Use of ichthyofauna by artisanal fishermen at two protected areas along the coast of Northeast Brazil

Pinto et al.
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Abstract

Background: Fishing is one of the oldest human activities and constitutes a source of income and livelihood for millions of people, particularly in coastal regions. This study aimed to characterize the types of fish use and test whether there is a relationship between uses of fish in the communities studied.

Methods: This study was conducted during the months of January to October 2013, on the beaches of Tamandaré and Batoque, both located in Northeast Brazil. Information was collected through interviews with 75 artisanal marine fishermen on the fishes they knew and their forms of use.

Results: The fishermen interviewed were male, between 22 and 84 years old, and they had been fishing for over 10 years and had a low educational level. Fishermen from Tamandaré mentioned 339 popular fish names, representing 222 taxa, while Batoque fishermen mentioned 305 popular fish names, representing 215 taxa. Six types of uses of fish were characterized: food, commercial, medicinal, handicrafts, spiritual-religious purposes and aquarium. It was found that there were multiple uses for fish and that there was a relationship between these different uses, reinforcing the importance that fish have on the culture and economic activities of fishing communities.

Conclusions: Artisanal fishing should be understood as a cultural activity, because the different and multiple uses fish make up the dynamics of fishing communities. Just as in the areas of this study, some of these communities are included in protected areas and, therefore, fishermen must be involved in the development and implementation of management plans of these units.

Keywords: Artisanal fishing, Local ecological knowledge, Conservation

Background

Archaeological, historical and ethnographic studies show that aquatic resources have been exploited as sources of products useful to humans since ancient times, highlighting the importance of fishing to humankind [1,2]. Such importance has been perpetuated throughout human history, and today, millions of people worldwide depend directly or indirectly on the fishing sector as a source of income and livelihood [3]. In Brazil alone, there are over a million fishermen located in the vicinity of marine and freshwater environments, from north to south [4].

However, like any other form of exploitation of natural resources, fishing causes pressure on the species caught, underscoring the urgent need to search for strategies for sustainable use of resources to enable the continuity of artisanal fisheries, the production of which in recent years has suffered a drastic decline [5]. This has caused a global crisis in the fisheries sector, strongly affecting the quality of life and sustainability of social and economic activities of people of the sea, mainly artisanal fishermen [6].

The uncontrolled exploitation of natural resources required conservation measures, which were proposed in 1992, in the Convention on Biological Diversity (CBD) [7]. One of the actions for in situ conservation was proposed by the CBD to establish a system of protected areas or areas where special measures would be taken to conserve biological diversity [7]. Accordingly, the Brazilian government, by Law No. 9985/2000 establishing the National System of Conservation Units of Nature [8], initiated a process for the creation of conservation units in the country.
However, the implementation of these protected areas has caused environmental conflicts, especially in those areas where there is overlap with the territory of traditional communities. To minimize these conflicts, after the Conference of the Parties to the Convention on Biological Diversity in 2004, the Brazilian government created the National Plan for Protected Areas [9], which establishes guidelines for environmental conservation based on the involvement of the people in and around the Conservation Units.

One relevant aspect in the definition of traditional cultures, among them the culture of artisanal fishermen, is the existence of systems for the management of natural resources, marked by respect for natural cycles and their exploitation within the recovery capacity of species used [10]. In this sense, the integration of these cultures with the environment can be an efficient way of preserving the ecological system, since their interests rest on the maintenance of ecosystems from which they derive their daily livelihood [11].

Given the scenario described above, the analysis of interactions between humans and fish through ethnoichthyological studies, is essential to think about ways of sustainable use, allowing the preservation of ichthyofaunal resources and the maintenance of the fishing culture, especially in protected areas. Ethnoichthyology aims to describe the knowledge about fish of a particular social group [12], providing support for the conservation of fish populations, by recording, recognizing and appreciating the ecological knowledge of fishermen [13].

The usefulness of fisheries resources for humans is diverse, especially as a protein source. Nevertheless, fish are used for various purposes, including commercial, handicrafts and medicinal purposes [13-15]. Most ethnoichthyological studies in Brazil have focused on fish used for food [16-19], and there are few studies on other uses of fish.

The present study was conducted in two different fishing communities on the northeastern coast of Brazil, with the following aims: i) to document and compare the richness of fish species according to the ichthyological knowledge of fishermen in the areas surveyed; ii) to characterize the types of fish used; iii) to assess the conservation status of the species recorded; and iv) to test whether there is a relationship between uses of fish in the communities studied. It was expected that the main use of fish was for food, and that other uses (medicinal purposes, making crafts, magical-religious purposes and aquarium) were associated with the byproducts of those fish used for food.

**Methods**

**Study areas**

The research was conducted with artisanal fishermen of Tamandaré Beach, in Pernambuco State, and Batoque Beach, in Ceará State, both on the coast of Northeast Brazil (Figure 1). Tamandaré Beach (8°45’10.81”S and 35°5’38.60”W) is located in the municipality of Tamandaré on the southern coast of Pernambuco, 110 km from the capital, Recife. The municipality of Tamandaré has 20,715 inhabitants [20] and is one of the major tourist centers of the Northeast, with infrastructure to meet the needs of natives, tourists and researchers. It is also harbors the Center for Research and Management of Fisheries Resources of the Northeast Coast (CEPENE), the Institute of the Environment and Renewable Natural Resources (IBAMA) and the Coastal Reef Institute (linked to the Federal University of Pernambuco), which influence the development and oversight of local artisanal fisheries.

Tamandaré Beach is in two protected areas: Municipal Natural Park of Fort Tamandaré and Coral Coast Environmental Protected Area. The Coral Coast Environmental Protection Area is the first and largest federal conservation unit to protect part of the coastal reefs.

Batoque Beach (4°0’06.13”S and 38°13’52.07”W) is located in the municipality of Aquiraz, east coast of Ceará State, and is 54 km from the capital, Fortaleza. Aquiraz has a population of 72,628 inhabitants [20], and it is characterized by high real estate speculation and tourism on its beaches. However, Batoque is a small fishing village, part of the Extractive Reserve (RESEX) of Batoque, created by Presidential Decree of June 5, 2003. RESEX covers 601 hectares and has a population of approximately 460 inhabitants and a few commercial establishments.

The study areas were chosen because they are in protected areas and have artisanal fishing as one of the main economic activities. Furthermore, the two beaches show socioeconomic and environmental disparities, suggesting the existence of differences in fishing activity and ichthyological knowledge of the fishermen. According to information from the Z-5 colony of fishermen, there are 40 registered artisanal fishermen fishing at Tamandaré Beach in motor boats or rowboats. In Batoque, according to the Association of Fishermen and shellfish gatherers of the Batoque RESEX, there are 48 artisanal fishermen who fish primarily in sail boats, locally called “jangadas”. The study was conducted with 36 fishermen (90%) of Tamandaré Beach and 39 (81%) of Batoque Beach, totaling 75 artisanal marine fishermen, whose catch is mostly fish.

**Data collection**

The data related to socioeconomic information and knowledge about the ichthyofauna richness recognized and used locally were obtained using structured and semi-structured interviews, complemented by free interviews [21] and informal conversations with the fishermen. Before each interview, we explained the objectives and nature of the study and requested permission for the interviews. The study was approved by the Ethics Committee on Research
Involving Human Subjects at the Federal University of Pernambuco (CAAE 05757512.5.0000.5208).

The first contacts with fishermen of Tamandaré and Batoque were through the aid of key informants [22] selected among all informants to cooperate more actively in research and to facilitate the contact with the community. Other respondents were indicated by the "snowball" technique [23], in a stratified sample that included only marine fishermen of each study location.

The interviews took place monthly from January to October 2013 and were conducted in the homes of the fishermen or on the beach and had an average duration of 40 minutes per respondent. To understand the socio-economic context of the fishing activity, we initially determined the profile of the fishermen on the basis of structured forms with reference to the name, age, schooling and income of fishermen, economic activities developed by them, and also the time they practiced their fishing activity.

Fishermen were asked about the fish they knew and used or were aware of any type of use for the fish, through three supplementary interviewing techniques - Free listed items [24], Nonspecific prompting and Reading Back the list [25]. Direct observations and informal interviews with fishermen were conducted during the fish landing.

The identification of fish was performed using specimens as well as photographs and drawings shown to the fishermen, as proposed by Lopes, Silvano and Begossi [26]. The specimens were identified with the aid of information from the database of the Fisheries Statistics Project (ESTATPESCA) of FishBase (www.fishbase.org) and Coastal Reefs Institute, as well as research on fish populations in Northeast Brazil [27,28]. Cross identification was carried out, where fishermen identified specimens of fish previously identified by other respondents [29]. This technique was applied with three fishermen in each community, which demonstrated greater knowledge, from the number of citations and descriptions of fish in interviews.

Data analysis
Analyses of species richness were performed using Primer 6.1 software. The chi-square test ($\alpha = 5\%$), using BioEstat 5.3 software, was performed to determine any differences between the two fishing communities in richness of the fish fauna. The use value (UV) was determined for each species recorded [30], which allowed us to demonstrate the relative importance of the species known locally, regardless of the opinion of the researcher. UV was calculated using the following formula: $UV = \sum U/n$, where $U =$ number of citations per species and $n =$ number of informants.

Additionally, we checked the conservation status of the species recorded in accordance with the list of endangered species of the International Union for Conservation of Nature (IUCN) in 2014 [31], the 2008 red list of the Brazilian Institute of Environment and Renewable Natural Resources [32], and the 2004 national list of species of...
aquatic invertebrates and fish overexploited or threatened overexploitation [33].

In cross-identification, the number of matches between the identifications of fishermen was considered. The fish that showed disagreements in identification were later identified by the consensus of a group of three to five fishermen.

