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Review

Traditional Ecological Knowledge of Fishermen: People Contributing towards Environmental Preservation

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Abstract: Studies on traditional ecological knowledge are relevant from the point of view of valuing traditional populations and environmental preservation of ecosystems throughout the planet. We aim to analyze the environmental preservation practices transmitted from the traditional ecological knowledge (TEK) of traditional fishermen. In this narrative literature review, we rely on information available in articles available in the Web of Science database. We inductively analyzed the convergences and divergences of the articles. Studies on TEK are spread around the world, with an emphasis on Brazil. Studies on TEK by fishermen demonstrate the importance of recording the memory of actions in the effort of transmitting traditional ecological knowledge, helping in the process of management and conservation of natural resources in different environments.

Keywords: artisanal fisheries; fishery management; natural resources; rural areas; sustainability

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1. Introduction

Artisanal or small-scale fishing can include subsistence or commercial fisheries, providing for local consumption or export is based on traditional fishing techniques involving fishing households and organization, as opposed to commercial, mechanized, and large-scale fishing [1,2], and structural, functional, environmental, social, and economic aspects differentiate it from industrial fishing [3]. Starting from different fishing techniques, this artisanal activity plays an important role for communities, generating employment, income, and a cheap source of protein [4].

Fishermen and fisherwomen have their own perception of access to fisheries resources, fisheries management, favorable environments for the activity, ecosystem, and sustainable management. This category has a very strong relationship with the environment where they live; they know nature in a deep way [5,6]. If well conserved, fishery resources generate ecosystem services and better socioeconomic conditions for fishermen [7].

Artisanal fishermen and women constitute a social and political category that have a deep connection with the environment, having knowledge of how to manipulate the tools used to develop their activities and guarantee the survival of their family [8,9]. The artisanal fisherman comprises a wide variety of groups that can be differentiated by their particularities such as type of fishing, gear used, culture, gender, and nationality, among others [10,11].

They also have knowledge of the techniques used, build their gear, and understand the dynamics of the environment based on the existing exchange with their ancestors, as they are the ones who keep the knowledge of the art of fishing in a mythological, environmental, technical, and laboral way necessary to perform the art of fishing [12]. This knowledge provides the ability to fully manipulate the environment in their communities, built from the ecological relationships that these communities establish with rivers, lakes, and their natural resources [13].

Traditional ecological knowledge (TEK) dominated by traditional populations, especially fishermen and women, has been the object of scientific research from different perspectives, disseminating information on fauna and flora in different environments [14]. Such interest refers to the importance that the set of information that these populations have on the dynamics of the local environment and the relationship with the environment in which they live. Generally, the transmission of this knowledge happens from generation to generation; however, it is still little valued by studies related to natural sciences [15,16].

The study of this type of traditional ecological knowledge can support scientific studies and, therefore, help to fill the gaps in the understanding between the relationship between human activities and different ecosystems [12,17–19]. This knowledge makes it possible to understand topics related to habitat, fish feeding habits, migratory process, species reproduction, management of fisheries resources, conservation of fisheries resources, and natural resource alterations to climatic events, among others [5,20–23]. This scientific effort has served as a source of information for the elaboration of public policies that guarantee the conservation, management, and sustainability of natural resources in traditional communities [24–26].

The traditional ecological knowledge of traditional peoples, especially fishermen, encompasses concepts that seek to preserve natural resources in a sustainable way to guarantee the survival of future generations [27,28]. It also involves a set of information, preferences, points of view, and values of the connection between the members of the communities and the environment where they live. Thus, studying how these communities understand the environment and recording their reports increases the probability of carrying out a plan adapted to the community reality [15,29–31]. This source of information is still little explored by academic studies and by the different spheres of governments. This is possible to perceive in public policies and in the planning carried out for the communities [27].

The elaboration of the bibliographic inventory on the subject is a tool that expands the understanding of the reality experienced in fishing communities around the world [32]. The broad understanding of the subject studied reveals that scientific publications expose the diversity of use of natural resources by fishermen in addition to fish, which can help to understand the forms of use and develop environmental conservation policies in different countries.

Our study is a narrative review sought simply to answer the following question: What are the main scientific approaches and contributions to the TEK of fishermen in the world? We report on this narrative review outlines several examples of the approach, application, and contribution of the TEK of traditional fishermen in the world and describes the challenges of fisheries management, environmental conservation, and considerations associated with this.

It is also important to observe how scientific research uses the fishermen's TEK. Furthermore, we want to know how science and society benefit from this form of traditional knowledge.

2. Methodology

Narrative reviews allow the synthesis of results from previous studies, and the statistical significance of the authors' findings should not be a relevant criterion [33]. As a technique, a narrative review of the literature is valuable for generating hypotheses on the subject studied, but there is no easy and available way to write a narrative review [34].

We carried out a bibliographic review based on scientific articles found in the Web of Science (WoS) database, where most of the validated and indexed scientific productions are registered. However, gray literature such as theses, conference proceedings, books and book chapters, technical brochures, and those that were "under review" or "in press" were excluded from the analysis. The keywords used were: "traditional ecological knowledge" and "fishermen" and "traditional ecological knowledge" and "fisherwomen".

Our choice of using the terms "fishermen" and "fisherwomen" is based on: (1) "fishermen" is more commonly used than "fisher", despite a recent preference for the latter [35]; (2) by not using a neutral term, such as "fisher", we recognize that there are differences in gender relations in fisheries, which are often studied by anthropology and forgotten by other areas [36].

As an inclusion criterion, the selected articles would need to contemplate the perspective of studies related to the TEK of fishermen in different approaches, such as management, co-management, fish feeding, local dynamics, climate change, and construction of gear.

The selected material was analyzed in three steps (Table 1). First, the theme and object of study were identified, and the database (WoS) was chosen. In the second moment, a survey of the material was carried out, starting from the search for articles with the selected keywords in order to select the articles that met the inclusion criteria, and excluded those that did not align with the research.

Table 1. Steps of the article selection process.

Step	Action	Description
I—Criteria for the article search	1.1 Choice of Database	Web of Science (Main Collection)
	1.2 Definition of Keywords for search	"Traditional ecological knowledge" and fishermen (89 results) "Traditional ecological knowledge" and fisherwomen (1 result, also included above)
	1.3 Definition of period coverage	No time filter: to access more articles about TEK and fishermen
II—Search and selection of articles	2.1 Survey and organization of articles	81 articles
	2.2 Reading of Titles and Abstracts	Searches about traditional ecological knowledge (TEK), involving traditional fishermen and environmental preservation (19 articles excluded)
	2.3 Selection of articles inside the scope of this research	
III—Reading and organization of data	3.1 Reading of complete articles	63 articles (Table A1)
	3.2 Systematization of converging information between articles	
	3.3 Analysis of data and organization of results	

In a third moment, we extracted, from the entire article, information that could still identify the common and discrepant evidence between the studies on the TEK of fishermen and fisherwomen. A total of 89 papers were identified for traditional ecological knowledge and fishermen, and only one when using the combination of TEK and fisherwomen, also included in the previous result. We excluded 6 conference papers; 1 retracted and 1 unavailable on the journal's website. Thus, 81 articles were selected by reading the title and abstracts. We excluded 19 articles because they were not in the scope of our research. In the end, 63 articles were included in this review.

The article analysis was performed by compiling, systematizing, and interpreting data on traditional ecological knowledge (TEK). Thus, we used an inductive approach to proceed with our interpretations of the qualitative information provided by the articles (Table A2). To reduce analysis bias, whenever possible, we use citations of samples, methods, specific results, and conclusions to show what the authors reported on the topic [34].

Then, the data found in Excel for Windows spreadsheets were tabulated. For the organization, we categorized as follows: nature of the work, title, year, authors, abstract, keywords, audience participating in the research, data collection instruments, and place of publication. We used the research areas of Web of Science to illustrate the main areas of the papers on TEK. We created a Venn diagram to compare the use of the four most used data collection instruments by the authors, using the interactive tool Venny 2.1 [37].

3. Findings and Results

3.1. Studies on TEK over Time

Studies on traditional ecological knowledge have been elements of research linked to ethnosciences in different perspectives. Initiatives in the scientific context emerged and became a form of interaction between the various forms of knowledge. An ethnoscience can be considered an alternative path to scientific rigor, without diminishing any of the methodologies produced by Western science, but using them as a tool for reinterpretations that allow a better understanding of the relationship between man and nature [38,39].

Fishermen and fisherwomen have traditional ecological knowledge that needs to be studied and systematized based on everyday practical actions, that is, revealing their direct relationship with the natural and cultural environment [15]. In the last two decades, many researchers have dedicated themselves to carrying out research showing how traditional ecological knowledge is linked to the community practices of traditional communities [14,40–43]. This scientific effort has contributed to the expansion of information about the fauna and flora, essential for the conservation of the ecosystem and endangered species, in addition to guaranteeing important data for scientific studies.

One of the first works on the relationship between man and the environment was published by Conklin [44], who recorded in detail the relationship of the Hanunóo people of the Philippines with plants and their cultivation, revealing that this people had a deep knowledge about the soil and plants. According to Souto [45], the scientific record carried out by Conklin demonstrated how the knowledge of traditional populations can contribute to classifying and recording information about local plants and animals. This scientific effort gave rise to a detailed theoretical foundation on the Hanunóo way of life and their relationship with the environment, especially with plants and soil, and demonstrated their diversity of knowledge and management of natural resources.

