	Title	Year	Journal	DOI
A008	Rasalato E, Maginnity V, Brunnschweiler JM	Using local ecological knowledge to identify shark river habitats in Fiji (South Pacific)	2010	Environmental Conservation	10.1017/S0376892910000317
A009	Ainsworth CH	Quantifying Species Abundance Trends in the Northern Gulf of California Using Local Ecological Knowledge	2011	Marine And Coastal Fisheries	10.1080/19425120.2010.549047
A010	Anderson RC, Adam MS,Kitchen-Wheeler AM, Stevens G	Extent and economic value of manta ray watching in maldives	2011	Tourism in Marine Environments	10.3727/154427310X12826772784793
A011	Anderson RC, Adam MS, Goes JI	From monsoons to mantas: Seasonal distribution of Manta alfredi in the Maldives	2011	Fisheries Oceanography	10.1111/j.1365-2419.2011.00571.x
A012	Lam VYY,Sadovy De Mitcheson Y	The sharks of South East Asia - unknown, unmonitored and unmanaged	2011	Fish and Fisheries	10.1111/j.1467-2979.2010.00383.x
A013	Fariña-Pestano AR, Ruiz-Velásquez LDJ, Flores MYR,Peñuela-Jiménez JH, González-Henríquez MN	Marine ethnobiology and fishery aspects in six coastal communities of the Paria Peninsula, Venezuela	2011	Interciencia	-
A014	Maynou F, Sbrana M,Sartor P, Maravelias C, Kavadas S, Damalas D, Cartes JE, Osio G	Estimating trends of population decline in long-lived marine species in the mediterranean sea based on fishers' perceptions	2011	PLoS ONE	10.1371/journal.pone.0021818
A015	Carruthers EH, Neis B	Bycatch mitigation in context: Using qualitative interview data to improve assessment and mitigation in a data-rich fishery	2011	Biological Conservation	10.1016/j.biocon.2011.06.007
A016	Ward-Paige CA, Lotze HK	Assessing the value of recreational divers for censusing elasmobranchs	2011	PLoS ONE	10.1371/journal.pone.0025609

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Code	Author(s)	Title	Year	Journal	DOI
A017	Taylor RB, Morrison MA, Shears NT	Establishing baselines for recovery in a marine reserve (Poor Knights Islands, New Zealand) using local ecological knowledge	2011	Biological Conservation	10.1016/j.biocon.2011.09.009
A018	Stacey NE, Karam J, Meekan MG, Pickering S, Ninef J	Prospects for whale shark conservation in Eastern Indonesia through bajo traditional ecological knowledge and community-based monitoring	2012	Conservation and Society	10.4103/0972-4923.92197
A019	Ramires M, Rotundo MM, Begossi A	The use of fish in Ilhabela (São Paulo/Brazil): preferences, food taboos and medicinal indications	2012	Biota Neotropica	10.1590/S1676-06032012000100002
A020	Li W, Wang Y, Norman B	A preliminary survey of whale shark Rhincodon typus catch and trade in China: An emerging crisis	2012	Journal of Fish Biology	10.1111/j.1095-8649.2012.03250.x
A021	Holcer D, Lazar B, Mackelworth P, Fortuna CM	Rare or just unknown? The occurrence of the giant devil ray (Mobula mobular) in the Adriatic Sea	2013	Journal of Applied Ichthyology	10.1111/jai.12034
A022	Previero M, Minte-Vera CV, Moura RL	Fisheries monitoring in Babel: Fish ethnotaxonomy in a hotspot of common names	2013	Neotropical Ichthyology	10.1590/S1679-62252013000200016
A023	Bentz J, Dearden P, Ritter E, Calado H	Shark diving in the Azores: Challenge and opportunity	2014	Tourism in Marine Environments	10.3727/154427314X14056884441789
A024	Villalobos-Rojas F,Herrera-Correal J,Garita-Alvarado C, Clarke T, Beita-Jiménez A	Economic activities that depend on ichthyofauna in the north pacific of Costa Rica	2014	Revista de Biologia Tropical	10.15517/rbt.v62i4.20038