In order to verify the similarity of the types of uses of fish, using Primer 6.1 software, it was performed cluster analysis with Euclidean Distance, represented by horizontal dendograms. The vertical lines represent the groups attached in descending order of similarity, while the horizontal lines indicate the distances between groups that were formed. The lower the value of the Euclidean Distance, the greater is the similarity between clusters.

Results
Socioeconomic profile of fishermen
The fishermen interviewed (n = 75) were male and aged between 22 and 84 years, with an average of 55 and 50 years in Tamandaré at Batoque, respectively. Some factors, according to the fishermen, explained why the disinterest of the younger men with fishing and the search for new employment opportunities, such as: 1) lack of government investment and subsidies for the storage, processing and selling of local fish; 2) the low market value of local fish, and 3) the weak supervision of illegal and commercial fishing.

Only six fishermen were less than 30 years old and fishing in the Batoque Beach, where there are few employment opportunities in comparison with the Tamandaré Beach. The average monthly income of fishermen is R$ 326 for Tamandaré and R$ 530 for Batoque. According to the fishermen, income depends on the amount and quality of fish, as well as weather and sea, which influence fishing. Of the total respondents, 88% work exclusively in fishing, and 12% work in other activities such as masons, carpenters, sailors, merchants or home custodians (people who are in charge of taking care of a house belonging to people who do not live in the community). Among the interviewed fishermen, 11 fished less than 20 years and 64 fished for over 20 years.

With regard to education, 15 Tamandaré fishermen were illiterate and 21 did not complete elementary school. In Batoque, 17 fishermen were illiterate, 20 did not complete primary school, and two did not complete high school.

Fishermen’s knowledge of the fish community richness
Fishermen Tamandaré mentioned 339 popular names of fish, representing 222 taxa (202 species and 20 identified at the genus level). Batoque fishermen mentioned 305 popular names of fish, representing 215 taxa (194 species and 21 identified at the genus level). There was no statistically significant difference (p = 0.737) between the two communities with regard to fish community richness.

In short, the fish that had 100% confirmation by fishermen in the cross-identification technique were recorded at the species level, whereas fish that had divergent identifications were recorded at the genus level.

Additionally, it was not possible to identify 24 fish cited by the Tamandaré fishermen and 18 fish cited by the Batoque fishermen, due to the difficulty they had in identifying fish through photographs and drawings, and also because it was not possible to collect them. There were cases where a popular name of a fish corresponded to one species and where a single species corresponded to several common names.

Types of uses of fish
Fishermen mentioned six types of uses of fish: food, commercial, medicinal, handicrafts, spiritual-religious purposes and aquarium. It is noteworthy that the fishermen cited commercial use only directed at fish for food consumption.

There were 207 species with use citations in Tamandaré and 209 in Batoque (Tables 1 and 2). The general use value (considering all the citations for different uses) of these species ranged from 0.02 to 1.94 in Tamandaré, and 0.02 to 1.92 in Batoque.

The fishermen cited 13 fish without current use, although some of these had had past use (Tables 1 and 2). One example is the “cação-espadarte” (Pristis sp.). According to the reports of the Batoque fishermen, this fish has not been found in the region for more than 40 years, although it used to be caught in large numbers and sold for food and handicraft purposes. Currently, the conservation status of this species is categorized as critical by the IUCN [31].

Citations of uses for food involved 92% of the species recorded in Tamandaré and 96% of species in Batoque. While for commercial purposes, 85% of the recorded species were cited by the Tamandaré fishermen and 92% by the Batoque fishermen. These data reveal that in Batoque, fishermen use a more diverse number of fish for food and selling than in Tamandaré where food consumption and trade are more centered on certain species.

In Tamandaré, fish with more citations for food and commercial use were “arabaiana”, also called locally “gurubatá” or “peixe-rei” (Elagatis bipinnulata) (n = 35), “dourado” (Coryphaena sp.) (N = 33) and “piraúna” (Cephalopholis fulva) (n = 33). In Batoque, the fish with the most citations for food and commercial use were the marine “bagre-giriaçu” (Genidens genidens) (n = 38), “sardinha-da-noite” (Pellona harroweri) (n = 36), “cioba” (Lutjanus analis) (n = 34), “biquara” (Haemulon plumieri) (n = 34) and “serra” (Scomberomorus sp.) (n = 34).

Some of the species recorded for commercial purposes are classified as vulnerable, endangered and critically
Table 1 Fish species recorded through interviews with marine artisanal fishermen of Tamandaré Beach, Pernambuco, Brazil

| Family          | Scientific name                        | Name in English* | Local name                      | IUCN (2014) | IBAMA (2004) | F | Co | Med | H | S-R | Aq | Use values |
|-----------------|----------------------------------------|-----------------|--------------------------------|-------------|--------------|---|----|-----|---|-----|----|------------|
| Acanthuridae    | Acanthurus bahianus (Castelnau, 1855)  | Ocean surgeon   | Caraúna                       | LC          | x            | x             | 0.61                        |
| Acanthuridae    | Acanthurus chirurgus (Bloch, 1787)     | Doctorfish      | Caraúna-preta                | LC          | x            | x             | 0.06                        |
| Acanthuridae    | Acanthurus coeruleus (Bloch & Schneider, 1801) | Blue tang surgeonfish | Caraúna-azul | LC          | x            | x             | 0.06                        |
| Achiridae       | Achiurus lineatus (Linnaeus, 1758)     | Lined sole      | Sóia-redonda                 | NE          | x            | x             | 0.00                        |
| Albulidae       | Albula nemoptera (Fowler, 1911)        | Threadfin bonefish | Ubarana-boca-de-rato          | DD          | x            | x             | 0.11                        |
| Albulidae       | Albula vulpes (Linnaeus, 1758)         | Bonefish        | Ubarana                       | NT          |             |               | 0.06                        |
| Antennariidae   | Antennarius multiocellatus (Valenciennes, 1837) | Longlure frogfish | Aniquim-mole                     | NE          |             |               | 0.00                        |
| Aridae          | Genidens genidens (Cuvier, 1829)       | Guri sea catfish | Bagre-ariaçu; Bagre-giriaçu; giriaçu; junaçu; Bagre-branco; Bagre-miguel-raio | LC          | x            | x             | 0.94                        |
| Aridae          | Bagre bagre (Linnaeus, 1766)           | Coco sea catfish | Bagre-bardecha; Bagre-bandeira; Bagre-fita | NE          | x            | x             | 0.39                        |
| Aridae          | Aspistor quadriscutis (Valenciennes, 1840) | Bressou sea catfish | Bagre-amarelo; Bagre-mestre-mané | NE          | x            |                | 0.33                        |
| Aridae          | Sciades proops (Valenciennes, 1840)    | Crucifex sea catfish | Bagre-corre-costa             | NE          | x            | x             | 0.17                        |
| Aridae          | Cathorops spixii (Agassiz, 1829)       | Madamango sea catfish | Bagre-bandim; Bagre-manguim | NE          | x            | x             | 0.11                        |
| Aridae          | Sciades herzbergii (Bloch, 1794)       | Pernecou sea catfish | Bagre-barba-roxa              | NE          | x            |                | 0.06                        |
| Balistidae      | Balistes vetula (Linnaeus, 1758)       | Queen triggerfish | Cangulo-amarelo; Cangulo-verdadeiro; cangulo-do-papo-amarelo; Cangulo-papo-louro; Cangulo-azul | VU          | x            | x             | 0.89                        |
| Balistidae      | Balistes capriscus (Gmelin, 1788)      | Grey triggerfish | Cangulo-fernando; Cangulo-fernandi; cangulo-branco; Cangulo-papo-branco; Cangulo-patriota | NE          | x            | x            | 0.72                        |
| Balistidae      | Canthidermis sufflamen (Mitchell, 1815) | Ocean triggerfish | Cangulo-mané-do-arroio; Cangulo-mané-de-arroz; Cangulo-preto; Cangulo-guiné | NE          | x            | x             | 0.50                        |
| Balistidae      | Melichthys niger (Bloch, 1786)         | Black triggerfish | Cangulo-mané-do-arroio; Cangulo-mané-de-arroz; Cangulo-preto; Cangulo-guiné | NE          | x            | x             | 0.50                        |
| Batrachoidiidae | Amphichthys cryptocentrus (Valenciennes, 1837) | Bocon toadfish | Pacamon; Pocomão         | LC          | x            | x             | 0.28                        |
| Batrachoidiidae | Batrachoides surinamensis (Bloch & Schneider, 1801) | Pacuma toadfish | Pacamon; Pocomão | NE          | x            | x             | 0.28                        |
| Batrachoidiidae | Trinidad Tob                           |                 | Pacamon; Pocomão             | NE          | x            | x             | 0.28                        |
| Table 1 Fish species recorded through interviews with marine artisanal fishermen of Tamandaré Beach, Pernambuco, Brazil (Continued) |
|---------------------------------------------------------------|
| **Belonidae**  |
| *Tylosurus acus* (Lacepède, 1803)  | Agujon needlefish | Aguilhão-branco | NE | x | x | 0,06 |
| **Belonidae**  |
| *Strongylura timucu* (Walbaum, 1792)  | Timucu | Aguilhão-espinha-verde | NE | x | x | 0,17 |
| **Bothidae**  |
| *Bothus spp.*  | Plate fish | Sóia | NE | 0,00 |
| **Carangidae**  |
| *Elochomus bipinnulatus* (Quoy & Gaimard, 1825)  | Rainbow runner | Arabaiana; Gurubatá; Guiubatá; Peixe-rei | NE | x | x | 1,94 |
| **Carangidae**  |
| *Caranx cryos* (Mitchill, 1815)  | Blue runner | Guarassuma; garassuma; Chincharro; Xerelete | LC | x | x | 1,33 |
| **Carangidae**  |
| *Decapterus macarellus* (Cuvier, 1833)  | Mackerel scad | Garapau | NE | x | x | 1,11 |
| **Carangidae**  |
| *Caranx latus* (Agassiz, 1831)  | Horse-eye jack | Garacimbora; Aracimbora; Garachimbora; Guachimbora | NE | x | x | 0,67 |
| **Carangidae**  |
| *Alectis ciliaris* (Bloch, 1787)  | African pompano | Galo-de-penacho; Galo-do-alto; Galo-de-fita | LC | x | x | 0,33 |
| **Carangidae**  |
| *Caranx ruber* (Bloch, 1793)  | Bar jack | Xaréu-preto; Garajuba-branca | NE | x | x | 0,28 |
| **Carangidae**  |
| *Trachinotus spp.*  | Floripa pompano | Pampo; Piraroba | NE | x | x | 0,22 |
| **Carangidae**  |
| *Caranx sp.*  |  |  |  |  |  |  |
| **Carangidae**  |
| *Seriola dumerili* (Risso, 1810)  | Greater amberjack | Olhete; Arabaiana-cachorro | NE | x | x | 0,17 |
| **Carangidae**  |
| *Seriola rivoliana* (Valenciennes, 1833)  | Longfin yellowtail | Arabaiana-chata | NE | x | x | 0,17 |
| **Carangidae**  |
| *Oligoplites palometa* (Cuvier, 1832)  | Maracaibo leatherjacket | Tibiro; Timbióro | NE | x | x | 0,11 |
| **Carangidae**  |
| *Oligoplites saliens* (Bloch, 1793)  | Castin leatherjacket | Tibiro; Timbióro | NE | x | x | 0,11 |
| **Carangidae**  |
| *Caranx sp.*  |  |  |  |  |  |  |
| **Carangidae**  |
| *Chloroscombrus chrysurus* (Linnaeus, 1766)  | Atlantic bumper | Pelombeta; Pilombeta; Palombeta | NE | x | x | 0,17 |
| **Carangidae**  |
| *Seriola australis* (Valenciennes, 1833)  | Yellowtail amberjack | Arabaiana-ama-arela; Arabaiana-preta | NE | x | x | 0,11 |
| **Carangidae**  |
| *Seriola fasciata* (Bloch, 1793)  | Lesser amberjack | Arabaiana-roliça; Arabaiana-branca | NE | x | x | 0,06 |
| **Carcharhinidae**  |
| *Galeocerdo cuvier* (Péron & Lesueur, 1822)  | Tiger shark | Caçao-pintadinho; Caçao-pintado; Jaguar; Caçao-tigre; Tubarão-tigre | NT | x | x | 0,72 |
| **Carcharhinidae**  |
| *Carcharhinus falciformis* (Müller & Henle, 1839)  | Silky shark | Caçao-aba-preta; Caçao-sicuri; Galha-preta; Tubarão-galha-preta; Tubarão-aba-preta; Caçao-flamengo | NT | x | x | 0,61 |
| **Carcharhinidae**  |
| *Carcharhinus limbatus* (Müller & Henle, 1839)  | Blacktip shark | Caçao-aba-preta; Caçao-sicuri; Galha-preta; | NT | x | x | 0,61 |
### Table 1 Fish species recorded through interviews with marine artisanal fishermen of Tamandaré Beach, Pernambuco, Brazil (Continued)