The publications on TEK found in the survey in the WoS database were registered from the year 1997, following a low number of publications for approximately 11 years. Only from 2008 onwards, scientific studies on traditional ecological knowledge seem to be highlighted in journals indexed in the Web of Science (Figure 1). After this period, it is expected that new paradigms about the man/environment relationship will emerge. From this evolution of the TEK systematization around the world, society can understand that man is an element of the environment and not the only one. The human being must leave behind the image of aggressor of the environment.

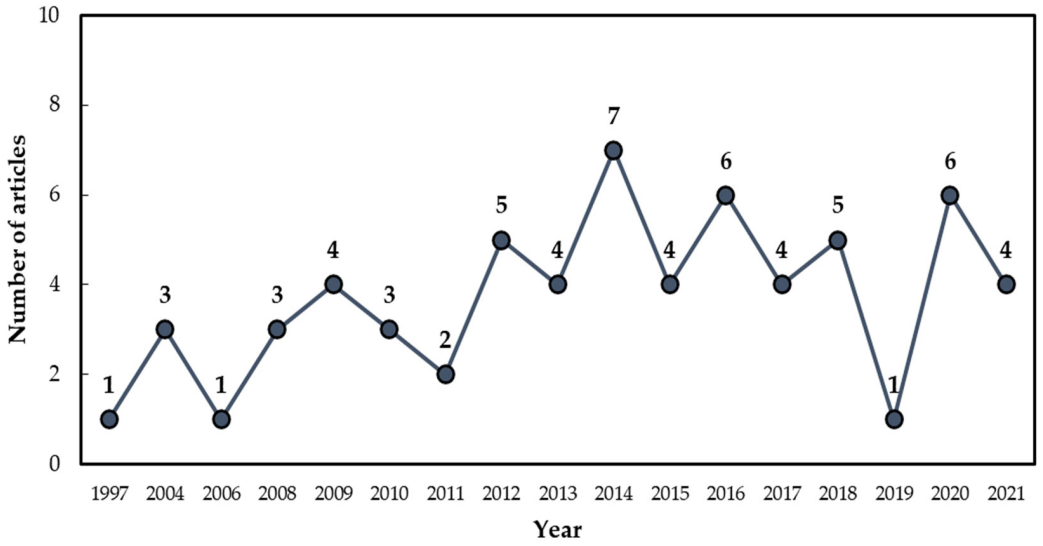


Figure 1. Number of articles published about the traditional ecological knowledge of fishermen around the world (n = 63). Source: Research data from Web of Science.

The oldest article found (1997) dealt with fishermen's TEK on fish occurrence patterns at various spatio-temporal scales in the Fatala Estuary in Guinea, West Africa [46]. Among the results, they emphasized that the TEK investigation should be used as a preliminary analysis to help define sampling projects in tropical rivers and estuaries.

On the other hand, the most recent studies (2021) systematize TEK surveys of fishermen and women linked to the following themes: management of natural resources and control of pressure on the fish stock; knowledge of capture techniques and usefulness of the species, being transmitted vertically in the community; fish feeding; fisheries management, difference in fishing effort between fishermen and fisherwomen; link between traditional and scientific ecological knowledge; and paraphernalia [47–50]. A consensus of the authors concerns the record that TEK strategies adopted are essential to support scientific technical knowledge and future studies.

3.2. Studies on TEK across Countries

Research on the sharing of TEK and the perception of fishing dynamics among traditional fishermen living in two watersheds in Paraíba, Brazil, showed that each community has particularities and traditional knowledge about fishing dynamics [47]. This article shows that the TEK is a source of information for the execution of water and fisheries resource management projects, resulting in significant advances in the quality of ecosystems and for the socio-economy of these communities.

In the Colombian Caribbean, in Uribia, the fishermen's TEK on sea turtles helped researchers in fisheries and biodiversity management [48]. The study of fishermen's knowledge is also necessary to understand and interpret the history of the way of life adopted by different fishing communities, countries, and continents, thus being an important element for scientific knowledge and for the construction of effective proposals for the maintenance of biodiversity in ecosystems and biomes. The scientific records of Nery et al. [47] and Vásquez-Carrillo and Peláez-Ossa [48] converge on the understanding that a qualified management of fisheries resources requires the appreciation of traditional knowledge, which is one of the fundamental elements for academic studies that discuss this topic linked to traditional communities. A deep understanding of past and current experiences of fishermen contributes to qualified interventions proposed by researchers together with fishermen. Although the TEK has great importance, there is still a devaluation in the process of elaborating local development programs and policies, which causes negative impacts on ecosystems and on the way of life of traditional communities [51].

Research related to the TEK of fishermen and women is being developed in different countries, proving to be a line of research of global importance among researchers. We highlight the role that Brazil plays in the number of publications on fishermen's TEK in this review (Figure 2).

In research carried out in the Patos Lagoon Estuary (Brazil), participatory mapping was carried out which revealed in detail the wealth of knowledge of fishermen, demonstrating a solid relationship between these subjects and the natural environment where they live, in addition to showing how the TEK helps in local fisheries management [52].

The TEK points to the need for information on fisheries management in Galicia (Spain). Through participatory mapping with the application of a questionnaire with key informant fishermen in the fisheries sector with extensive knowledge, advantage, and experience in fishing [42], these participants contributed data on the social, technical, and ecological characteristics of the fishery, which supported improvements in fisheries management and in ensuring the environmental sustainability of an economically important region in Spain. The studies by Pita et al. [42] and Schafer and Reis [52] were conducted on different continents, but they discuss the method for collecting the data to achieve their objectives, which allow the opportunity for fishermen to portray their local realities and future perceptions of the environment where they live and fish.

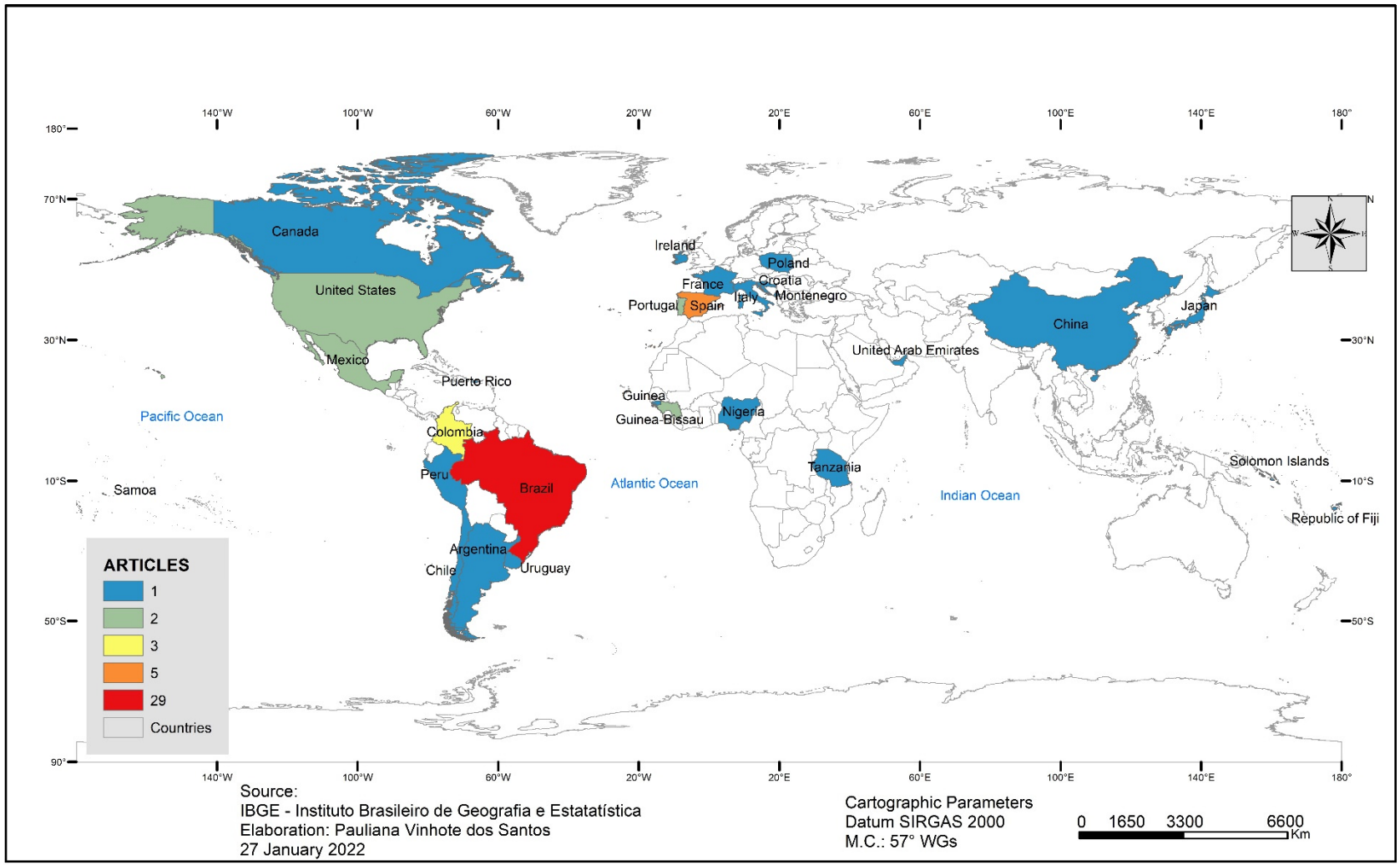


Figure 2. Countries highlighted in scientific article publication about the traditional ecological knowledge of fishermen and fisherwomen. Source: Research data from Web of Science.