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Code	Author(s)	Title	Year	Journal	DOI
A025	Serra-Pereira B, Erzini K, Maia C, Figueiredo I	Identification of potential essential fish habitats for skates based on fishers' knowledge	2014	Environmental Management	10.1007/s00267-014-0257-3
A026	Barbosa-Filho MLV, Schiavetti A, Alarcon DT, Costa-Neto EM	"Shark is the man!" : Ethnoknowledge of Brazil's South Bahia fishermen regarding shark behaviors	2014	Journal of Ethnobiology and Ethnomedicine	10.1186/1746-4269-10-54
A027	Leeney RH, Poncelet P	Using fishers' ecological knowledge to assess the status and cultural importance of sawfish in Guinea-Bissau	2015	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.2419
A028	Jabado RW, Al Ghais SM, Hamza W, Henderson AC	The shark fishery in the United Arab Emirates: An interview based approach to assess the status of sharks	2015	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.2477
A029	Glaus KBJ,Adrian-Kalchhauser I, Burkhardt-Holm P,White WT,Brunnschweiler JM	Characteristics of the shark fisheries of Fiji	2015	Scientific Reports	10.1038/srep17556
A030	Reis-Filho JA, Freitas RHA, Loiola M, Leite L, Soeiro G,Oliveira HHQ,Sampaio CLS, Nunes JCC, Leduc AOHC	Traditional fisher perceptions on the regional disappearance of the largetooth sawfish Pristis pristis from the central coast of Brazil	2016	Endangered Species Research	10.3354/esr00711
A031	Irigoyen A, Trobbiani G	Depletion of trophy large-sized sharks populations of the argentinean coast, south-western atlantic: Insights from fishers' knowledge	2016	Neotropical Ichthyology	10.1590/1982-0224-20150081
A032	Giglio VJ, Bornatowski H	Fishers' ecological knowledge of smalleye hammerhead, Sphyrna tudes, in a tropical estuary	2016	Neotropical Ichthyology	10.1590/1982-0224-20150103

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Code	Author(s)	Title	Year	Journal	DOI
A033	Acebes JMV, Barr Y, Pereda JMR, Santos MD	Characteristics of a previously undescribed fishery and habitat for Manta alfredi in the Philippines	2016	Marine Biodiversity Records	10.1186/s41200-016-0098-2
A034	Leeney RH, Downing N	Sawfishes in The Gambia and Senegal - shifting baselines over 40years	2016	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.2545
A035	Leeney RH	Fishers' ecological knowledge of sawfishes in Lake Piso, Liberia	2016	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.2542
A036	Fortibuoni T, Borme D, Franceschini G, Giovanardi O, Raicevich S	Common, rare or extirpated? Shifting baselines for common angelshark, Squatina squatina (Elasmobranchii: Squatinidae), in the Northern Adriatic Sea (Mediterranean Sea)	2016	Hydrobiologia	10.1007/s10750-016-2671-4
A037	Begossi A, Salivonchyk S,Lopes PFM, Silvano RAM	Fishers' knowledge on the coast of Brazil	2016	Journal of Ethnobiology and Ethnomedicine	10.1186/s13002-016-0091-1
A038	Acebes JMV, Tull M	The history and characteristics of the mobulid ray fishery in the Bohol Sea, Philippines	2016	PLoS ONE	10.1371/journal.pone.0161444
A039	O'Bryhim JR, Parsons ECM,Gilmore MP, Lance SL	Evaluating support for shark conservation among artisanal fishing communities in Costa Rica	2016	Marine Policy	10.1016/j.marpol.2016.05.005
A040	Iqbal M, Yustian I	Occurrence of the giant freshwater stingray Urogymnus polylepis in Sumatra, Indonesia (Chondrichthyes: Dasyatidae)	2016	Ichthyological Exploration of Freshwaters	