| Family               | Species                                      | Common Names                  | Status   | Abundance |
|----------------------|----------------------------------------------|--------------------------------|----------|-----------|
| Carcharhinidae       | Carcharhinus leucas (Müller & Henle, 1839)  | Bull shark; Cãcao-galha-preta; Cãcao-abas-preta; Cãcao-flamengo | NT       | x x 0,44  |
| Carcharhinidae       | Prionace glauca (Linnaeus, 1758)             | Blue shark; Cãcao-azul; Cãcao-barriga-mole | NT       | x x 0,33  |
| Carcharhinidae       | Carcharhinus spp.                            | Cãcao-lombo-preto; Sem avaliação |          | x x 0,06  |
| Carcharhinidae       | Carcharhinus sp.                             | Cãcao-tolah; Sem avaliação    |          | 0,00      |
| Carcharhinidae       | Rhizoprionodon lalandi (Valenciennes, 1839) | Brazilian sharpnose shark; Caçao-verga-de-ouro | DD       | 0,00      |
| Carcharhinidae       | Rhizoprionodon porosus (Richardson, 1836)   | Caribean sharpnose shark; Caçao-verga-de-ouro | LC       | 0,00      |
| Centropomidae        | Centropomus pectinatus (Poey, 1860)          | Tarpon snook; Camurim-branco; Camurim-impim; Camurim-tábuia | NE       | x x 0,67  |
| Centropomidae        | Centropomus undecimalis (Bloch, 1792)        | Common snook; Camurim-áçu; Camurim-corcundo; Camurim-preto | NE       | x x 0,61  |
| Chaetodontidae       | Chaetodon spp.                               | Spotfin butterflyfish; Parum-jandáia; Peixe-prato; Pintado | LC       | 0,00      |
| Clupeidae            | Opisthionema ogilvum (Lesueur, 1818)         | Atlantic thread herring       | NE       | x x 0,56  |
| Clupeidae            | Harengula jaguana (Poey, 1865)               | Scaled herring; Sardinha-cascuda; Sardinha-cascagrossa | NE       | x x 0,44  |
| Clupeidae            | Sardinella undecimalis (Valenciennes, 1847)  | Round sardinella; Sardinha-maromba | NE       | x x 0,11  |
| Clupeidae            | Sardinella brasiliensis (Steindachner, 1879)| Brazilian sardinella; Sardinha-rolícia | NE       | x x 0,06  |
| Coryphaenidae        | Coryphaena equiellis (Linnaeus, 1758)        | Pompano dolphinfish; Dourado; Dourado-azedinho | LC       | x x 1,86  |
| Coryphaenidae        | Coryphaena hippurus (Linnaeus, 1758)         | Common dolphinfish; Dourado; Dourado-cabeça-de-bolina | LC       | x x 1,86  |
| Coryphaenidae        | Symphurus spp.                               | Spotted fin tonguefish; Sória-linguado; Linguado | NE       | 0,00      |
| Dasyatidae           | Dasyatis guttata (Bloch & Schneider, 1801)   | Longnose stingray; Arraia-branca; Arraia-couro-de-lixa | DD       | x x 0,33  |
| Dasyatidae           | Dasyatis americana (Hildebrand & Schroeder, 1928) | Southern stingray; Arraia-mijona | DD       | x 0,28    |
| Dasyatidae           | Dasyatis sp.                                 | Arraia-de-pedra; Arraia-de-croa | LC       | x x 0,22  |
| Diodontidae          | Chilomycterus antillarum (Jordan & Rutter, 1897) | Web burrfish; Baiacu-espinho | NE       | x 0,22    |
| Diodontidae          | Chilomycterus spinosus spinosus (Linnaeus, 1758) | Web burrfish; Baiacu-espinho | NE       | x 0,22    |
| Echeneidae           | Echeneis naucrates (Linnaeus, 1758)          | Live sharksucker; Piolho       | NE       | x 0,17    |
Table 1  Fish species recorded through interviews with marine artisanal fishermen of Tamandaré Beach, Pernambuco, Brazil (Continued)