We identified a study on TEK with Atlantic cod (*Gadus morhua*), a fish much appreciated in the world and of cultural and economic importance for some regions. DeCelles et al. [53] studied the TEK related to cod spawning in the Atlantic Ocean, in addition to adopting documentary research, and interviews with cod fishermen, and recording observations during fishing, concluding with ichthyoplankton research. The combination of these methods helped to describe the spatial and temporal distribution of cod spawning in Georges Bank, in the Atlantic. In addition, the study revealed that fishermen have detailed knowledge about the distribution of space and time of the spawning period, as well as the particularities of the cod habitat, helping to enrich the scientific record of this species. In addition, the results can collaborate with management strategies to increase the cod stock.

3.3. Research Areas of the Studies on TEK

Many of the studies on traditional ecological knowledge are related to different areas within the academic environment, often interconnected. For understanding purposes, the more frequent Web of Science areas are showed in Figure 3. Biodiversity conservation was the one that most frequent, aiming to analyze temporal patterns, fish diet, reproductive cycle, fish spawning, biological and ecological characteristics, fish behavior, and the spatial and temporal variation of species.

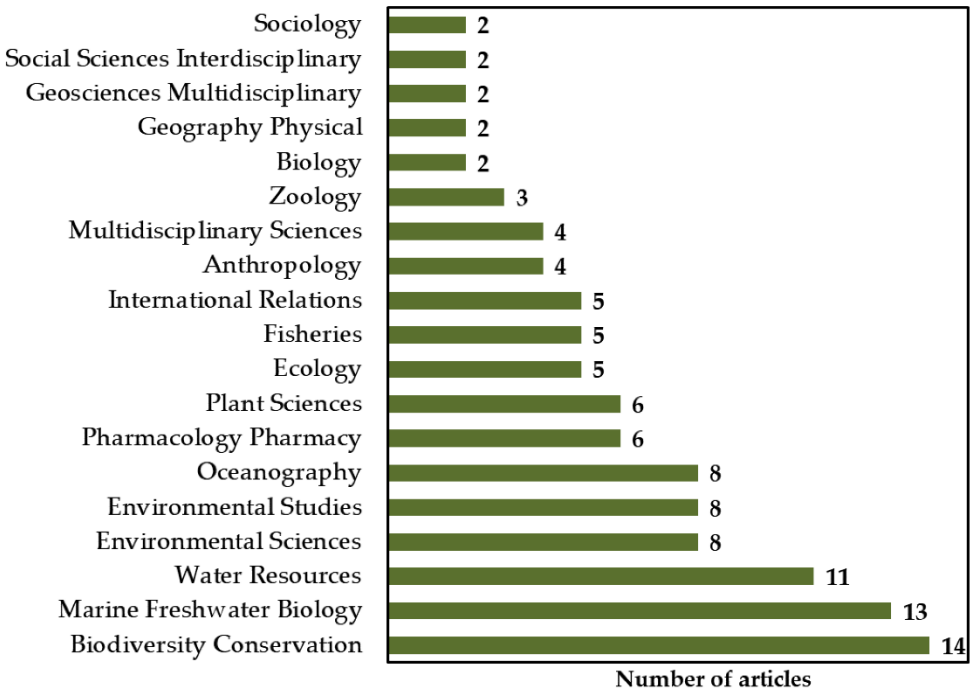


Figure 3. Traditional ecological knowledge of fishermen and fisherwomen and themes involved by scientific research. Source: Research data from Web of Science.

The fishermen's TEK also contributed information associated with the biology and ecology of sardines (*Sardina pilchardus*) in the North Atlantic [54]. The authors systematized the TEK of fishermen who live in the traditional communities of Peniche, in Portugal. Fishermen provided valuable information on taxonomy, habitat, behavior, migration, development, spawning season, and accumulation of fat in sardines; and this traditional knowledge had agreements with the scientific literature [54]. The authors also recorded the main dietary habits and beliefs of fishermen, knowledge that can help improve the management of fisheries resources, consequently in the conservation of sardines.

In the United Arab Emirates (UAE), fishermen's TEK in relation to sawfish ecology is in particular linked to the status, uses, and cultural significance of the species for the community [55]. The data revealed that there is a great decline of the population of the sawfish,

and that the waters of Abu Dhabi play an important role for the existence of the studied species. In addition, in this region, it is possible to carry out research and to monitor the species. In the end, the authors stated that in this place it is important to carry out actions for the conservation and recovery of the sawfish, as a strategy to avoid the total disappearance and recover the species. The association of scientific and traditional knowledge is evidenced in the European (Peniche, Portugal) and Asian (United Arab Emirates) continents, according to records published, respectively, by Braga et al. [54] and Jabado et al. [55]. The authors converge based on the results on the association of TEK and academic knowledge to support actions to mitigate environmental degradation and the elaboration of concrete proposals for the conservation of fish stocks, especially sardines and sawfish, respectively.

Studies with other species of aquatic fauna were also highlighted in research on TEK, such as manatees, turtles, dolphins, *Cassis tuberosa*, and otters. When analyzing manatee hunting techniques, researchers observed a food preference for 29 species of aquatic and semiaquatic plants, in addition to realizing that fishermen have mastery over the biology and behavior of this mammal in Amazonian waters [56]. Study of this scale and nature are essential to help in the elaboration of conservation plans for the species in the region, especially for this species that is fished in a predatory way.

We also can cite a study with fishermen from Aguadilla in the north coast to Guánica in the south, in Puerto Rico [57]. In this study, the authors showed that fishermen hold information about coastal ecosystems, fish behavior, temporal patterns, and spatial distribution. Traditional ecological knowledge is an important source of information to be collected, systematized, and studied in order to support the understanding of the ecology and management of fisheries resources. The studies published by Franzini et al. [56] and Valdés-Pizzini and García-Quijano [57] have synergy in their results, both of which indicate the relevance and richness that the fishermen's TEK has, in particular on information related to the biology and ecology of fisheries resources existing in different ecosystems. Such information contributes to the fishermen and their community organizations to have mastery and to be able to propose effective measures for the management plans within the study ecosystems.

Researchers have linked fishermen's TEK with fish feeding in Manacapuru, Brazilian Amazon. The results revealed that fishermen have knowledge about the diet of tambaqui (*Colossoma macropomum*), tucunaré (*Cichla* sp.), pacu (*Mylossoma albiscopum*), acara-açu (*Astronotus crassipins*), curimatã (*Prochilodus nigricans*), aruanã (*Osteoglossidae bicirrhosum*), matrinxã (*Brycon amazonicus*), piranha (*Pygocentrus nattereri*), and pirapitinga (*Piaractus brachypomus*). Such knowledge is similar to analyses carried out in the laboratory and scientific publications on the subject [58]. The authors state that this knowledge should serve as a scientific subsidy for future management research in the lakes, thus helping to reduce long-term research costs.

Octopus fishermen from the Galicia region of Spain have qualified TEK that helped researchers in mapping the distribution of fishermen within the region, helping in the effort estimation process and catch per unit of effort (CPUE) [42]. It also contributed to the observation of the social, technical, and ecological particularities of the fishing activity, which, added to the information collected using the questionnaires, can contribute to the management and sustainability of octopus fishing in Spain. The authors suggest the creation and implementation of a long-term co-management plan as an instrument for the sustainability of fishing stocks and profitability of the artisanal fleet.

Fishermen's TEKs are comprehensive and specialized [42,58]. These authors understand that through this traditional knowledge, it was possible to systematize issues related to elements about the social, technical, and ecological characteristics of fishing in Galicia, Spain [42], as well as to record the diet of different species of fish in the Amazon [58]. Such information is also valuable for the planning and implementation of co-management for the sustainable use of fisheries resources [59,60], allowing the construction of a shared and participatory management model, with responsibilities in the elaboration and implementation of shared norms, between the state and the community.

Regarding the Indo-Pacific humpback dolphin (*Sousa chinensis*), research carried out with fishermen in the eastern estuary of Guangdong, China, combined the TEK of fishermen in the region with scientific methods to monitor ecological information of the species, which had previously been neglected by scientific research [61]. The results revealed that this species of dolphin has a predisposition to be geographically isolated, and that it is constantly threatened, requiring great effort to guarantee the conservation of the species. Future scientific studies that consider the TEK may contribute to the proposition and implementation of conservation strategies for this dolphin species.

Sea turtles are the target of predatory and incidental fishing, leading to the risk of extinction, along the Brazilian coast. As a public policy, Brazil developed the National Program for the Conservation of Sea Turtles, which had studied the influence on the perception of fishermen regarding the conservation of sea turtles [62]. The authors showed that the green turtle (*Chelonia mydas*) is the most accidentally caught in nets (trawlers, gillnets, and fishing lines) at the bottom of the river. The researchers observed that fishermen have in-depth knowledge about the diet of this species, coming from regional practices. The program has subtly influenced the perception and attitude of fishermen regarding the species. Based on the systematized data, the authors proposed the redirection of the strategies adopted in the program to ensure that fishermen can act as local conservation agents, ranging from the installation of radio stations to educational campaigns to the training of fishermen.

These studies are similar in studying species threatened by the practice of predatory fishing and for indicating similar alternatives for mitigating the extinction of species through scientific studies based on TEK [61,62]. Also in South America, researchers concerned with the conservation of mangrove ecosystems carried out an ethnographic study to systematize the TEK of fishermen in the Gulf of Urabá, Colombia, in relation to the surrounding mangrove ecosystems and their conservation [63]. They observed that the existence of multiple territories has caused an overlap of rules and customs, with an implicit power relationship, reflecting in the division of responsibility in a differentiated way in the process of conservation and restoration of mangroves in the region, among local leaders. The authors stated that the inexistence of a qualified action, aiming at the protection of marine and coastal resources, is one of the contradictions that influences the economic, social, and political daily life of the residents of the researched region.