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Code	Author(s)	Title	Year	Journal	DOI
A041	Nascimento DM,Alves RRN, Barboza RRD,Schmidt AJ, Diele K, Mourão JS	Commercial relationships between intermediaries and harvesters of the mangrove crab Ucides cordatus (Linnaeus, 1763) in the Mamanguape River estuary, Brazil, and their socio-ecological implications	2017	Ecological Economics	10.1016/j.ecolecon.2016.08.017
A042	Leeney RH	Are sawfishes still present in Mozambique? A baseline ecological study	2017	PeerJ	10.7717/peerj.2950
A043	Cardeñosa D, Glau KBJ, Brunnschweiler JM	Occurrence of juvenile bull sharks (Carcharhinus leucas) in the Navua River in Fiji	2017	Marine and Freshwater Research	10.1071/MF16005
A044	Abati PAM, Torrez PPQ, Franca FOD, Tozzi FL, Guerreiro FMB,Santos SAT, Oliveira SMS, Haddad V	Injuries caused by freshwater stingrays in the Tapajos River Basin: a clinical and sociodemographic study	2017	Revista da Sociedade Brasileira de Medicina Tropical	10.1590/0037-8682-0016-2017
A045	Barrowclift E, Temple AJ, Stead S, Jiddawi NS, Berggren P	Social, economic and trade characteristics of the elasmobranch fishery on Unguja Island, Zanzibar, East Africa	2017	Marine Policy	10.1016/j.marpol.2017.06.002
A046	Taylor SM, Braccini JM, Bruce BD, McAuley RB	Reconstructing Western Australian white shark (Carcharodon carcharias) catches based on interviews with fishers	2018	Marine and Freshwater Research	10.1071/MF17140
A047	Leeney RH, Mana RR, Dulvy NK	Fishers' ecological knowledge of sawfishes in the Sepik and Ramu rivers, northern Papua New Guinea	2018	Endangered Species Research	10.3354/esr00887

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Code	Author(s)	Title	Year	Journal	DOI
A048	Giglio VJ, Ternes MLF,Luiz OJ, Zapelini C,Freitas MO	Human consumption and popular knowledge on the conservation status of groupers and sharks caught by small-scale fisheries on Abrolhos Bank, SW Atlantic	2018	Marine Policy	10.1016/j.marpol.2017.12.020
A049	Barash A, Pickholtz R, Pickholtz E, Blaustein L, Rilov G	Seasonal aggregations of sharks near coastal power plants in Israel: an emerging phenomenon	2018	Marine Ecology Progress Series	10.3354/meps12478
A050	Martins APB, Feitosa LM, Lessa RP, Almeida ZS, Heupel M, Silva WM, Tchaicka L, Nunes JLS	Analysis of the supply chain and conservation status of sharks (Elasmobranchii: Superorder Selachimorpha) based on fisher knowledge	2018	PLoS ONE	10.1371/journal.pone.0193969
A051	Busilacchi S, Butler JRA, Rochester WA, Posu J	Drivers of illegal livelihoods in remote transboundary regions: The case of the Trans-Fly region of Papua New Guinea	2018	Ecology and Society	10.5751/ES-09817-230146
A052	van den Boog T, Bulkan J, Tansey J, van Andel TR	Sustainability issues of commercial non-timber forest product extraction in West Suriname	2018	Journal of Ethnobiology and Ethnomedicine	10.1186/s13002-018-0244-5
A053	Esakkimuthu S,Sylvester Darvin S, Mutheeswaran S, Gabriel Paulraj M, Pandikumar P, Ignacimuthu S, Al-Dhabi NA	A study on food-medicine continuum among the non-institutionally trained siddha practitioners of Tiruvallur district, Tamil Nadu, India	2018	Journal of Ethnobiology and Ethnomedicine	10.1186/s13002-018-0240-9
A054	Vierus T, Gehrig S, Brunnschweiler JM,Glaus K, Zimmer M,Marie AD, Rico C	Discovery of a multispecies shark aggregation and parturition area in the Ba Estuary, Fiji Islands	2018	Ecology and Evolution	10.1002/ece3.4230