| Family               | Species Name                                      | Common Name                          | Abundance | Status |
|----------------------|---------------------------------------------------|--------------------------------------|-----------|--------|
| Echeneidae           | Remora remora (Linnaeus, 1758)                    | Shark sucker                         | NE        | x      |
| Echinothirididae     | Echinothirius brucus (Bonnaterre, 1788)           | Bramble shark                        | DD        | x x    |
| Elopidae             | Elops saurus (Linnaeus, 1766)                     | Ladyfish                             | LC        | x x    |
| Anchoa januaria (Steindachner, 1879) | Anchoa januaria (Steindachner, 1879) | Ladyfish                             | LC        | x x    |
| Engraulidae          | Anchoa tricolor (Spix & Agassiz, 1829)            | Piquitinga anchovy                   | NE        | x x    |
| Lycengraulis grossidens (Spix & Agassiz, 1829) | Lycengraulis grossidens (Spix & Agassiz, 1829) | Atlantic sabretooth anchovy          | NE        | x x    |
| Engraulidae          | Lycengraulis batesi ( Günther, 1868)              | Atlantic sabretooth anchovy          | NE        | x x    |
| Ephippidae           | Cypselurus cyanopterus (Valenciennes, 1846 )      | Atlantic spadefish                   | NE        | x x    |
| Exocoetidae          | Hirundichthys affinis ( Günther, 1866)            | Fourwing flyingfish                  | NE        | x x    |
| Exocoetidae          | Exocoetus volitans (Linnaeus, 1758)               | Tropical two-wing flyingfish         | NE        | x x    |
| Fistularidae         | Fistula elongata (Lacepède, 1803)                 | Red cornetfish                       | NE        | x x    |
| Gerreidae            | Diapterus rhombeus (Cuvier, 1829)                 | Caimpana mojarra                     | NE        | x x    |
| Gerreidae            | Eugenes brasiliensis (Cuvier, 1830)               | Brazilian mojarra                    | NE        | x x    |
| Gerreidae            | Diapterus auratus (Ranzani, 1842)                 | Irish mojarra                        | NE        | x x    |
| Gerreidae            | Eucinostomus sp.                                  | Slender mojarra                      | NE        | x x    |
| Gerreidae            | Eucinostomus cinereus (Walbaum, 1792)             | Yellon fin mojarra                   | NE        | x x    |
| Gerreidae            | Eucinostomus havana (Nichols, 1912)               | Bigeye mojarra                       | NE        | x x    |
| Gerreidae            | Eucinostomus gua (Quoy & Gaimard, 1824)           | Jenny mojarra                        | NE        | x x    |
| Ginglymostomatidae   | Ginglymostoma cirratum (Bonnaterre, 1788)        | Nurse shark                          | DD        | x x    |
| Gymnuridae           | Gymnura micrura (Bloch & Schneider, 1801)         | Smooth butterfly ray                 | DD        | x x    |
| Haemulidae           | Haemulon plumieri (Lacepède, 1801)                | White grunt                          | NE        | x x    |
| Haemulidae           | Anisotremus surinamensis (Bloch, 1791)            | Black margate                        | NE        | x x    |
| Family           | Scientific Name                                   | Common Names                                      | Conservation Status | Abundance x x | Length (m) |
|------------------|---------------------------------------------------|---------------------------------------------------|---------------------|--------------|------------|
| Haemulidae       | Haemulon parra (Desmarest, 1823)                  | Sailor’s grunt                                    | NE                  | 0.50         |            |
|                  | Anisotremus virginicus (Linnaeus, 1758)           | Porkfish                                          | NE                  | 0.33         |            |
|                  | Orthopristis ruber (Cuvier, 1830)                | Corocoro grunt                                     | NE                  | 0.33         |            |
|                  | Pomadasys corvinaeformis (Steindachner, 1868)    | Roughneck grunt                                    | NE                  | 0.19         |            |
|                  | Conodon nobilis (Linnaeus, 1758)                 | Barred grunt                                       | NE                  | 0.14         |            |
|                  | Haemulon aurolineatum (Cuvier, 1830)             | Tomtate grunt                                      | NE                  | 0.11         |            |
|                  | Haemulon album (Cuvier, 1830)                    | White margate                                      | NE                  | 0.11         |            |
|                  | Haemulon chrysargyreum (Günther, 1859)           | Smallmouth grunt                                   | NE                  | 0.11         |            |
|                  | Haemulon squamipinna (Rocha & Rosa, 1999)        | Xira listradim; xira-amarela                      | NE                  | 0.11         |            |
|                  | Haemulon steindachneri (Jordan e Gilbert, 1882)  | Xira-chere-grunt                                   | LC                  | 0.06         |            |
|                  | Haemulon macrostomum (Günther, 1859)             | Spanish chere-grunt                                | NE                  | 0.06         |            |
| Hemiramphidae    | Hemiramphus balao (Lesueur, 1821)                | Balao halfbeak                                    | NE                  | 0.83         |            |
|                  | Hyporhamphus robusti (Valenciennes, 1847)        | Slender halfbeak                                   | LC                  | 0.72         |            |
| Hemiramphidae    | Hemiramphus brasiliensis (Linnaeus 1758)         | Ballyhoo halfbeak                                  | NE                  | 0.28         |            |
| Holocentridae    | Holocentrus adscensionis (Osbeck, 1765)          | Squillrefish                                       | NE                  | 0.56         |            |
| Holocentridae    | Myripristis jacobus (Cuvier, 1829)               | Blackbar soldierfish                               | NE                  | 0.06         |            |
| Istiophoridae    | Kajikia albida (Poey, 1860)                      | Atlantic White marlin                              | VU                  | 0.61         |            |
| Istiophoridae    | Makaira nigricans (Lacepède, 1802)               | Blue marlin                                        | VU                  | 0.61         |            |
| Istiophoridae    | Tetrapurus pfluegeri (Robins & de Sylva, 1963)   | Longbill spearfish                                 | LC                  | 0.17         |            |
| Istiophoridae    | Istiophorus albicans (Latreille, 1804)           | Atlantic sailfish                                  | NE                  | 0.06         |            |
Table 1 Fish species recorded through interviews with marine artisanal fishermen of Tamandaré Beach, Pernambuco, Brazil (Continued)