In Fiji, Vanua Levu Island, the subject of study was tropical corals. Fishermen and fisherwomen's TEK was studied to improve reef conservation planning [64]. The methodology used allowed the authors to show that combining marine protected areas (MPAs) with knowledge of the species and the life reports of fishermen and women would support a future conservation project model, integrating the traditional ecological knowledge of fishermen in the planning of activities of ecosystem conservation.

Data collected from fishermen from the Negro River in the Amazon and from farmers living in the Atlantic Forest showed how TEK can help in the conservation of streams in Brazil [65]. The data obtained in the Amazon region revealed that fishermen have control over the diet and habitats of 14 species of fish, and revealed unprecedented biological information about the plant species that are a food source for these species. In addition, the researchers showed that data obtained from farmers in the Atlantic Forest indicate the existence of 11 forest characteristics that are within the concept of ecosystem services. According to the authors, the results can contribute to the elaboration of effective measures for the management of ecosystems with a view to the conservation of streams, their lowland forests in the Negro River, and the Atlantic Forest.

As noted, fishermen's use of TEK can also help identify ecosystems threatened with degradation [63–65]. The results indicated the implementation of strategic actions that guarantee the recovery of ecosystems, allowing the construction of an efficient model of a conservation project that unifies scientific and traditional knowledge. As far as fishing activity is concerned, this review shows research trends related to fishing areas, fishing modes, fishing frequency, catch per unit of effort (CPUE), fishing techniques, and strategies.

Schafer and Reis [52] organized information collected from fishermen from Patos Lagoon estuary in Brazil. The authors showed that the fishermen's TEK helped in the identification and georeferencing of 124 fishing areas, proving that the fisherman's knowledge is rich in details, as a result of his relationship with the environment. These subjects must be incorporated into strategies for the conservation and management of fisheries resources in communities.

Purcell et al. [66] studied fishing modes, fishing frequency, catch per unit of effort, resource preferences, and fish stock perceptions among artisanal gastropod (*Trochus*) fishermen in Samoa, Polynesia. In view of this information, the authors understood the fertilization process and the trend of population abundance of the *Trochus* mollusc over time and in the surroundings where the study was carried out. The authors identified similarities between the TEK of fishermen and fisherwomen regarding fishing efficiency, catch diversity, and perspectives on stocks, and for fisherwomen, this species of mollusc is very important for their productive activities.

The TEK of fishermen from the Gulf of Salamanca in the Caribbean Sea (Colombia) helped to reveal the fish locations, such as the particularities of the historical transformations of the set of gillnets used in this region [67]. Based on the data, the authors stated that temporal variations may have contributed to the decrease in meshes, in addition to having influenced the travel time to carry out the fishing activity and the spatial distribution of fishing effort. The study with the use of TEK by fishermen constituted a fisheries management strategy and control rules by government agencies, especially in regions where there is pressure on the fish stock.

The growing publications on the unification of academic knowledge with TEK of fishermen and other traditional populations have shown that there is a new paradigm of scientific perception being produced. This new look provides an interdisciplinary perception of recognition and joining of knowledge, cultures, and perceptions, as a path to efficient government strategies for fisheries management and the balance of the study ecosystem [66,67].

3.4. TEK Research Data Collection Instruments

We sought to see which instruments and methodological techniques were most used by the authors in research on TEK. Some were used in isolation and others together. The interview was the most used instrument, revealing the authors' preference for collecting qualitative and quantitative data (Figure 4). Regardless of the instrument or technique, it is up to the researcher to understand the methodological paths, their particularities, and moments, using language adapted to their interlocutors, in this case the fishermen.

Herrera-Racionero, Lizcano-Fernandez, and Miret-Pastor [68] researched fishermen from a specific Spanish port in the Mediterranean (Gandia) and, through semi-structured interviews, found that the biggest problem experienced by fishermen is the lack of legitimacy of political organizations. The authors showed that in order to implement an effective fisheries management policy, it is necessary to re-establish the power of institutions, as well as resorting to the fishermen's TEK to develop new paradigms of fisheries co-management.

In Brazil, in Ilhéus (Bahia), the semi-structured interview as a technique was chosen for collecting TEK data from specialist fishermen [69]. This data collection instrument helped to identify information on the total number of fish species found in the environment.

Bulengela et al. [70] collected data through semi-structured interview, participant observation, focus group, and field visit, and identified the perception of fishermen and community leaders in Tanzania. The researchers showed how TEK is used in the process of sustainable fisheries management, maintenance of the ecological conditions of the studied lake, and even the dynamics of seasonal climatic issues.

The interview with open questions was used to compare differences and similarities of the TEK of crustacean fishermen in Chile with scientific data, with internal variability being observed between these two knowledges [71]. The author emphasizes that, even

so, the TEK must be considered as a source of information in research that uses natural resources and, thus, successfully implement crustacean co-management programs.

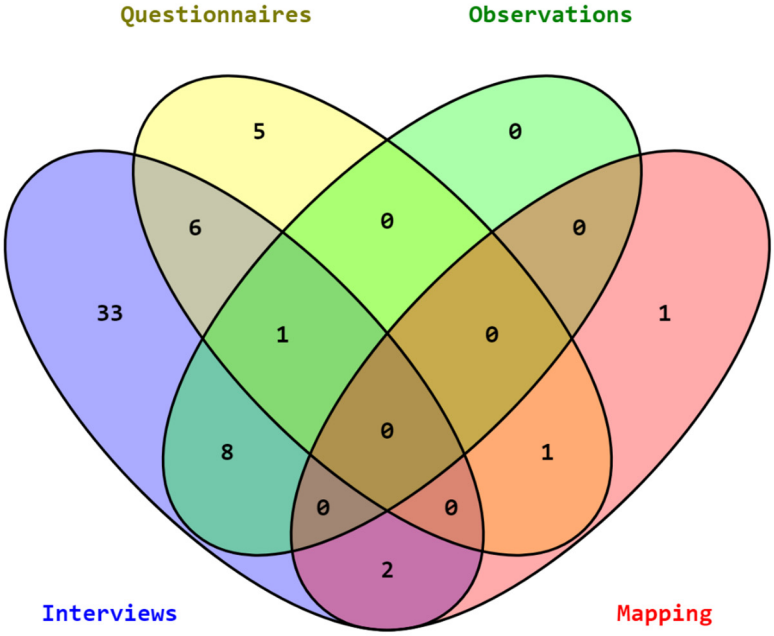


Figure 4. Venn diagram of the four most used data collection instruments in TEK research.

Paredes and Hopkins [72] surveyed fishing communities on the Peruvian north coast in order to highlight the quality of the TEK of fishermen and describe changes in the use of totora (*Schoenoplectus californicus*) in the Huanchaco region. The authors used participant observation and individual interviews, and found that fishermen are using totora in three ways: building boats, building reed mats, and souvenirs. The TEK study helps to understand the changes that have been taking place in the region, as well as the understanding that the existing economic and technological changes are influenced by globalization.

The use of mapping involving fishermen as protagonists is a strategy for researchers to understand and systematize the social, cultural, and community organizational dynamics, as well as the process used to transmit TEK and ensure the sustainability of the activity developed in fishing territories, as was shown by Pita et al. [42] and Schafer and Reis [52]. The study carried out by Gerhardinger et al. [73] surveyed the TEK of experienced fishermen to map and describe the abundance of giant grouper (*Epinephelus itajara*) in Babitonga Bay, southern Brazil. The collection instrument consisted of rapid participatory mapping, being a promising instrument for the conservation and co-management of marine resources in Brazilian territory. Mapping was also used as one of the techniques for collecting TEK data from fishermen in the study carried out by Mckenna et al. [74] in Lough Neagh, Northern Ireland. The authors made a mind map with the research participants in order to compare with scientific data. The technique revealed to researchers and managers that they should consider TEK, thus decreasing skepticism about the data obtained in this type of data collection technique.

In addition, valuing fishermen's social organizations, as well as the partnership of this social group with different governmental spheres, are strategies that can generate positive results for the conservation and defense of fishing territories [75]. Scientific studies with an approach to "traditional knowledge" and "local knowledge" are now used with the objective of showing the world the importance of this knowledge, often invisible or even despised, but which can help in the understanding of man's relationships with nature, including subsidizing public policies for the conservation and management of natural

resources, in addition to being a form of recognition of the cultural, social, and strategic value of this knowledge.

4. Conclusions

We systematized studies on traditional ecological knowledge—TEK, emphasizing the main discussions and contributions that the theme has given to the scientific environment and traditional communities, as well as contributing to the construction of the foundation of future studies.

Studies on TEK were developed in different continents, proving to be essential for researchers to develop studies that can deal with regional themes and thus build the memory of the activities and efforts of fishermen and artisanal fisherwomen in transmitting their traditional ecological knowledge and how it has helped in the process of managing and conserving natural resources in different environments and locations. Most studies were conducted in the Southern Hemisphere, covering developing countries that face overfishing as a serious socio-environmental problem. We can hypothesize that these countries possibly include fishermen as social actors in participatory management and decision-making actions related to fisheries.

These people act as protectors of aquatic ecosystems, especially when in their daily lives, they use ecosystems with less environmental impact. More than that, by valuing this type of knowledge, it is possible to build more solid and effective public policies for the conservation of aquatic ecosystems.