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Code	Author(s)	Title	Year	Journal	DOI
A055	Murphy SE, Campbell I, Drew JA	Examination of tourists' willingness to pay under different conservation scenarios; Evidence from reef manta ray snorkeling in Fiji	2018	PLoS ONE	10.1371/journal.pone.0198279
A056	Peñaherrera-Palma C,van Putten I, Karpievitch YV, Frusher S,Llerena-Martillo Y,Hearn AR, Semmens JM	Evaluating abundance trends of iconic species using local ecological knowledge	2018	Biological Conservation	10.1016/j.biocon.2018.07.004
A057	Carvalho MM, Oliveira MR, Lopes PFM, Oliveira JEL	Ethnotaxonomy of sharks from tropical waters of Brazil	2018	Journal of Ethnobiology and Ethnomedicine	10.1186/s13002-018-0273-0
A058	Duarte DLV,Broadhurst MK,Dumont LFC	Challenges in adopting turtle excluder devices (TEDs) in Brazilian penaeid-trawl fisheries	2019	Marine Policy	10.1016/j.marpol.2018.10.048
A059	Cuevas JM, García M, Hozbor N, Faria VV,Paesch L	Tracing the occurrence of the Critically Endangered smalltooth sawfish Pristis pectinata at its southernmost distribution in the Southwest Atlantic Ocean	2019	Endangered Species Research	10.3354/esr00932
A060	Barbosa-Filho MLV, Hauser-Davis RA,Siciliano S, Dias TLP,Alves RRN, Costa-Neto EM	Historical shark meat consumption and trade trends in a global richness hotspot	2019	Ethnobiology Letters	10.14237/ebl.10.1.2019.1560
A061	Valerio-Vargas JA, Espinoza M	A beacon of hope: Distribution and current status of the largetooth sawfish in Costa Rica	2019	Endangered Species Research	10.3354/esr00992

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A062	Rubio-Cisneros NT, Moreno-Báez M, Glover J, Rissolo D, Sáenz-Arroyo A, Götz C, Salas S, Andrews A, Marín G, Morales-Ojeda S, Antele F, Herrera-Silveira J	Poor fisheries data, many fishers, and increasing tourism development: Interdisciplinary views on past and current small-scale fisheries exploitation on Holbox Island	2019	Marine Policy	10.1016/j.marpol.2018.10.003
A063	Glaus KBJ,Adrian-Kalchhauser I, Piovano S, Appleyard SA, Brunnschweiler JM, Rico C	Fishing for profit or food? Socio-economic drivers and fishers' attitudes towards sharks in Fiji	2019	Marine Policy	10.1016/j.marpol.2018.11.037
A064	Mason JG,Alfaro-Shigueto J,Mangel JC,Brodie S, Bograd SJ, Crowder LB, Hazen EL	Convergence of fishers' knowledge with a species distribution model in a Peruvian shark fishery	2019	Conservation Science and Practice	10.1111/csp2.13
A065	Giovos I, Stoilas V-O,Al-Mabruk SAA,Doumpas N, Marakis P, Maximiadi M,Moutopoulos D, Kleitou P, Keramidas I, Tiralongo F, Maddalena A	Integrating local ecological knowledge, citizen science and long-term historical data for endangered species conservation: Additional records of angel sharks (Chondrichthyes: Squatinidae) in the Mediterranean Sea	2019	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.3089
A066	Hiddink JG, Shepperson J, Bater R, Goonesekera D, Dulvy NK	Near disappearance of the Angelshark Squatina squatina over half a century of observations	2019	Conservation Science and Practice	10.1111/csp2.97
A067	Lowe J, Tejada JFC, Meekan MG	Linking livelihoods to improved biodiversity conservation through sustainable integrated coastal management and community based dive tourism : Oslob Whale Sharks	2019	Marine Policy	10.1016/j.marpol.2019.103630