| Family    | Genus                     | Scientific Name               | Common Names                                      | Threat Status | Conservation | Abundance |
|-----------|---------------------------|-------------------------------|---------------------------------------------------|---------------|--------------|-----------|
| Labridae  | Bodianus rufus            | (Linnaeus, 1758)              | Spanish hogfish                                   | LC            | x x          | 0.28      |
|           | Labrisomus nuchipinnis    | (Quoy & Gaimard, 1824)        | Hairy blenny                                      | NE            | 0.00         |
| Lamnidae  | Carcharodon carcharias    | (Linnaeus, 1758)              | White shark                                       | VU            | x x          | 0.44      |
| Lamnidae  | Isurus oxyrinchus         | (Rafinesque, 1810)           | Shortfin mako                                      | VU            | x x          | 0.33      |
| Lobotidae | Lobotis surinamensis      | (Bloch, 1790)                 | Tripletail                                        | NE            | x x          | 0.06      |
| Lutjanidae| Lutjanus analis           | (Cuvier, 1828)               | Mutton snapper                                    | VU            | x x          | 1.69      |
| Lutjanidae| Lutjanus spp.             |                               | Dog snapper                                       | NE            | x x          | 1.39      |
| Lutjanidae| Lutjanus vivanus          | (Cuvier, 1828)               | Silk snapper                                      | NE            | x x          | 0.72      |
| Lutjanidae| Lutjanus buccanella       | (Cuvier, 1828)               | Blackfin snapper                                  | NE            | x x          | 0.67      |
| Lutjanidae| Lutjanus griseus          | (Linnaeus, 1758)             | Grey snapper                                      | NE            | x x x        | 0.64      |
| Lutjanidae| Rhomboplites aurorubens   | (Cuvier, 1829)               | Vermillion snapper                                 | NE            | x x          | 0.33      |
| Lutjanidae| Etelis oculatus           | (Valenciennes, 1828)         | Queen snaper                                      | NE            | x x          | 0.28      |
| Lutjanidae| Lutjanus spp.             |                               |                                    |               |              |           |
| Lutjanidae| Ocyurus chrysurus         | (Bloch, 1791)                | Yellowtail snapper                                | NE            | x x          | 0.08      |
| Malacanthidae| Malacanthus plumieri   | (Bloch, 1786)                | Sand tilefish                                     | NE            | x x          | 0.44      |
| Megalopidae| Megalops atlanticus     | (Valenciennes, 1847)         | Tarpon                                            | VU            | x x x x      | 0.28      |
| Monacanthidae| Aluterus spp.               |                               | Dotterel filefish                                 | NE            | x x          | 0.44      |
| Monacanthidae| Monacanthus ciliatus     | (Mitchell, 1818)             | Fringed filefish                                  | NE            | x x          | 0.19      |
| Mugilidae | Mugil spp.                |                               |                              |               |              |           |
| Mullidae  | Pseudupeneus maculatus    | (Bloch, 1793)                | Spotted goatfish                                  | NE            | x x          | 0.67      |
| Mullidae  | Mullilaudichthys martinicus | (Cuvier, 1829)             | Yellow goatfish                                   | NE            | x x          | 0.06      |
| Muraenidae| Gymnothorax funebris      | (Ranzani, 1839)             | Green moray                                       | NE            | x x          | 0.33      |
| Muraenidae| Spotted moray             |                               | Moréia-pintada                                    | NE            | x x          | 0.33      |
| Family           | Species                                                                                       | Common Names                                                                 | Status  | Frequency | Notes |
|------------------|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|---------|-----------|-------|
| Gymnothorax      | *Gymnothorax moringa* (Cuvier, 1829)                                                          | Caribbean ocellated moray Moréia-pintada                                     | NE      | x x       | 0.33  |
| *Gymnothorax     | *Gymnothorax ocellatus* (Agassiz, 1831)                                                        | Golden ocellated moray Moréia-preta                                          | NE      | x x       | 0.17  |
| Muraenidae       | *Aetobatus narinari* (Euphrasen, 1790)                                                         | Spotted eagle ray Arraia-pintada; Arraia-malhada; Arraia-chita               | NT      | x x x     | 1.17  |
| *Muraenidae      | *Manta birostris* (Walbaum, 1792)                                                              | Giant manta Moréia-dois-chifres; Arraia-jamanta; Arraia-morcego              | VU      | x x       | 0.56  |
| Rhinoptera       | *Rhinoptera bonasus* (Mitchill, 1815)                                                          | Cowrnose ray Arraia-boca-de-gaveta; arraia-gaveta                           | NT      | x x       | 0.28  |
| Narcinidae       | *Narcine spp.*                                                                               | Lesser electric ray Treme-treme                                              | CR      |           | 0.00  |
| Ocyocephalus     | *Ocyocephalus vespertilio* (Linnaeus, 1758)                                                    | Seadevil Cachimbo; Cachimbau                                                 | NE      |           | 0.00  |
| Ostraciidae      | *Lactophrys trigonus* (Linnaeus, 1758)                                                         | Buffalo trunkfish Baiacu-caixão                                              | NE      |           | 0.00  |
| Polydactylus     | *Polydactylus oligodon* (Günther, 1860)                                                        | Littlescale threadfin Barbudo                                                 | NE      | x x       | 0.33  |
| *Polydactylus    | *Polydactylus virginicus* (Linnaeus, 1758)                                                     | Barb thickness                  | NE      | x x       | 0.33  |
| *Pomacentrus     | *Pomacentrus areolatus* (Linnaeus, 1758)                                                       | Gray angelfish Parum-preto; Peixe-vidro; Quebra-pedra                        | LC      | x x       | 0.11  |
| *Pomacentrus     | *Abudelfuf saxatilis* (Linnaeus, 1758)                                                         | Sergeant-major Saberé; Saberé-rajado; Sargentinho                           | NE      | x x x x   | x 0.36|
| *Pomacentrus     | *Stegastes pectoralis* (Castelnau, 1855)                                                       | Yellowtip damselfish Castanha                                                | NE      |           | 0.11  |
| *Pomatomus       | *Pomatomus saltatrix* (Linnaeus, 1766)                                                         | Bluefish Enchova; Anchova                                                    | NE      | x x x     | 0.33  |
| Priacanthidae    | *Priacanthus arenatus* (Cuvier, 1829)                                                          | Atlantic bigeye Cantante                                                   | NE      | x x       | 0.17  |
| *Pristigasteridae| *Pellona harroweri* (Fowler, 1917)                                                              | American coastal pellona Sardinha-berimberim                               | NE      | x x       | 0.06  |
| Rachycentron     | *Rachycentron canadum* (Linnaeus, 1766)                                                        | Cobia Beijupirá; cação-de-escama                                             | NE      | x x       | 0.83  |
| *Rhinodontidae   | *Rhinodon typus* (Smith, 1828)                                                                                 | Whale shark Tubarão-baleia; Tubarão-cachalote                              | VU      |           | 0.00  |
| *Rhinobatidae    | *Rhinobatos percellens* (Walbaum, 1792)                                                         | Chola guitarfish Cação-voia; Viola                                          | NT      | x         | 0.11  |
| *Scaridae*       | *Scarius trispinosus* (Valenciennes, 1840)                                                      | Greenback parrotfish Bobó-espinha-verde; Budião-azul; Budião-bico-verde      | EN      | x x       | 0.72  |
| *Scaridae*       | *Scarius taeniopterus* (Lesse, 1829)                                                             | Princess parrotfish Budião                                                  | LC      | x x       | 0.22  |
| *Scaridae*       | *Scarius zelindae* (Moura, Figueiredo & Sazima, 2001)                                           | Zelinda’s parrotfish Budião                                                  | DD      | x x       | 0.22  |
| *Scaridae*       | *Grey parrotfish*                                                                             | Budião                                                                       | DD      | x x       | 0.22  |
| Family        | Species                          | Common Names                           | Distribution | Size | Weight |
|--------------|----------------------------------|----------------------------------------|--------------|------|--------|
| Scaridae     | *Sparisoma axillare* (Steindachner, 1878) | Batata; Batatoa; Boboa; Bobó-batatão; Bobó-cabeça-seca; Budião-batata; Budião; Budião-rabo-de-forquilha | DD           | x    | 0.22   |
| Scaridae     | *Sparisoma frondosum* (Agassiz, 1831)  | Agassiz's parrotfish | Budião | x    | 0.22   |
| Scaridae     | *Sparisoma radians* (Valenciennes, 1840) | Bucktooth parrotfish | LC          | x    | 0.06   |
| Scaridae     | *Sparisoma amplus* (Ranzani, 1841) | Reef parrotfish | Budião-rabo-de-forquilha | LC | x    | 0.83   |
| Sciaenidae   | *Cynoscion leichnus* (Cuvier, 1830) | Smooth weakfish | Pescada-branca | NE | x    | 0.83   |
| Sciaenidae   | *Cynoscion virescens* (Cuvier, 1830) | Green weakfish | NE          | x    | 0.67   |
| Sciaenidae   | *Cynoscion acoupa* (Lacepède, 1801) | Acoupa weakfish | Pescada-amarela | LC | x    | 0.61   |
| Sciaenidae   | *Lanitis breviceps* (Cuvier, 1830) | Shorthead drum | Boca-mole | NE | x    | 0.11   |
| Sciaenidae   | *Micropogonias fumieri* (Desmarest, 1823) | Whitemouth croaker | Curuca; Cururuca; Corvina | NE | x    | 0.61   |
| Sciaenidae   | *Paraonchonurus brasilienis* (Steindachner, 1875) | Banded croaker | Coróqui-de-barbela; Pescada-perna-de-moça | NE | x    | 0.33   |