The set of these studies can promote the creation or improvement of teaching programs (formal and informal), research, valorization, and conservation of TEK in different parts of the world, with special attention to fragile ecosystems and those of great global importance. The conservation and valorization of biodiversity, discussed here, will not only contribute to the protection of socio-environmental and cultural landscapes, but will also provide rural development, provided that these social actors are included in the policies for the use and conservation of these ecosystems.

From what was shown in the analyzed studies, we show that the participatory fisheries management model or co-management that values the TEK of fishermen and fisherwomen has a greater chance of showing more successful results. In this logic, there is the active involvement of social subjects (local fishermen, governmental and non-governmental institutions) in the deliberation process of decisions on the use and conservation of resources in the fishing territory. Thus, we see this appreciation as a strategy to mitigate the pressure on the fish stock and order the use of these areas.

Finally, we can conclude that the first studies on TEK sought to understand the biology and ecology of aquatic fauna species (fish, mammals, molluscs, and reptiles), in addition to assisting in the management and management of fisheries resources. Scientific studies on fishermen's TEK in areas of fish biology and ecology were aimed at confirming or complementing scientific data. However, studies that integrate traditional knowledge and fishermen as social actors in public fisheries policies and those that prioritize the use of participatory methodologies in data collection, aiming at greater researcher–fisherman interaction and systematization of qualitative–quantitative data for planning fisheries are recent.

Thus, important actions to be carried out include: (1) a joint effort between researchers in the area to investigate the differences in gender relations in fishing and the role of women in fishing; (2) the strengthening and/or creation of programs and/or partnerships between research institutions, fishermen's associations, non-governmental organizations, and fishing agencies or companies, with a view to participatively establishing guidelines for fisheries management; (3) attracting and training new researchers in TEK; and (4) promotion of studies that analyze the transmission of the TEK of fishermen between generations, subsidizing future actions of creation and strengthening of integrative networks of knowledge and of rescue and cultural valorization of this form of knowledge.

Finally, as a limitation and immediate suggestion for future research, we recognize that the use of the word "fishermen" and "fisherwomen", without the insertion of the word "fishers" may have resulted in fewer scientific articles. This point leads us to hypothesize that the work of women in fishing is little contemplated in research or that the use of "fisher" makes women invisible in articles on fishermen's TEK. We also recommend that future studies use other indexing bases, especially those that include local and regional studies.

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Appendix A

Table A1. List of articles consulted on the traditional ecological knowledge of fishermen.

Authors	Title of Article	Year	Journal	DOI or Access Link
Vásquez-Carrillo and Peláez-Ossa	Insights into the ecology of sea turtles and the fisheries of eastern Guajira from the traditional knowledge of fishermen	2021	Fisheries Research	https://doi.org/10.1016/j.fishres.2021.105915 (accessed on 14 February 2022)
Nery et al.	Diagnosis of ethnoecological knowledge of fishermen in hydrographic basins in the semiarid of Paraiba	2021	Geoambiente On-line	https://doi.org/10.5216/revgeoamb.i39.66849 (accessed on 14 February 2022)
Psuty and Całkiewicz	Natural and social science approaches are both needed to manage bird bycatch in small-scale fisheries	2021	Aquatic Conservation: Marine and Freshwater Ecosystems	https://doi.org/10.1002/aqc.3730 (accessed on 14 February 2022)
Ladislau et al.	Current situation and future perspectives of ethnoichthyology in Brazil	2021	Ethnobiology and Conservation	https://doi.org/10.15451/ec2020-11-10.09-1-35 (accessed on 14 February 2022)
Bulengela et al.	"Bring fishermen at the center": the value of local knowledge for understanding fisheries resources and climate-related changes in Lake Tanganyika	2020	Environment, Development and Sustainability	https://doi.org/10.1007/s10668-019-00443-z (accessed on 14 February 2022)
Mota et al.	Fishing, trade, and local ecological knowledge of the marine gastropod, *Cassis tuberosa*—a target species of the international shell trade	2020	Ethnobiology and Conservation	https://doi.org/10.15451/ec2020-06-9.23-1-11 (accessed on 14 February 2022)
Jacobi et al.	Feeding of *Arapaima* sp.: integrating stomach contents and local ecological knowledge	2020	Journal of Fish Biology	https://doi.org/10.1111/jfb.14372 (accessed on 14 February 2022)
Purcell et al.	Understanding Gender and Factors Affecting Fishing in an Artisanal Shellfish Fishery	2020	Frontiers in Marine Science	https://doi.org/10.3389/fmars.2020.00297 (accessed on 14 February 2022)
Florido del Corral	Hybridations of knowledge and cultural rationalities in fishing: living of the sea and at the sea in Andalucia (Spain) and Chiloe (Chile) within present day context	2020	Estudios Atacameños	https://doi.org/10.22199/issn.0718-1043-2020-0019 (accessed on 14 February 2022)
Salazar-Pérez et al.	Short-term changes in demersal fish assemblages exploited by an artisanal set gill net fishery in the Caribbean Sea (Colombia)	2020	Ciencias Marinas	https://doi.org/10.7773/cm.v46i1.3041 (accessed on 14 February 2022)
Azzurro et al.	Detecting the occurrence of indigenous and non-indigenous megafauna through fishermen knowledge: A complementary tool to coastal and port surveys	2019	Marine Pollution Bulletin	https://doi.org/10.1016/j.marpolbul.2018.01.016 (accessed on 14 February 2022)

Table A1. *Cont.*

Authors	Title of Article	Year	Journal	DOI or Access Link
Andrade et al.	Fishermen do more than fish: local ecological knowledge of raftsmen about the arboreal species used to construct rafts (Bahia, Brazil)	2018	Journal of Ethnobiology and Ethnomedicine	https://doi.org/10.1186/s13002-018-0279-7 (accessed on 14 February 2022)
Awabdi et al.	Influences of conservation action on attitudes and knowledge of fishermen towards sea turtles along the southeastern Brazil	2018	Marine Policy	https://doi.org/10.1016/j.marpol.2018.06.024 (accessed on 14 February 2022)
Musiello-Fernandes et al.	Small-scale fisheries of the Atlantic seabob shrimp (*Xiphopenaeus kroyeri*): Continuity of commercialization and maintenance of the local culture through making public policies on the Brazilian coast	2018	Ocean and Coastal Management	https://doi.org/10.1016/j.ocecoaman.2018.01.033 (accessed on 14 February 2022)
Paredes and Hopkins	Dynamism in Traditional Ecological Knowledge: Persistence and Change in the Use of Totora (*Schoenoplectus californicus*) for Subsistence in Huanchaco, Peru	2018	Ethnobiology Letters	https://doi.org/10.14237/ebl.9.2.2018.1176 (accessed on 14 February 2022)
Zappes et al.	Artisanal fishing and the franciscana (*Pontoporia blainvillei*) in Southern Brazil: ethnoecology from the fishing practice	2018	Journal of the Marine Biological Association of the United Kingdom	https://doi.org/10.1017/S0025315416001788 (accessed on 14 February 2022)
DeCelles et al.	Using Fishermen's Ecological Knowledge to map Atlantic cod spawning grounds on Georges Bank	2017	ICES Journal of Marine Science	https://doi.org/10.1093/icesjms/fsx031 (accessed on 14 February 2022)
Abreu et al.	Is there dialogue between researchers and traditional community members? The importance of integration between traditional knowledge and scientific knowledge to coastal management	2017	Ocean and Coastal Management	https://doi.org/10.1016/j.ocecoaman.2017.03.003 (accessed on 14 February 2022)
Braga et al.	Sharing fishers 'ethnoecological knowledge of the European pilchard (*Sardina pilchardus*) in the westernmost fishing community in Europe	2017	Journal of Ethnobiology and Ethnomedicine	https://doi.org/10.1186/s13002-017-0181-8 (accessed on 14 February 2022)
Jabado et al.	Is this the last stand of the Critically Endangered green sawfish *Pristis zijsron* in the Arabian Gulf?	2017	Endangered Species Research	https://doi.org/10.3354/esr00805 (accessed on 14 February 2022)
Pita et al.	The use of the traditional ecological knowledge of fishermen, cost-effective tools and participatory models in artisanal fisheries: Towards the co-management of common octopus in Galicia (NW Spain)	2016	Fisheries Research	https://doi.org/10.1016/j.fishres.2015.07.021 (accessed on 14 February 2022)