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A068	Marques RA, Julio TG,Sole-Cava AM, Vianna M	A new strategy proposal to monitor ray fins landings in south-east Brazil	2020	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.3203
A069	Silva GA, Poscai AN, Casas ALD	Injuries Caused by Freshwater Stingrays in the Western Amazon: Folk Medicine and Beliefs	2020	Ethnobiology Letters	10.14237/ebl.11.1.2020.1586
A070	Ceyhan T, Akyol O,Demir-Saglam Y, Sen H, Ozgul A, Duzbastilar FO	The gathering of predators around the sea-cage fish farms in the Aegean Sea	2020	Cahiers De Biologie Marine	10.21411/CBM.A.F8856C42
A071	Hani MS, Lück M, Jompa J, Nessa MN, White AT, Hanifah MIHP	The role of small-scale manta ray tourism in eastern Indonesia's marine protected areas	2020	International Journal of Innovation, Creativity and Change	–
A072	Braulik G, Kasuga M, Majubwa G	Local ecological knowledge demonstrates shifting baselines and the large-scale decline of sawfishes (Pristidae) in Tanzania	2020	African Journal of Marine Science	10.2989/1814232X.2020.1728379
A073	Garcia-Rodriguez E,Sosa-Nishizaki O	Artisanal fishing activities and their documented interactions with juvenile white sharks inside a nursery area	2020	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.3300
A074	Karnad D, Sutaria D, Jabado RW	Local drivers of declining shark fisheries in India	2020	Ambio	10.1007/s13280-019-01203-z
A075	Mason JG, Alfaro-Shigueto J, Mangel JC, Crowder LB, Ardoin NM	Fishers' solutions for hammerhead shark conservation in Peru	2020	Biological Conservation	10.1016/j.biocon.2020.108460
A076	Cisneros-Montemayor AM, Townsel A, Gonzales CM, Haas AR, Navarro-Holm EE, Salorio-Zuñiga T,Johnson AF	Nature-based marine tourism in the Gulf of California and Baja California Peninsula: Economic benefits and key species	2020	Natural Resources Forum	10.1111/1477-8947.12193

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A077	Martínez-Candelas IA, Pérez-Jiménez JC, Espinoza-Tenorio A, McClenachan L,Méndez-Loeza I	Use of historical data to assess changes in the vulnerability of sharks	2020	Fisheries Research	10.1016/j.fishres.2020.105526
A078	Colloca F, Carrozzi V, Simonetti A, Di Lorenzo M	Using Local Ecological Knowledge of Fishers to Reconstruct Abundance Trends of Elasmobranch Populations in the Strait of Sicily	2020	Frontiers in Marine Science	10.3389/fmars.2020.00508
A079	Ladislau DS, Ribeiro MWS, Castro PDS, Aride PHR, Paiva AJV, Polese MF, Souza AB, Bassul LA, Lavander HD, Oliveira AT	Ornamental fishing in the region of Barcelos, Amazonas: socioeconomic description and scenario of activity in the view of piabeiros	2020	Brazilian Journal Of Biology	10.1590/1519-6984.215806
A080	Dinkel TM,Sánchez-Lizaso JL	Involving stakeholders in the evaluation of management strategies for shortfin mako (Isurus oxyrinchus) and blue shark (Prionace glauca) in the Spanish longline fisheries operating in the Atlantic Ocean	2020	Marine Policy	10.1016/j.marpol.2020.104124
A081	Cuevas-Gómez GA,Pérez-Jiménez JC,Méndez-Loeza I,Carrera-Fernández M, Castillo-Géniz JL	Identification of a nursery area for the critically endangered hammerhead shark (Sphyrna lewini) amid intense fisheries in the southern Gulf of Mexico	2020	Journal of Fish Biology	10.1111/jfb.14471
A082	Campbell E, Pasara-Polack A, Mangel JC, Alfaro-Shigueto J	Use of Small Cetaceans as Bait in Small-Scale Fisheries in Peru	2020	Frontiers in Marine Science	10.3389/fmars.2020.534507