| Sciaenidae   | *Micropogonias undulatus* (Linnaeus, 1766) | Atlantic croaker | Pescada-perna-de-moça | NE | x    | 0.17   |
| Sciaenidae   | *Isopisthus parvippinnis* (Cuvier, 1830) | Bigtooth corvina | Pescada-chata | NE | x    | 0.11   |
| Sciaenidae   | *Stellifer microps* (Steindachner, 1864) | Smalleye drum | Pescada-cururuca; Pescada-cabeça-de-cobra; Pescada-cururuca | NE | x    | 0.11   |
| Sciaenidae   | *Cynoscion jamaicensis* (Vaillant & Bocourt, 1883) | Jamaica weakfish | Goete | NE | 0.00   |
| Sciaenidae   | *Cynoscion microlepidotus* (Cuvier, 1830) | Smallscale weakfish | Pescada-de-dente | NE | 0.00   |
| Scombridae   | *Acanthocybium solandri* (Cuvier, 1832) | Wahoo | Cavala-impim; cavala-impingé; cavala-preta | LC | x    | 1.25   |
| Scombridae   | *Scomberomorus cavalla* (Cuvier, 1829) | King mackerel | Cavala-branca; cavala-perna-de-moça | LC | x    | 1.22   |
| Scombridae   | *Scomberomorus regalis* (Bloch, 1793) | Cero | Serra | LC | x    | 1.06   |
| Scombridae   | *Thunnus albacares* (Bonnaterre, 1788) | Yellowfin tuna | Albacora-de-aba-amarela; Albacora-gaia-amarela; Albacora-amarela; Albacora-de-lajo | NT | x    | 0.83   |
| Scombridae   | *Thunnus obesus* (Lowe, 1839) | Bigeye tuna | Albacora-de-aba-amarela; Albacora-gaia-amarela; Albacora-amarela | VU | x    | 0.83   |
| Scombridae   | *Thunnus atlanticus* (Lesson, 1831) | Blackfin tuna | Albacora-cachorro; Albacora-preta | LC | x    | 0.78   |
| Family            | Genus                        | Species                   | Common Names/Collected Names                                                                 | Status | Life Form | Abundance |
|-------------------|------------------------------|---------------------------|---------------------------------------------------------------------------------------------|--------|-----------|-----------|
| Scombridae        | Scomberomorus brasiliensis   | (Collette, Russo & Zavala-Camin, 1978) | Serra Spanish mackerel Serra-pininga; Serra-pinta-amarela                                    | LC     | x x       | 0.44      |
| Scombridae        | Auxis rochei                 | (Risso, 1810)             | Bullet tuna Atum; Bonito                                                                     | LC     | x x       | 0.33      |
| Scombridae        | Auxis thazard                | (Lacepède, 1800)          | Frigate tuna Atum; Bonito                                                                     | LC     | x x       | 0.33      |
| Scombridae        | Euthynnus alletteratus       | (Rafinesque, 1810)        | Little tuna Atum; Bonito                                                                     | LC     | x x       | 0.33      |
| Scombridae        | Katsuwonus pelamis           | (Linnaeus, 1758)          | Skipjack tuna Atum                                                                       | LC     | x x       | 0.33      |
| Scombridae        | Sarda sarda                  | (Bloch, 1793)             | Atlantic bonito Atum                                                                       | LC     | x x       | 0.33      |
| Scombridae        | Scomber collas               | (Gmelin, 1789)            | Atlantic chub mackerel Cavelinha; Cavelinha-do-sul                                         | LC     | x x       | 0.22      |
| Scombridae        | Thunnus alalunga             | (Bonnaterre, 1788)        | Blackfin tuna Albacora-branca; Albacora-legítima                                            | NT     | x x       | 0.06      |
| Scombridae        | Thunnus thynnus              | (Linnaeus, 1758)          | Atlantic bluefin tuna Albacora-maguru                                                       | EN     | x x       | 0.06      |
| Scorpaenidae      | Scorpaena brasiliensis       | (Cuvier, 1829)            | Barbfish Aniquim                                                                          | NE     | x         | 0.22      |
| Scorpaenidae      | Scorpaena plumieri           | (Bloch, 1789)             | Spotted scorpionfish Aniquim; Beatriz                                                       | NE     | x         | 0.22      |
| Scorpaenidae      | Scorpaenodes spp.            |                           | Reef scorpionfish Aniquim                                                                    | NE     | x         | 0.22      |
| Serranidae        | Lutjanus fulviflammatus      | (Linnaeus, 1758)          | Coney Piraúna-amarela; Piraúna-flor-de-algodão; Piraúna-perua-choca; Piraúna-vermelha; Piraúna-preta | LC     | x x       | 1.83      |
| Serranidae        | Mycteroperca venenosa        | (Linnaeus, 1758)          | Yellowfin grouper Sirigado; Badejo                                                         | NT     | x x       | 1.22      |
| Serranidae        | Mycteroperca tigris          | (Valenciennes, 1833)      | Tiger grouper Sirigado; Badejo                                                            | LC     | x x       | 1.22      |
| Serranidae        | Epinephelus adscensionis     | (Osbeck, 1771)            | Rock hind Peixe-gato; Mané-velho; Garoupa-pintada                                          | LC     | x x       | 0.67      |
| Serranidae        | Mycteroperca acutostris      | (Valenciennes, 1828)      | Combi grouper Sirigado-papuá                                                              | LC     | x x       | 0.50      |
| Serranidae        | Epinephelus itajara          | (Lichtenstein, 1822)      | Atlantic goliath grouper Mero                                                               | CR     | x         | 0.42      |
| Serranidae        | Mycteroperca microlepis      | (Goode & Bean, 1879)      | Gag grouper Sirigado-bico-fino; Sirigado-masca-fumo                                       | LC     | x x       | 0.22      |
| Serranidae        | Epinephelus guttatus         | (Linnaeus, 1758)          | Red hind Garoupa-preta                                                                   | LC     | x x       | 0.17      |
| Serranidae        | Alphestes affinis            | (Bloch, 1793)             | Muttom hamlet Sapé                                                                        | LC     | x x       | 0.11      |
| Serranidae        | Epinephelus maculatus        | (Valenciennes, 1828)      | Red grouper Garoupa-branca                                                                | NT     | x x       | 0.11      |
| Serranidae        | Rypticus saponaceus          | (Bloch & Schneider, 1801)  | Greater soapfish Sabão                                                                   | NE     | x x       | 0.11      |
| Serranidae        | Epinephelus guttatus         | (Linnaeus, 1758)          | Yellowmouth grouper Sirigado-boca-de-sino                                                  | VU     | x x       | 0.06      |
| Family            | Species                                             | Common Name                      | Food | Commercial | Medicinal | Handicrafts | Spiritual-religious | Aquarium |
|-------------------|-----------------------------------------------------|----------------------------------|------|------------|-----------|-------------|--------------------|----------|
| Sparidae          | Mycteroperca interstitialis (Poey, 1860)            | Western Atlantic seabream       | NE   | x          | x         |             |                    |          |
| Sparidae          | Archosargus rhomboidalis (Linnaeus, 1758)           | Sargo                            | NE   | x          | x         |             |                    | 0.22     |
| Sparidae          | Calamus pennatula (Guichenot, 1868)                 | Pluma porgy                      | NE   | x          | x         |             |                    | 0.11     |
| Sparidae          | Archosargus probatocephalus (Walbaum, 1792)        | Sheephead                        | NE   | x          | x         |             |                    | 0.06     |
| Sparidae          | Calamus penno (Valenciennes, 1830)                 | Sheephead porgy                   | NE   | x          | x         |             |                    | 0.06     |
| Sphyraenidae      | Sphyraena barracuda (Edwards, 1771)                | Great barracuda                  | NE   | x          | x         |             |                    | 1.00     |
| Sphyraenidae      | Sphyraena guachanco (Cuvier, 1829)                 | Guachanche barracuda             | NE   | x          | x         |             |                    | 1.00     |
| Sphyraenidae      | Sphyraena sphyraena (Linnaeus, 1758)               | European barracuda               | NE   | x          | x         |             |                    | 1.00     |
| Sphymidae         | Sphyraena lewini (Griffith & Smith, 1834)           | Scalloped hammerhead            | EN   | x          | x         |             |                    | 1.00     |
| Sphymidae         | Sphyraena mokaran (Rüppell, 1837)                  | Great hammerhead                 | EN   | x          | x         |             |                    | 1.00     |
| Sphymidae         | Sphyraena zygana (Linnaeus, 1758)                  | Smooth hammerhead               | VU   | x          | x         |             |                    | 1.00     |
| Sphymidae         | Sphyraena rubra (Linnaeus, 1758)                   | Bonnethead                       | LC   | x          | x         |             |                    | 0.06     |
| Squalidae         | Squalus cubensis (Howell Rivero, 1936)             | Cuban dogfish                    | DD   | x          | x         |             |                    | 0.17     |
| Syngnathidae      | Hippocampus reidi (Ginsburg, 1933)                 | Longsnout seahorse               | DD   | x          | x         | x          |                    | 0.31     |
| Synodontidae      | Trachinocephalus myops (Forster, 1801)             | Snakefish                        | NE   |             |           |             |                    | 0.06     |
| Tetraodontidae    | Lagocephalus spp.                                  | Smooth puffer                    | NE   | x          | x         |             |                    | 0.44     |
| Tetraodontidae    | Spheroideis spp.                                   | Bandtail puffer                  | NE   | x          | x         |             |                    | 0.44     |
| Triakidae         | Mustelus sp.                                        | Caçao-namorado; Caçao-banguelo   | x    |             |           |             |                    | 0.28     |
| Triakidae         | Mustelus sp.                                        | Caçao-manteiga                   | x    |             |           |             |                    | 0.03     |
| Trichiuridae      | Trichiurus lepturus (Linnaeus, 1758)               | Largehead hairtail               | NE   |             |           |             |                    | 0.11     |
| Xiphiidae         | Xiphius gladius (Linnaeus, 1758)                   | Swordfish                        | LC   | x          | x         |             |                    | 0.17     |