Table A1. *Cont.*

Authors	Title of Article	Year	Journal	DOI or Access Link
Pinto et al.	How do Artisanal Fishermen Name Fish? An Ethnotaxonomic Study in Northeastern Brazil	2016	Journal of Ethnobiology	https://doi.org/10.2993/0278-0771-36.2.348 (accessed on 14 February 2022)
Manzan and Lopes	The behavior of the estuarine dolphin (*Sotalia guianensis*, van Beneden, 1864) according to fishermen from different fishing environments	2016	Ocean and Coastal Management	https://doi.org/10.1016/j.ocecoaman.2016.06.011 (accessed on 14 February 2022)
Wang et al.	A framework for the assessment of the spatial and temporal patterns of threatened coastal delphinids	2016	Scientific Reports	https://doi.org/10.1038/srep19883 (accessed on 14 February 2022)
Irigoyen and Trobbiani	Depletion of trophy large-sized sharks populations of the Argentinean coast, south-western Atlantic: insights from fishers' knowledge	2016	Neotropical Ichthyology	https://doi.org/10.1590/1982-0224-20150081 (accessed on 14 February 2022)
Gómez Aguirre and Turbay	Relación de una comunidad de pescadores del golfo de Urabá (Colombia) con los ecosistemas de manglar y su conservación	2016	Revista de Estudios Sociales	https://doi.org/10.7440/res55.2016.07 (accessed on 14 February 2022)
Herrera-Racionero et al.	"Us" and "them". Fishermen from Gandia and the loss of institutional legitimacy	2015	Marine Policy	https://doi.org/10.1016/j.marpol.2014.12.018 (accessed on 14 February 2022)
Lloret et al.	How a multidisciplinary approach involving ethnoecology, biology and fisheries can help explain the spatio-temporal changes in marine fish abundance resulting from climate change	2015	Global Ecology and Biogeography	https://doi.org/10.1111/geb.12276 (accessed on 14 February 2022)
Bulian	Invisible landscapes. Winds, experience and memory in Japanese coastal fishery	2015	Japan Forum	https://doi.org/10.1080/09555803.2015.1042012 (accessed on 14 February 2022)
Leeney and Poncelet	Using fishers' ecological knowledge to assess the status and cultural importance of sawfish in Guinea-Bissau	2015	Aquatic Conservation: Marine and Freshwater Ecosystems	https://doi.org/10.1002/aqc.2419 (accessed on 14 February 2022)
Ferreira et al.	Local ecological knowledge of the artisanal fishers on *Epinephelus itajara* (Lichtenstein, 1822) (Teleostei: Epinephelidae) on Ilheus coast-Bahia State, Brazil	2014	Journal of Ethnobiology and Ethnomedicine	https://doi.org/10.1186/1746-4269-10-51 (accessed on 14 February 2022)
Silva et al.	Traditional Ecological Knowledge About Dietary and Reproductive Characteristics of *Tupinambis merianae* and *Hoplias malabaricus* in Semiarid Northeastern Brazil	2014	Human Ecology	https://doi.org/10.1007/s10745-014-9698-9 (accessed on 14 February 2022)

Table A1. *Cont.*

Authors	Title of Article	Year	Journal	DOI or Access Link
Bender et al.	Local Ecological Knowledge and Scientific Data Reveal Overexploitation by Multigear Artisanal Fisheries in the Southwestern Atlantic	2014	PLOS ONE	https://doi.org/10.1371/journal.pone.0110332 (accessed on 14 February 2022)
Côrtes et al.	Ethnoecology, gathering techniques and traditional management of the crab *Ucides cordatus* Linnaeus, 1763 in a mangrove forest in south-eastern Brazil	2014	Ocean and Coastal Management	https://doi.org/10.1016/j.ocecoaman.2014.03.021 (accessed on 14 February 2022)
Golden et al.	Combining Natural History Collections with Fisher Knowledge for Community-Based Conservation in Fiji	2014	PLOS ONE	https://doi.org/10.1371/journal.pone.0098036 (accessed on 14 February 2022)
Castro et al.	Fishermen's perception of Neotropical otters (*Lontra longicaudis*) and their attacks on artisanal fixed fence traps: The case of caicara communities	2014	Ocean and Coastal Management	https://doi.org/10.1016/j.ocecoaman.2014.01.008 (accessed on 14 February 2022)
Mellado et al.	Use of local knowledge in marine protected area management	2014	Marine Policy	https://doi.org/10.1016/j.marpol.2013.10.004 (accessed on 14 February 2022)
Franzini et al.	What do Local People Know About Amazonian Manatees? Traditional Ecological Knowledge of *Trichechus inunguis* in the Oil Province of Urucu, AM, Brazil	2013	Natureza e Conservação	https://doi.org/10.4322/natcon.2013.012 (accessed on 14 February 2022)
Braga and Schiavetti	Attitudes and local ecological knowledge of experts fishermen in relation to conservation and bycatch of sea turtles (reptilia: testudines), Southern Bahia, Brazil	2013	Journal of Ethnobiology and Ethnomedicine	https://doi.org/10.1186/1746-4269-9-15 (accessed on 14 February 2022)
Oliveira	Fishers as advocates of marine protected areas: a case study from Galicia (NW Spain)	2013	Marine Policy	https://doi.org/10.1016/j.marpol.2012.12.024 (accessed on 14 February 2022)
Tamuno and Smith	Fish Species as Eco-indicators in the Comparative Ecological Characterisation of two Creeks in the Central Niger Delta, Nigeria	2013	Water Resources Management	https://doi.org/10.1007/s11269-013-0308-1 (accessed on 14 February 2022)
Magalhães et al.	Local knowledge of traditional fishermen on economically important crabs (Decapoda: Brachyura) in the city of Conde, Bahia State, Northeastern Brazil	2012	Journal of Ethnobiology and Ethnomedicine	https://doi.org/10.1186/1746-4269-8-13 (accessed on 14 February 2022)
Sampaio et al.	Cold-water corals landed by bottom longline fisheries in the Azores (north-eastern Atlantic)	2012	Journal of the Marine Biological Association of the UK	https://doi.org/10.1017/S0025315412000045 (accessed on 14 February 2022)

Table A1. *Cont.*

Authors	Title of Article	Year	Journal	DOI or Access Link
Bezerra et al.	Influence of tides and winds on fishing techniques and strategies in the Mamanguape River Estuary, Paraiba State, NE Brazil	2012	Anais da Academia Brasileira de Ciências	https://doi.org/10.1590/S0001-37652012005000046 (accessed on 14 February 2022)
Barbieri et al.	Interactions between the Neotropical otter (*Lontra longicaudis*) and gillnet fishery in the southern Brazilian coast	2012	Ocean and Coastal Management	https://doi.org/10.1016/j.ocecoaman.2012.03.007 (accessed on 14 February 2022)
Hamilton et al.	Fishing in the dark-local knowledge, night spearfishing and spawning aggregations in the Western Solomon Islands	2012	Biological Conservation	https://doi.org/10.1016/j.biocon.2011.11.020 (accessed on 14 February 2022)
Schumann	Navigating the Knowledge Interface: Fishers and Biologists Under Co-Management in Chile	2011	Society and Natural Resources	https://doi.org/10.1080/08941920.2010.521810 (accessed on 14 February 2022)
Le Fur et al.	Contribution of local fishermen to improving knowledge of the marine ecosystem and resources in the Republic of Guinea, West Africa	2011	Canadian Journal of Fisheries and Aquatic Sciences	https://doi.org/10.1139/f2011-061 (accessed on 14 February 2022)
Rebelo et al.	Fish diet from Manacapuru Big Lake complex (Amazon): a approach starting from the traditional knowledge	2010	Biota Neotropica	https://doi.org/10.1590/S1676-06032010000300003 (accessed on 14 February 2022)
Morais and Silva	Traditional ecological knowledge of fruit trees used for fishery at Estirao Comprido Community, Barao de Melgaco-Panatanal Matogrossense	2010	Biota Neotropica	https://doi.org/10.1590/S1676-06032010000300023 (accessed on 14 February 2022)
Batista and Lima	In search of traditional bio-ecological knowledge useful for fisheries co-management: the case of jaraquis *Semaprochilodus* spp. (Characiformes, Prochilodontidae) in Central Amazon, Brazil	2010	Journal of Ethnobiology and Ethnomedicine	https://doi.org/10.1186%2F1746-4269-6-15 (accessed on 14 February 2022)
Valdés-Pizzini and García-Quijano	Coupling of humans, habitats and other species: a study of the fishers' traditional ecological knowledge (TEK) in La Parguera	2009	Caribbean Journal of Science	https://doi.org/10.18475/cjos.v45i2.a1 (accessed on 14 February 2022)
Caló et al.	Local ecological and taxonomic knowledge of snapper fish (Teleostei: Actinopterygii) held by fishermen in Ilhéus, Bahia, Brazil	2009	Neotropical Ichthyology	https://doi.org/10.1590/S1679-62252009000300007 (accessed on 14 February 2022)
Gerhardinger et al.	Fishers' resource mapping and goliath grouper *Epinephelus itajara* (Serranidae) conservation in Brazil	2009	Neotropical Ichthyology	https://doi.org/10.1590/S1679-62252009000100012 (accessed on 14 February 2022)
Aguilar-Perera et al.	Fishery of the Goliath grouper, *Epinephelus itajara* (Teleostei: Epinephelidae) based on local ecological knowledge and fishery records in Yucatan, Mexico	2009	Revista de Biología Tropical	https://www.scielo.sa.cr/scielo.php?script=sci_arttext&pid=S0034-77442009000300009 (accessed on 14 February 2022)

Table A1. *Cont.*

Authors	Title of Article	Year	Journal	DOI or Access Link
Schafer and Reis	Artisanal fishing areas and traditional ecological knowledge: The case study of the artisanal fisheries of the Patos Lagoon estuary (Brazil)	2008	Marine Policy	https://doi.org/10.1016/j.marpol.2007.06.001 (accessed on 14 February 2022)
Silvano et al.	Contributions of ethnobiology to the conservation of tropical rivers and streams	2008	Aquatic Conservation: Marine and Freshwater Ecosystems	https://doi.org/10.1002/aqc.825 (accessed on 14 February 2022)
McKenna et al.	Accurate Mental Maps as an Aspect of Local Ecological Knowledge (LEK): a Case Study from Lough Neagh, Northern Ireland	2008	Ecology and Society	https://www.ecologyandsociety.org/vol13/iss1/art13/ (accessed on 14 February 2022)
Silvano et al.	When does this fish spawn? Fishermen's local knowledge of migration and reproduction of Brazilian coastal fishes	2006	Environmental Biology of Fishes	https://doi.org/10.1007/s10641-006-9043-2 (accessed on 14 February 2022)
Miller et al.	Cultural consensus analysis and environmental anthropology: Yellowfin tuna fishery management in Hawaii	2004	Cross-Cultural Research	https://doi.org/10.1177%2F1069397104264278 (accessed on 14 February 2022)
Kovacs et al.	Examining local ecological knowledge of hurricane impacts in a mangrove forest using an analytical hierarchy process (AHP) approach	2004	Journal of Coastal Research	http://www.jstor.org/stable/4299337 (accessed on 14 February 2022) (accessed on 14 February 2022)
Torre-Castro and Rönnbäck	Links between humans and seagrasses-an example from tropical East Africa	2004	Ocean and Coastal Management	https://doi.org/10.1016/j.ocecoaman.2004.07.005 (accessed on 14 February 2022)
Poizat and Baran	Fishermen's knowledge as background information in tropical fish ecology: a quantitative comparison with fish sampling results	1997	Environmental Biology of Fishes	https://doi.org/10.1023/A:1007317423165 (accessed on 14 February 2022)

Source: Web of Science.