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A083	Temple AJ, Stead SM,Hind-Ozan E, Jiddawi N, Berggren P	Comparison of local knowledge and researcher-led observations for wildlife exploitation assessment and management	2020	Environmental Conservation	10.1017/S0376892920000296
A084	Haque AB, D'Costa NG, Washim M, Baroi AR, Hossain N, Hafiz M, Rahman S, Biswas KF	Fishing and trade of devil rays (Mobula spp.) in the Bay of Bengal, Bangladesh: Insights from fishers' knowledge	2021	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.3495
A085	Barbosa MLV, Ramires M, Mourao JS, Rosa RD,Alves RRN, Costa-Neto EM	Ethnotaxonomy of Sharks by Expert Fishers from South Bahia, Brazil: Implications for Fisheries Management and Conservation	2021	Ethnobiology and Conservation	10.15451/ec2021-08-10.02-1-12
A086	Malara D, Battaglia P, Consoli P, Arcadi E,Longo F, Stipa MG,Pagano L, Greco S, Andaloro F, Romeo T	When opportunistic predators interact with swordfish harpoon fishing activities: shark depredation over catches in the Strait of Messina (central Mediterranean Sea)	2021	European Zoological Journal	10.1080/24750263.2021.1879284
A087	Freitas RF, Machado LP, Freitas RHA, Hanazaki N	Differences and similarities in local ecological knowledge about rays among fishers, residents, and tourists	2021	Ethnobiology and Conservation	10.15451/ec2021-05-10.25-1-14

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A088	Barbato M, Barria C,Bellodi A, Bonanomi S, Borme D, Cetkovic I, Colloca F, Colmenero AI, Crocetta F, De Carlo F, Demir E, Di Lorenzo M, Follesa MC, Garibaldi F, Giglio G, Giovos I,Guerriero G, Hentati O, Ksibi M, Kruschel C,Lanteri L, Leonetti FL,Ligas A, Madonna A,Skoko SM, Mimica R, Moutopoulos DK, Mulas A, Nerlovic V, Pesic A,Porcu C, Riginella E, Sperone E, Tsouknidas K, Tuncer S, Vrdoljak D, Mazzoldi C	The use of fishers' Local Ecological Knowledge to reconstruct fish behavioural traits and fishers' perception of the conservation relevance of elasmobranchs in the Mediterranean Sea	2021	Mediterranean Marine Science	10.12681/mms.25306
A089	López-Angarita J,Cubillos-M JC,Villate-Moreno M, Del Cid A, Díaz JM, Cooke R,Cagua EF, Tilley A	Bright spots for research and conservation of the largetooth sawfish Pristis pristis in Colombia and Panamá	2021	Endangered Species Research	10.3354/esr01150
A090	Leduc AOHC, Carvalho FHD, Hussey NE,Reis-Filho JA, Longo GO, Lopes PFM	Local ecological knowledge to assist conservation status assessments in data poor contexts: a case study with the threatened sharks of the Brazilian Northeast	2021	Biodiversity and Conservation	10.1007/s10531-021-02119-5
A091	Queiroz JDGR,Bezerra NPA, Macena BCL, Hazin FHV	Back from the dead? Not really. The tale of the Galapagos shark (Carcharhinus galapagensis) in a remote Brazilian archipelago	2021	Biological Conservation	10.1016/j.biocon.2021.109097