*Font: fishbase.org

Legend: NE – Not Evaluated; DD – Data Deficient; LC – Least Concern; NT – Near Threatened; VU – Vulnerable; EN – Endangered; CR – Critically Endangered.
F – Food; Co – Commercial; Med – Medicinal; H – Handicrafts; S-R – Spiritual-religious; Aq – Aquarium.
| Family          | Scientific name                     | Name in English* | Local name                                                                 | IUCN (2014) | IBAMA (2004) | F | Co | Med | H | S-R | Aq | Use values |
|-----------------|--------------------------------------|------------------|----------------------------------------------------------------------------|-------------|--------------|---|----|-----|---|-----|----|------------|
| Acanthuridae    | Acanthurus chirurgus (Bloch, 1787)   | Doctorfish       | Lanceta                                                                    | LC          | x            | x | x  |     |   |     |    | 1,03       |
| Albulidae       | Albula vulpes (Linnaeus, 1758)       | Bonefish         | Ubarana                                                                     | NT          | x            | x | x  |     |   |     |    | 0,49       |
| Albulidae       | Albula nemoptera (Fowler, 1911)      | Threadfin bonefish| Jutubarana; Tijubarana; Gitubarana                                         | DD          | x            | x | x  |     |   |     |    | 0,46       |
| Ariidae         | Genidens genidens (Cuvier, 1829)     | Guri sea catfish  | Bagre-ariaçu; Bagre-giriaçu; giraçu; Juruçu; Bagre-branco; Bagre-canhacoco; Bagre-mole | LC          | x            | x | x  |     |   |     |    | 1,92       |
| Ariidae         | Aspistor quadricutis (Valenciennes, 1840) | Bressou sea catfish | Bagre-amarelo; Bagre-mestre-mané; Bagre-mestre-mané-beiçudo; Bagre-boca-de-boi | NE          | x            | x |     |     |   |     |    | 1,64       |
| Ariidae         | Bagre bagre (Linnaeus, 1766)         | Coco sea catfish  | Bagre-fita                                                                  | NE          | x            | x |     |     |   |     |    | 1,13       |
| Ariidae         | Cathorops spixii (Agassiz, 1829)     | Madamango sea catfish| Bagre-bandim; Bagre-manguim                                                | NE          | x            | x |     |     |   |     |    | 0,62       |
| Ariidae         | Sciaes herzbergii (Bloch, 1794)      | Pemecou sea catfish| Bagre-camboeiro; Bagre-cambuim                                            | NE          | x            | x |     |     |   |     |    | 0,41       |
| Aulostomidae    | Aulostomus maculatus (Valenciennes, 1841) | Trumpetfish       | Trombeta                                                                    | NE          | x            | x | x  |     |   |     |    | 0,13       |
| Balistidae      | Canthidermis sufflamen (Mitchill, 1815) | Ocean triggerfish | Cangulo-guerra-de-garoupa; Cangulo-rabo-de-garoupa; Cangulo-garoupa; Cangulo-preto | NE          | x            | x |     |     |   |     |    | 1,28       |
| Balistidae      | Melichthys niger (Bloch, 1786)       | Black triggerfish | Cangulo-guerra-de-garoupa; Cangulo-rabo-de-garoupa; Cangulo-garoupa; Cangulo-preto | NE          | x            | x | x  |     |   |     |    | 1,28       |
| Balistidae      | Balistes capriscus (Gmelin, 1788)    | Grey triggerfish  | Cangulo-fernando; Cangulo-fernandi; Cangulo-branco; Cangulo-papo-branco    | NE          | x            | x | x  |     |   |     |    | 1,23       |
| Balistidae      | Balistes vetula (Linnaeus, 1758)     | Queen triggerfish | Cangulo-amarelo; Cangulo-verdeheiro; cangulo-do-papo-amarelo; Cangulo-papo-louro; Cangulo-azul | VU          | x            | x | x  |     |   |     |    | 1,13       |
| Batrachooididae | Amphichthys cryptocentrus (Valenciennes, 1837) | Bocon toadfish    | Pacamon; Pocomão                                                           | LC          | x            | x |     |     |   |     |    | 0,72       |
| Batrachooididae | Batrachoides surinamensis (Bloch & Schneider, 1801) | Pacuma toadfish   | Pacamon; Pocomão                                                           | NE          | x            | x |     |     |   |     |    | 0,72       |
| Batrachooididae | Thalassophryne nattereri (Steindachner, 1876) | Trinidad Tob     | Pacamon; Pocomão                                                           | NE          | x            | x |     |     |   |     |    | 0,72       |
| Belonidae       | Platybelone argalus (Lesueur, 1821)  | Keeltail needlefish| Zambaia-cachorro                                                          | LC          | x            | x |     |     |   |     |    | 0,69       |
| Belonidae       | Strongylura marina (Walbaum, 1792)   | Atlantic needlefish| Zambaia-azul; Agulha-torta                                                 | LC          | x            | x |     |     |   |     |    | 0,64       |
| Belonidae       | Tylosurus crocodilus (Péron & Lesueur, 1821) | Hound needlefish  | Zambaia-rolíco                                                            | NE          | x            | x |     |     |   |     |    | 0,49       |
| Belonidae       | Ablennes hians (Valenciennes, 1846)  | Flat needlefish   | Zambaia-do-alto; Zambaia-fino; Zambaia-largo; Zambaia-sardinhado           | NE          | x            |     |     |     |   |     |    | 0,26       |
| Family            | Species Name                                      | Common Name                     | NE | LC | x  |
|-------------------|---------------------------------------------------|---------------------------------|----|----|----|
| Belonidae         | Strongylura timucu (Walbaum, 1792)                | Timucu                          | NE | x  | x  |
| Bothidae          | Bothus spp.                                       | Plate fish                      | NE | x  | x  |
| Carangidae        | Etagotis bipinnulata (Quay & Gaimard, 1825)       | Rainbow runner                  | NE | x  | 1,36|
| Carangidae        | Caranx bartholomoei (Cuvier, 1833)               | Yellow jack                     | NE | x  | 1,23|
| Carangidae        | Caranx lugubris (Poey, 1860)                     | Black jack                      | NE | x  | 1,10|
| Carangidae        | Serrisa lalani (Valenciennes, 1833)              | Yellowtail amberjack            | NE | x  | 1,08|
| Carangidae        | Caranx ruber (Bloch, 1793)                       | Bar jack                        | NE | x  | 0,97|
| Carangidae        | Caranx latus (Agassiz, 1831)                     | Horse-eye jack                  | NE | x  | 0,77|
| Carangidae        | Caranx hippos (Linnaeus, 1766)                   | Crevale jack                    | NE | x  | 0,69|
| Carangidae        | Alectus ciliaris (Bloch, 1787)                   | African pompano                 | LC | x  | 0,67|
| Carangidae        | Selene vomer (Linnaeus, 1758)                    | Lookdown                        | NE | x  | 0,67|
| Carangidae        | Chloroscombus chrysus (Linnaeus, 1766)           | Atlantic bumper                 | NE | x  | 0,64|
| Carangidae        | Selene setapinnis (Mitchill, 1815)               | Atlantic moonfish               | NE | x  | 0,54|
| Carangidae        | Selene brownii (Cuvier, 1816)                    | Caribbean moonfish              | NE | x  | 0,54|
| Carangidae        | Trachinotus spp.                                 | Floripa pompano                 | NE | x  | 0,44|
| Carangidae        | Oligoplites palometa (Cuvier, 1832)              | Maracaibo leatherjack          | NE | x  | 0,23|
| Carangidae        | Oligoplites siliens (Bloch, 1793)                | Castin leatherjacket            | NE | x  | 0,23|
| Carangidae        | Oligoplites saurus (Bloch & Schneider, 1801)     | Leatherjacket                  | NE | x  | 0,23|
| Carangidae        | Decapterus macarellus (Cuvier, 1833)             | Mackerel scad                   | NE | x  | 0,15|
| Carangidae        | Caranx crysos (Mitchill, 1815)                   | Blue runner                     | LC | x  | 0,10|
| Carangidae        | Trachinotus sp.                                  | Pelado; Pataca                  | Sem avaliação | x | 0,10|
| Carangidae        | Serrisa rivolana (Valenciennes, 1833)            | Longfin yellowtail             | NE | x  | 0,03|
| Carcharhinidae    | Carcharhinus falciformis (Müller & Henle, 1839)  | Silky shark                     | NT | x  | 1,38|
| Carcharhinidae    | Carcharhinus limbatus (Müller & Henle, 1839)     | Blacktip shark                  | NT | x  | 1,38|
| Carcharhinidae    | Tiger shark                                      | NT                             | x  | x  | 0,97|
Table 2 Fish species recorded through interviews with marine artisanal fishermen of the Extractive Reserve Batoque, Ceará, Brazil