Table A2. Highlights of articles consulted on traditional ecological knowledge of fishermen.

Authors	Year	Study Object	Highlights
Vásquez-Carrillo and Peláez-Ossa	2021	Fishermen's TEK as an element for understanding marine species fisheries, particularly sea turtles.	Fishermen's TEK is highly accurate and can support fisheries and biodiversity management in Guajira.
Nery et al.	2021	Fishermen's TEK investigation for the perception of fishing dynamics between two hydrographic basins in Brazil.	Fishermen's TEK and scientific knowledge are similar in terms of describing fishing dynamics. The only differences were the specialization of fishing and the use of other species, in addition to Nile Tilapia, to supply fish stocks.
Psuty and Całkiewicz	2021	Fishermen's TEK for fisheries monitoring and management through social science methods	Fishermen's TEK associated with continuous monitoring of bird species to minimize the scale of bycatch
Ladislau et al.	2021	Current situation of ethnoichthyological studies in Brazil.	Significant increase in publications on ethnoichthyology in Brazil, with few studies in the south and center-west regions, which will indicate future efforts to increase information on conservation and resource management.
Bulengela et al.	2020	TEK value of Kigoma fishermen on fish and lake climate-related issues along the northeast shores of Lake Tanganyika.	Future generations should take ownership of fishermen's TEK, as they know the ecological conditions of the lake and pressures from fishing practices, as a way to motivate fishermen to actively participate and contribute to the sustainable management of fisheries resources.
Mota et al.	2020	Fishermen's TEK assists in the collection of unpublished data on the characterization of the fishing and commercial chain of *Cassis tuberosa* (shell).	Fishermen's TEK indicated a population decline of *Cassis tuberosa* (shell) caused by increased fishing.
Jacobi et al.	2020	Scientific knowledge associated with the TEK of fishermen to subsidize information on the diet of arapaima in the Amazon.	Fishermen's TEK revealed consistent information about the feeding ecology of the arapaima, such information can help in management projects in the region.
Purcell et al.	2020	TEK dos pescadores contribuindo para informações sobre a frequência de pesca e captura por unidade de esforço (CPUE), preferências de recursos e percepções do estoque pesqueiro de gastrópodes (trochus) em Samoa	The data revealed that there was a difference in the importance of gastropods between fishermen and fisherwomen. Additionally, it showed the historical colonization of the trochus around Samoa and current trends in population abundance.
Florido del Corral	2020	TEK of fishermen from southern Spain linked to different modes of material and cognitive appropriation systems in the marine environment.	Need to maintain a deep dialog between the fishermen's TEK and scientific knowledge, since the intersection of practices and knowledge can help in the political and economic fields of fisheries in Spain.
Salazar-Pérez et al.	2020	TEK of fishermen assisting in the geographical identification of fishermen and changes over time in gillnets used in the Gulf of Salamanca.	Fishermen's CET revealed that changes over time can influence changes in gillnets, as well as in the period of travel and in the area for fishing, due to this, there is a decrease in the capture rates of artisanal fishermen.

Table A2. *Cont.*

Authors	Year	Study Object	Highlights
Azzurro et al.	2019	Use of fishermen's TEK and port surveys to effectively monitor the landscape of indigenous and non-indigenous megafauna in the Adriatic Sea.	The results revealed that the combination of fishermen's TEK with port studies helped to monitor the emergence of new species in time and space. It was a method of acquiring coherent knowledge that can help improve environmental management and decision-making at a very low cost.
Andrade et al.	2018	Fishermen's TEK is used to describe the tree species applied in the construction of the traditional rafts in three municipalities in Bahia, Brazil.	TEK of the fishermen helped in the knowledge of the tree plant species linked to their fishing activity.
Awabdi et al.	2018	Fishermen's TEK on sea turtles from southeastern Brazilian fishermen; and evaluation of the influence of the National Sea Turtle Conservation Program on fishermen's perception and attitude towards sea turtles.	Fishermen's TEK assists in redefining the development of specific program strategies for fishing communities.
Musiello-Fernandes et al.	2018	Fishermen's TEK helps the elaboration of public policies	TEK of fishermen shows that the shrimp production chain without the presence of intermediaries and with the involvement of the family in the improvement of the species, increases the final value of the product, providing more profit to the fishermen.
Paredes and Hopkins	2018	Fishermen's TEK to create vessels using botanical resources, showing the persistence and changes in the use of totora by the fishing community of Huanchaco.	The TEK modifications show the dynamic quality of this type of knowledge, as they accompany the economic and technological changes caused by the intensification of globalization.
Zappes et al.	2018	Description of the ethnoecology of the franciscana (*Pontoporia blainvillei*) using the fishermen's TEK in Brazil.	TEK of fishermen showed that the environment is used for feeding and reproduction of the species, confirming what the literature presents on the subject. This finding reveals the importance of involving fishermen in promoting scientific and management studies.
DeCelles et al.	2017	Combining fishermen's TEK with traditional scientific data to develop a more holistic understanding of cod spawning in Georges Bank.	The data can support the development of management actions to promote the reconstruction of Georges Bank cod, as well as record information for future studies on spawning and the structure of cod stock.
Abreu et al.	2017	TEK of marine fishermen associated with scientific research carried out in Brazil.	There is dialog between scientific knowledge and TEK, which is essential for the joint search for solutions to social and environmental problems, especially in areas designated as priorities for conservation in the coastal environment.
Braga et al.	2017	Investigate fishermen's TEK in sardine biology and ecology in Portugal.	The ethnoecological data on European sardines provided by local fishermen can be important for the management and conservation of this fishery resource, through an adaptive structure between the actors involved.

Table A2. *Cont.*

Authors	Year	Study Object	Highlights
Jabado et al.	2017	Fishermen's TEK as an analytical tool to monitor the status, uses, and cultural significance of the sawfish.	The study showed the decline of sawfish and Abu Dhabi waters as an important area for monitoring and a base for conservation and recovery, thus mitigating the extinction of the sawfish.
Pita et al.	2016	Fishermen's TEK was tested to map the distribution of fisheries and log GPS data and logbooks to estimate effort intensity and CPUE.	TEK assisted in the elaboration of a long-term co-management plan to guarantee the sustainability of stocks and the profitability of this artisanal fleet.
Pinto et al.	2016	Ethnotaxonomy sought to understand how people identify, name, and classify living organisms, associating the fishermen's TEK with the scientific one.	The results will be useful in the implementation of participatory conservation and management plans; fishermen's TEK and their ethnobiological and ethnotaxonomic systems provided information about fish richness, diversity and bioecology.
Manzan and Lopes	2016	TEK from fishermen helping to collect information on the behavior of aquatic species.	It is necessary to consider the fishermen's TEK to provide information on cetaceans and help in the management and conservation process of the species, especially when there are no scientific records or need to be supplemented.
Wang et al.	2016	Combining fishermen's TEK with regional survey methods provided basic information on the status of a dolphin species in the eastern Guangdong estuary.	Based on the fishermen's statistical and TEK data, it was observed that dolphins are probably geographically isolated, so they are vulnerable to being threatened. The information helps in the construction of strategies to increase the greater effort for the conservation of the species.
Irigoyen and Trobbiani	2016	Fishermen's TEK to analyze the conservation status of sharks in the coastal region of Argentina.	The fishermen's TEK revealed the variation in abundance and critical status of the species, indicating the need to implement management strategies, especially for the endangered tiger shark in the region.
Gómez Aguirre and Turbay	2016	Fishermen's TEK combination to help conserve mangrove ecosystems.	Fishermen's TEK indicated for constructing an environmental education strategy to ensure the protection of mangroves
Herrera-Racionero et al.	2015	Fishermen's TEK analyzed some of the possible causes of the recognized failure of fisheries policy in the field of traditional fishing.	The biggest problem was the lack of legitimacy of political organizations linked to fishermen. It is important to value fishermen's TEK to implement an effective fishery.
Lloret et al.	2015	Fishermen's TEK as an information tool to predict the impact of climate change on marine ecosystems or how fish and other species are adapting to rising sea temperatures.	The combination of fishermen's TEK with other data collection techniques provides a new approach to observing changes in fish diversity and abundance in relation to climate change.
Bulian	2015	Fishermen's TEK associated with other institutional knowledge, such as meteorology, provides information on the complex situation of the winds and their influences on fisheries in the coastal region of Japan.	The results showed that the fishermen's TEK is revolutionary and if it does not try to overlap with scientific knowledge, it actually adds to such knowledge.