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A092	Lopes PFM, Hanazaki N, Nakamura EM,Salivonchyk S, Begossi A	What fisher diets reveal about fish stocks	2021	Ambio	10.1007/s13280-021-01506-0
A093	Haque AB, Washim M, D'Costa NG, Baroi AR, Hossain N, Nanjiba R, Hasan SJ, Khan NA	Socio-ecological approach on the fishing and trade of rhino rays (Elasmobranchii: Rhinopristiformes) for their biological conservation in the Bay of Bengal, Bangladesh	2021	Ocean and Coastal Management	10.1016/j.ocecoaman.2021.105690
A094	Tanna A, Fernando D, Gobiraj R, Pathirana BM, Thilakaratna S, Jabado RW	Where have all the sawfishes gone? Perspectives on declines of these Critically Endangered species in Sri Lanka	2021	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.3617
A095	Baremore IE, Graham RT, Witt MJ	Fishing down the reef slope: Characteristics of the nearshore deepwater fisheries of MesoAmerica	2021	Ocean and Coastal Management	10.1016/j.ocecoaman.2021.105773
A096	Almojil D	Local ecological knowledge of fisheries charts decline of sharks in data-poor regions	2021	Marine Policy	10.1016/j.marpol.2021.104638
A097	Nuez I, Gazo M, Cardona L	A closer look at the bycatch of medium-sized and large sharks in the northern Catalan coast (north-western Mediterranean Sea): Evidence of an ongoing decline?	2021	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.3651

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A098	Grant MI, White W,Amepou Y, Baje L,Diedrich A, Ibana D,Jogo DJ, Jogo S, Kyne PM, Li O, Mana R, Mapmani N, Nagul A, Roeger D, Simpfendorfer CA, Chin A	Local knowledge surveys with small-scale fishers indicate challenges to sawfish conservation in southern Papua New Guinea	2021	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.3678
A099	Lopez-Angarita J,Villate-Moreno M, Diaz JM, Cubillos JC, Tilley A	Identifying nearshore nursery habitats for sharks and rays in the Eastern Tropical Pacific from fishers' knowledge and landings	2021	Ocean and Coastal Management	10.1016/j.ocecoaman.2021.105825
A100	Silva PM, Teixeira CM,Pita C, Cabral HN, Franca S	Portuguese Artisanal Fishers' Knowledge About Elasmobranchs-A Case Study	2021	Frontiers in Marine Science	10.3389/fmars.2021.684059
A101	Mustika PLK,Wonneberger E, Erzini K, Pasisingi N	Marine megafauna bycatch in artisanal fisheries in Gorontalo, northern Sulawesi (Indonesia): An assessment based on fisher interviews	2021	Ocean and Coastal Management	10.1016/j.ocecoaman.2021.105606
A102	Gonzáles-Mantilla PG, Gallagher AJ, León CJ, Vianna GMS	Challenges and conservation potential of shark-diving tourism in the Macaronesian archipelagos	2021	Marine Policy	10.1016/j.marpol.2021.104632
A103	Santos SR Macedo MLC, Maciel TR, Souza GBG, Almeida LD, Gadig OBF, Vianna M	A tale that never loses in the telling: Considerations for the shifting ethnobaseline based on artisanal fisher records from the southwestern Atlantic	2022	Ethnobiology and Conservation	10.15451/ec2022-01-11.03-1-20
A104	Nazareth E, D'Souza E, Arthur R, Jabado RW	Distribution of the Critically Endangered Giant Guitarfish (Glaucostegus typus) based on Local Ecological Knowledge in the Andaman Islands, India.	2022	Ocean and Coastal Management	10.1016/j.ocecoaman.2022.106075

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A105	Leeney RH, Quayson E	Short note: An assessment of the status of sawfishes and of guitarfish landings in artisanal fisheries in Ghana	2022	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.3824
A106	Haque AB, Cavanagh RD, Spaet JLY	Fishers' tales-Impact of artisanal fisheries on threatened sharks and rays in the Bay of Bengal, Bangladesh	2022	Conservation Science and Practice	10.1111/csp2.12704
A107	Sekey W, Obirikorang KA, Alimo TA, Soku M,Acquah B, Gyampoh BA, Adjei-Boateng D,Asare-Ansah O,Ashiagbor G, Kassah JE	Evaluation of the shark fisheries along the Coastline of Ghana, West Africa	2022	Regional Studies in Marine Science	10.1016/j.rsma.2022.102434
A108	Espino F, Gonzalez JA, Bosch NE, Otero-Ferrer FJ, Haroun R, Tuya F	Distribution and population structure of the smooth-hound shark, Mustelus mustelus (Linnaeus, 1758), across an oceanic archipelago: Combining several data sources to promote conservation	2022	Ecology and Evolution	10.1002/ece3.9098
A109	Barker J, Davies J, Goralczyk M, Patel S, O'Connor J, Evans J,Sharp R, Gollock M,Wood FR, Rosindell J, Bartlett C, Garner BJ,Jones D, Quigley D, Wray B	The distribution, ecology and predicted habitat use of the Critically Endangered angelshark (Squatina squatina) in coastal waters of Wales and the central Irish Sea	2022	Journal of Fish Biology	10.1111/jfb.15133

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A110	Caceres C, Kiszka JJ,Luna-Acosta A, Herrera H, Zarza E, Heithaus MR	Predatory fish exploitation and relative abundance in a data-poor region from the Caribbean coast of Colombia, inferred from artisanal fishery interview surveys and baited remote underwater video systems	2022	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.3853
A111	Medeiros MC, Pinto, AS, Santos DR, Martel G,Lopes SD, Mourao JD	Folk taxonomy and scientific nomenclature: Working together for conservation of fishery resources in Brazil	2022	Journal For Nature Conservation	10.1016/j.jnc.2022.126214
A112	Guttridge TL, Carroll K, Guttridge AE, Matich P	Local ecological knowledge from Andros Island, The Bahamas, reveals new insights on the distribution and use of the Critically Endangered smalltooth sawfish, Pristis pectinata	2022	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.3867
A113	Pagel CD, Lück M	#Wildlifeselfies: insights into the ocular consumption of marine wildlife	2022	Tourism Recreation Research	10.1080/02508281.2022.2026151
A114	Robinson D, Newman SP, Whittingham MJ,Francksen RM, Adam MS, Stead SM	Fisher–shark interactions: A loss of support for the Maldives shark sanctuary from reef fishers whose livelihoods are affected by shark depredation	2022	Conservation Letters	10.1111/conl.12912
A115	Choy CPP, Jabado RW, Clark-Shen N, Huang D, Choo MY, Rao M	Unraveling the trade in wedgefishes and giant guitarfishes in Singapore	2022	Marine Policy	10.1016/j.marpol.2021.104914
A116	Blanco-Parra MP, Sandoval-Laurrabaquio-Alvarado N, Díaz-Jaimes P, Niño-Torres CA	Evidence of a nursery area for bull shark, Carcharhinus leucas (Müller y Henle, 1839) in the Mesoamerican Reef System region	2022	Environmental Biology of Fishes	10.1007/s10641-022-01338-1

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A117	Blanco-Parra MP,Gasca AA, Rincón CAR, Martínez NHG,Niño-Torres CA	Citizen Science as a Tool to Get Baseline Ecological and Biological Data on Sharks and Rays in a Data-Poor Region	2022	Sustainability (Switzerland)	10.3390/su14116490
A118	Papageorgiou M, Hadjioannou L, Jimenez C, Georgiou A, Petrou A	Understanding the Interactions Between Cetaceans and Other Megafauna With the Albacore Tuna Fishery: A Case Study From the Cyprus' Pelagic Longline Fishery	2022	Frontiers in Marine Science	10.3389/fmars.2022.868464
A119	Katzer RJ, Schultz C,Pham K, Sotelo MA	The Natural History of Stingray Injuries	2022	Prehospital and Disaster Medicine	10.1017/S1049023X22000565
A120	Seidu I, Cabada-Blanco F, Brobbey LK, Asiedu B, Barnes P, Seidu M,Dulvy NK	"Every fish in the sea is meat and so are guitarfishes": Socio-economic drivers of a guitarfish fishery in Ghana	2022	Marine Policy	10.1016/j.marpol.2022.105159