Table A2. *Cont.*

Authors	Year	Study Object	Highlights
Leeney and Poncelet	2015	Fishermen's TEK as a tool to provide past and current data that can support scientific studies in situations where there is no information, in addition, it can show local actions in relation to species, such as sawfish.	The study showed important information about the sawfish and the existing concerns for its conservation. Fishermen's TEK helped direct future academic studies to locate and protect sawfish in Guinea-Bissau.
Ferreira et al.	2014	TEK from fishermen to contribute information on the conservation of marine ecosystems and their endangered species.	Fishermen's TEK proved to provide valuable information for the conservation of endangered species, by revealing important biological data that can support the development of actions for participatory and sustainable management of marine resources.
Silva et al.	2014	Relationship between fishermen's TEK and conventional knowledge, based on ethnoecological and ecological information on the diet and reproduction of two fish species in the semi-arid northeast of Brazil.	Fishermen's TEK on diet and reproduction of *Tupinambis merianae* and *Hoplias malabaricus* was similar to biological data collected in academic research.
Bender et al.	2014	Combine fishermen's TEK information from fisheries landing data and underwater visual census to assess fish species decline in southeastern Brazil.	The fishermen's TEK is important to highlight data from the past, organize the present and the future, because of subsidizing public awareness of the subject.
Côrtes et al.	2014	Combining mangrove fishermen's TEK with scientific knowledge plays a critical role in the development and implementation of management plans in these ecosystems.	The fishermen's TEK added to scientific knowledge helps researchers to understand environmental conflicts and the interests of a community, in addition to providing subsidies for the definition of conservation strategies and the elaboration of laws and, thus, improving management plans.
Golden et al.	2014	Fishermen's TEK as a tool to improve conservation planning in developing regions.	The association of fishermen's TEK with ecological data offered project models for future conservation of natural ecosystems.
Castro et al.	2014	TEK was used to verify caiçara fishermen's perception of neotropical otters and their attacks on fixed fence traps in Cananéia and Comprida islands, in São Paulo, Brazil.	Fishermen's TEKs were an important source of information for developing neotropical otter management and conservation strategies.
Mellado et al.	2014	TEK of fishermen to understand the ecological issues related to fishing within the Rocha Lagoon and to highlight an existing conflict between two fishing communities.	The fishermen's TEK highlighted the main factors that should be considered in the elaboration of the management plan. It also provides inter-community debate and increases the acceptance of the future management plan.
Franzini et al.	2013	Fishermen's TEK on the Amazonian manatee (*Trichechus inunguis*), listed as Vulnerable on the IUCN Red List.	Fishermen have robust knowledge of the biology and behavior of the Amazonian manatee, which is essential information to aid conservation plans in the Amazon.
Braga and Schiavetti	2013	TEK of fishermen on sea turtles and attitudes toward conservation and bycatch in southern Bahia, Brazil.	Monitoring spawning areas, preservation of traditional practices, strategies to moderate the use of fisheries resources and local ecological knowledge/attitudes can provide data to improve conservation and management practices for sea turtles.

Table A2. *Cont.*

Authors	Year	Study Object	Highlights
Oliveira	2013	The fishermen's TEK with the partnership with biologists and social scientists, environmentalists and members of the government contributing to the elaboration of a proposal of marine reserve in Galicia.	The inclusion of the fishermen's TEK in decision-making and in the construction of the reserve proposal promoted understanding of the benefits and compliance with fisheries legislation.
Tamuno and Smith	2013	Exploration of the TEK of experienced fishermen was associated with statistical data to collect data on the ecological characteristics of two surface waters in the same geoecological zone, in addition to verifying the spatial and temporal variation of the distribution of fish species in these streams	The fishermen's TEK together with the statistical data revealed that there were no statistically significant ecological differences between the two streams.
Magalhães et al.	2012	TEK records of crab collectors on the north coast of Bahia, northeast Brazil.	TEK of crab collectors is an important source of information that should be considered in studies of management and sustainable use of fisheries resources in the north coast of Bahia.
Sampaio et al.	2012	TEK of fishermen, also captains of boats, as a tool to identify the main species of cold-water corals in the Azores, Portugal.	TEK confirmed that the corals recorded were representative of its experience and revealed general agreement that there has been a decrease in bycatch of Cold-water corals in traditional fisheries.
Bezerra et al.	2012	Fishermen's TEK to identify tidal and wind ratings as well as their fishing strategies and techniques.	The fishermen's TEK revealed its importance in the elaboration of management plans and conservation studies in northeast Brazil.
Barbieri et al.	2012	Fishermen's TEK as a tool for information on the biology and conservation issues of the neotropical otter (*Lontra longicaudis*)	The fishermen's TEK helped mitigate fish depredation caused by otters in gillnets, as well as helped develop measures to compose fisheries management.
Hamilton et al.	2012	Fishermen's TEK collaborative effort and scientific knowledge to achieve better management results.	The combination of TEK and science was used to implement effective management measures.
Schumann	2011	Examined the similarities and differences between the biological knowledge and TEK of small-scale fishermen and the professional biologists assigned to work with them in a crustacean co-management program in Chile.	There is no dichotomy between fishermen's TEK and biological knowledge, and there needs to be an integration of both forms of knowledge.
Le Fur et al.	2011	Assessment of fishermen's TEK as a potential source of information on coastal ecosystem functioning in the Republic of Guinea.	The fishermen's TEK can be used as a supplementary source of information on the functioning of the coastal ecosystem in the Republic of Guinea
Rebelo et al.	2010	TEK of fishermen on the diet of fish caught for feeding families and marketing.	It provided detailed information on the food base of some species, such as tambaqui, tucunaré, pacu, acara-acu, curimata, aruana, matrinxa, piranha, and pirapitinga. The laboratory analyses and specific literature are similar. This information can be useful for studying lake management.

Table A2. *Cont.*

Authors	Year	Study Object	Highlights
Morais and Silva	2010	TEK of fishermen related to fruit trees in Patanal, Brazil	The study showed that this Pantanal community has TEK on the fruit trees that are the base of the food chain of commercially valuable fish species.
Batista and Lima	2010	Association of scientific knowledge with the fishermen's TEK as a source of information on the dynamics of aquatic resources and environments, fundamental to enable the co-management of fisheries resources.	Scientific knowledge data and TEK have affinity for the following items: length of the first sexual maturation; spawning type; parental care; trophic relationships; migratory behavior; and some aspects of mortality and growth of the species
Valdés-Pizzini and García-Quijano	2009	TEK of fishermen to show the habitat and relationship with the species as *Lutjanus analis.*	Fishermen's TEK can be an important component of the information used in ecosystem-based management, as well as support knowledge about the local ecology and health of fisheries resources.
Caló et al.	2009	Combination of fishermen's TEK and taxonomic of the species identified as red in the municipality of Ilhéus, Bahia, Brazil.	The fishermen's TEK helped identify the fish's eating habits, indicating that most were carnivorous, in agreement with the existing data in the specialized literature consulted. The inclusion of fishermen's TEK for management plans and decision-making.
Gerhardinger et al.	2009	Fishermen's TEK as a tool for mapping and describing *Epinephelus itajara*, in southern Brazil	TEK's contribution in mapping fishermen's resources provided a means of exchanging information between various disciplines, maintaining methodological rigor in a clear and direct way by involving fishermen's knowledge.
Aguilar-Perera et al.	2009	TEK of fishermen to elucidate the absence of data on *Epinephelus itajara* and determination of its fishing status	The fishermen's TEK is an important source of information for reinterpreting the history of *E. itajara* fishing in the north of the Yucatan Peninsula.
Schafer and Reis	2008	Fishermen's use TEK to identify fishing areas in Patos Lagoon, Brazil.	TEK of fishermen is rich in information, revealing their solid relationship with the environment where they live, and can be used as a potential tool for fisheries management.
Silvano et al.	2008	Linking the TEK of fishermen and farmers with basic ethnobiological research for the conservation of Brazilian streams.	The TEK of fishermen and farmers contributed to the formulation of management measures for the ecosystems of the Negro River and the Atlantic Forest, because of guaranteeing the conservation of the rivers and their associated floodplain forests.
McKenna et al.	2008	Comparison of mental maps made by TEK of fishermen with maps made by science.	The result revealed high accuracy of the maps prepared by the fishermen's TEK.
Silvano et al.	2006	Fishermen's TEK related to fisheries resources to improve tropical artisanal fisheries management, Brazil.	The results revealed that using fishermen's TEK is a strategy to collect coherent, cheap, and agile information, which can be incorporated to improve fisheries management.
Miller et al.	2004	Comparison of fishermen's TEK and the knowledge of fisheries scientists in Hawaii regarding stock structure, fish movement, resource abundance, stock condition, and fisheries interactions.	The data showed that there is a consensus between the fishermen's TEK and ecological scientific knowledge.

Table A2. *Cont.*

Authors	Year	Study Object	Highlights
Kovacs et al.	2004	Fishermen's TEK on hurricane impact on a tree based on three attributes: main stem condition, main stem diameter, and species in the mangrove forest of the Mexican Pacific.	Fishermen's TEK provided data to support the scientific data.
Torre-Castro and Rönnbäck	2004	Identification and description of the interaction between humans and seagrass on the east coast of Zanzibar.	Fishermen's TEK was substantial for the use and management approach of the seascape.
Poizat and Baran	1997	Fishermen's TEK on fish occurrence patterns at various spatial-temporal scales.	Fishermen's TEK can be used as a preliminary study to help define fish sampling in tropical rivers and estuaries.

Source: Web of Science.

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