| Fish Family | Scientific Name | Common Name | Conservation Status | IUCN Code | Length (m) |
|-------------|-----------------|-------------|---------------------|-----------|------------|
| Carcharhinidae | Galeocerdo cuvier (Péron & Lesueur, 1822) | Cação-pintadinho; cação-pintado; jaguara; cação-tigre; tubarão-tigre | VU | x | 0.51 |
| Carcharhinidae | Rhizoprionodon spp. | Brazilian sharpnose shark | DD | x | 0.44 |
| Carcharhinidae | Rhizoprionodon lalandii (Valenciennes, 1839) | Cação-verga-de-ouro | LC | x | 0.44 |
| Carcharhinidae | Carcharhinus obscurus (LeSueur, 1818) | Dusky shark | VU | x | 0.13 |
| Carcharhinidae | Carcharhinus spp. | Cação-fi-d'água; Cação-fidalgo | Sem avaliação | x | 0.13 |
| Carcharhinidae | Negaprion brevirostris (Poey, 1868) | Lemon shark | NT | x | 0.08 |
| Centropomidae | Centropomus ensiferus (Poey, 1860) | Swordspine snook | Camurim-branco | x | 0.85 |
| Centropomidae | Centropomus pectinatus (Poey, 1860) | Tarpon snook | Camurim-suvela; Camurim-gaia | NE | x | 0.77 |
| Centropomidae | Centropomus parallelus (Poey, 1860) | Fat snook | Camurim-arnarelo | x | 0.64 |
| Centropomidae | Centropomus undecimalis (Bloch, 1792) | Common snook | Camurim-preto | NE | x | 0.03 |
| Chaetodontidae | Chaetodon spp. | Spotfin butterflyfish | Parum-jandáia; Peixe-prato; Pintado | LC | x | 0.33 |
| Clupeidae | Harengula jaguana (Poey, 1865) | Scaled herring | Sardinha-cascuda; Sardinha-casca-grossa | NE | x | 1.46 |
| Clupeidae | Opisthonema oglinum (Lesueur, 1818) | Atlantic thread herring | Sardinha-azul | NE | x | 0.64 |
| Clupeidae | Sardinella brasiliensis (Steindachner, 1879) | Brazilian sardinella | Sardinha-rolicha | NE | x | 0.05 |
| Coryphaenidae | Coryphaena equiselis (Linnaeus, 1758) | Pompano dolphinfish | Dourado | LC | x | 1.33 |
| Coryphaenidae | Coryphaena hippurus (Linnaeus, 1758) | Common dolphinfish | Dourado | LC | x | 1.33 |
| Cynoglossidae | Symphurus spp. | Spottedfin tonguefish | Sóia-linguado; Linguado | NE | x | 0.00 |
| Dactylopteridae | Dactylorhiza volitans (Linnaeus, 1758) | Flying gurnard | Avuador-carga-de-palha | NE | x | 0.05 |
| Dasyatidae | Dasyatis americana (Hildebrand & Schroeder, 1928) | Southern stingray | Arraia-bico-de-remo | DD | x | 0.77 |
| Dasyatidae | Dasyatis guatamala (Bloch & Schneider, 1801) | Longnose stingray | Arraia-couro-de-lixa; Arraia-verdadeira; Arraia-couro-verde | DD | x | 0.59 |
| Dasyatidae | Dasyatis sp. | Arraia-de-pedra | Arraia-verdadeira; Arraia-couro-verde | LC | x | 0.31 |
| Dasyatidae | Dasyatis sp. | Arraia-verdadeira; Arraia-couro-verde | Sem avaliação | x | 0.26 |
| Dasyatidae | Dasyatis manimae (Gomes, Rosa & Gadig, 2000) | Brazilian large-eyed stingray | Arraia-do-oião; Arraia-oiuda | DD | x | 0.26 |
| Taxonomy       | Scientific Name                          | Common Name                           | NE  | x  | x  | 0.49 |
|---------------|-----------------------------------------|---------------------------------------|-----|---|---|------|
| Diodontidae   | *Diodon hystrix* (Linnaeus, 1758)        | Spot-fin porcupinefish               |     |   |   |      |
|               |                                         | Baiacu-graviola; Baiacu-espinho      | NE  | x | x | 0.49 |
| Diodontidae   | *Chilomycterus antillarum* (Jordan & Rutter, 1897) | Web burrfish                      |     |   |   |      |
|               |                                         | Baiacu-espinho; Baiacu-bola         | NE  | x | x | 0.15 |
| Diodontidae   | *Chilomycterus spinosus* (Linnaeus, 1758) |                                       |     |   |   |      |
|               |                                         | Baiacu-espinho                      | NE  | x | x | 0.15 |
| Echeneidae    | *Echeneis naucrates* (Linnaeus, 1758)   | Live sharksucker                     |     |   |   | 1.00 |
|               |                                         | Piolho                               | NE  | x | x | x | 1.00 |
| Echeneidae    | *Remora remora* (Linnaeus, 1758)        | Shark sucker                         |     |   |   |      |
|               |                                         | Piolho                               | NE  | x | x | 1.00 |
| Echinothiridae| *Echinarhinus brucus* (Bonneraterre, 1788) | Bramble shark                      |     |   |   |      |
|               |                                         | Peixe-prego                          | DD  | x | x | 0.18 |
| Engraulidae   | *Lycengraulis grossidens* (Spix & Agassiz, 1829) | Atlantic sabretooth anchovy         |     |   |   |      |
|               |                                         | Arem                                 | NE  | x | x | 0.10 |
| Engraulidae   | *Lycengraulis batesii* (Günther, 1868)  | Bates’ sabretooth anchovy            |     |   |   |      |
|               |                                         | Arem                                 | NE  | x | x | 0.10 |
| Engraulidae   | *Anchoa januaria* (Steindachner, 1879)  | Rio anchovy                          |     |   |   | 0.05 |
|               |                                         | Manjuba                              | NE  | x |   | 0.05 |
| Engraulidae   | *Anchoa tricolor* (Spix & Agassiz, 1829) | Piquitinga anchovy                   |     |   |   | 0.05 |
|               |                                         | Manjuba                              | NE  | x |   | 0.05 |
| Echippiidae   | *Chaeotadiperus faber* (Brousset, 1782)  | Atlantic spadefish                   |     |   |   | 0.33 |
|               |                                         | Enxada; Parum-branco                 | NE  | x | x | 0.33 |
| Exocoetidae   | *Hirundichthys rondeletti* (Valenciennes, 1847) | Black wing flyingfish               |     |   |   | 0.36 |
|               |                                         | Avuador-tainha                        | LC  | x | x | 0.36 |
| Exocoetidae   | *Exocoetus volitans* (Linnaeus, 1758)   | Tropical two-wing flyingfish         |     |   |   | 0.10 |
|               |                                         | Avuador-do-alto; Peixe-avuador-grande| NE  | x | x | 0.10 |
| Exocoetidae   | *Hirundichthys affinis* (Günther, 1866)  | Fourwing flyingfish                  |     |   |   | 0.05 |
|               |                                         | Avuador-da-pesca; Peixe-avuador-pequeno| NE  | x | x | 0.05 |
| Gempylidae    | *Gempylus serpens* (Cuvier, 1829)       | Snake mackerel                        |     |   |   | 0.41 |
|               |                                         | Espada; Peixe-espada                 | NE  | x | x | 0.41 |
| Gerreidae     | *Diapterus auratus* (Ranzani, 1842)     | Irish mojarra                         |     |   |   | 0.31 |
|               |                                         | Caratinga; Carapeba                  | NE  | x | x | 0.31 |
| Gerreidae     | *Diapterus rhombeus* (Cuvier, 1829)     | Caihipa mojarra                      |     |   |   | 0.26 |
|               |                                         | Carapeba                             | NE  | x | x | 0.26 |
| Gerreidae     | *Eucinostomus sp.*                      | Slender mojarra                      |     |   |   | 0.10 |
|               |                                         | Carapicu                             | NE  | x | x | 0.10 |
| Gerreidae     | *Eucinostomus havana* (Nichols, 1912)   | Bigeye mojarra                       |     |   |   | 0.05 |
|               |                                         | Carapicu-rolício                     | NE  | x | x | 0.05 |
| Gerreidae     | *Eucinostomus gula* (Quay & Gaimard, 1824) | Jenny mojarra                    |     |   |   | 0.05 |
|               |                                         | Carapicu-açu                         | NE  | x | x | 0.05 |
| Gerreidae     | *Eugeres brasilius* (Cuvier, 1830)      | Brazilian mojarra                    |     |   |   | 0.00 |
|               |                                         | Carapeba                             | NE  | x | x | 0.00 |
| Gerreidae     | *Gerres cinereus* (Walbaum, 1792)       | Yellow fin mojarra                   |     |   |   | 0.00 |
|               |                                         | Carapicu                             | NE  | x | x | 0.00 |
| Ginglymostomatidae | *Ginglymostoma ciratum* (Bonneterre, 1788) | Nurse shark                          |     |   |   | 0.92 |
|               |                                         | Cação-lixa                           | DD  | x | x | x | 0.92 |
| Gymnuridae    | *Gymnura micrura* (Bloch & Schneider, 1801) | Smooth butterfly ray               |     |   |   |      |
|               |                                         | Arraia-manteiga                      | DD  | x | x | 0.92 |
| Haemulidae    | *Haemulon plumieri* (Lacepède, 1801)    | White grunt                          |     |   |   | 1.77 |
|               |                                         | Biquara                              | NE  | x | x | x | 1.77 |
| Haemulidae    | *Haemulon chrysargyreus* (Günther, 1859) | Smallmouth grunt                     |     |   |   | 1.41 |
|               |                                         | Sapuruna                             | NE  | x | x | 1.41 |
| Family          | Species                                                                 | Common Name                          | Status | NE 1 | NE 2 |
|-----------------|--------------------------------------------------------------------------|---------------------------------------|--------|------|------|
| Haemulidae      | Anisotremus surinamensis (Bloch, 1791)                                   | Black margate                         |        | NE   |     |
|                 | Genyatremus luteus (Bloch, 1790)                                        | Torroto grunt                         | NE     | x    | x    |
|                 | Haemulon aurlineatum (Cuvier, 1830)                                     | Tommtate grunt                        | NE     | x    | x    |
|                 | Pomadasys convinaeformis (Steindacher, 1868)                             | Roughneck grunt                       | NE     | x    | x    |
|                 | Conodon nobilis (Linnaeus, 1758)                                        | Barred grunt                          | NE     | x    | x    |
|                 | Haemulon steindachneri (Jordan e Gilbert, 1882)                          | Chere-chere grunt                     | LC     | x    | x    |
|                 | Orthopristis ruber (Cuvier, 1830)                                       | Corocoro grunt                        | NE     | x    | x    |
|                 | Haemulon squamipinna (Rocha & Rosa, 1999)                                | Sapuruna-branca                       | NE     | x    | x    |
|                 | Haemulon para (Desmarest, 1823)                                         | Sailor’s grunt                        | NE     | x    | x    |
|                 | Anisotremus virginicus (Linnaeus, 1798)                                  | Porkfish                              | NE     | x    | x    |
|                 | Haemulon album (Cuvier, 1830)                                           | White margate                         | NE     | x    | x    |
|                 | Haemulon macrostomum ( Günther, 1859)                                    | Spanish grunt                         | NE     | x    | x    |
| Hemiramphidae   | Hemiramphus balao (Lesueur, 1821)                                       | Balao halfbeak                        | NE     | x    | x    |
| Hemiramphidae   | Hyporhamphus robusti ( Valenciennes, 1847)                               | Slender halfbeak                      | LC     | x    | x    |
| Holocentridae   | Holocentrus adscensionis (Osbeck, 1765)                                 | Squirrelfish                          | NE     | x    | x    |
| Holocentridae   | Myripristis jacobus (Cuvier, 1829)                                      | Blackbar soldierfish                 | NE     | x    | x    |
| Istiophoridae   | Istiophorus albicans ( Latreille, 1804)                                 | Atlantic sailfish                     | NE     | x    | x    |
| Labridae        | Bodianus rufus (Linnaeus, 1758)                                         | Spanish hogfish                       | LC     | x    | x    |
| Lamnidae        | Carcharodon carcanias ( Linnaeus, 1758)                                 | White shark                           | VU     | x    | x    |
| Lamnidae        | Isurus oxyrinchus ( Rafinesque, 1810)                                   | Shortfin mako                         | VU     | x    | x    |
| Lobotidae       | Lobates surinamensis (Bloch, 1790)                                      | Tripletail                            | NE     | x    | x    |
| Lutjanidae      | Lutjanus analis (Cuvier, 1828)                                          | Mutton snapper                        | VU     | x    | x    |
| Lutjanidae      | Ocyurus chrysurus (Bloch, 1791)                                         | Yellowtail snapper                    | NE     | x    | x    |
| Lutjanidae      | Lutjanus purpureus (Poey, 1866)                                         | Pargo-verdeiro                        | NE     | x    | x    |
| Family               | Species Name                  | Common Names                  | NE | x  | x  | 1,18 |
|----------------------|-------------------------------|-------------------------------|----|----|----|------|
| Lutjanidae           | *Lutjanus synagris* (Linnaeus, 1758) | Southern red snapper          |    |    |    |      |
| Lutjanidae           | *Lutjanus vivanus* (Cuvier, 1828) | Lane snapper                  |    |    |    |      |
| Lutjanidae           | *Lutjanus* spp.               | Silk snapper                  |    |    |    |      |
| Lutjanidae           | *Lutjanus griseus* (Linnaeus, 1758) | Dog snapper                   |    |    |    |      |
| Lutjanidae           | *Etelis oculatus* (Valenciennes, 1828) | Grey snapper                  |    |    |    |      |
| Lutjanidae           | *Lutjanus* spp.               | Queen snapper                 |    |    |    |      |
| Lutjanidae           | *Rhomboplites aurorubens* (Cuvier, 1829) | Vermillion snapper            |    |    |    |      |
| Malacanthidae        | *Malacanthus plumieri* (Bloch, 1786) | Sand tilefish                |    |    |    |      |
| Megalopidae          | *Megalops atlanticus* (Valenciennes, 1847) | Tarpon                       |    |    |    |      |
| Monacanthidae        | *Stephanolepis hispidus* (Linnaeus, 1766) | Planehead filefish            |    |    |    |      |
| Monacanthidae        | *Cantherhines* spp.           | American whitespotted filefish|    |    |    |      |
| Monacanthidae        | *Monacanthus ciliatus* (Mitchell, 1818) | Fringed filefish              |    |    |    |      |
| Monacanthidae        | *Aluterus* spp.               | Dotterel filefish             |    |    |    |      |
| Mullidae             | *Pseudopeneus maculates* (Bloch, 1793) | Spotted goatfish              |    |    |    |      |
| Muraenidae           | *Gymnothorax moringa* (Cuvier, 1829) | Spotted moray                |    |    |    |      |
| Muraenidae           | *Gymnothorax ocellatus* (Agassiz, 1831) | Caribbean ocellated moray    |    |    |    |      |
| Muraenidae           | *Gymnothorax* spp.            | Goldentail moray              |    |    |    |      |
| Muraenidae           | *Gymnothorax funebris* (Ranzani, 1839) | Green moray                  |    |    |    |      |
| Myliobatidae         | *Aetobatus narinari* (Euphrasen, 1790) | Spotted eagle ray             |    |    |    |      |
| Myliobatidae         | *Rhinoptera bonasus* (Mitchell, 1815) | Cownose ray                  |    |    |    |      |
| Myliobatidae         | *Manta birostris* (Walbaum, 1792) | Giant manta                   |    |    |    |      |
| Narcinidae           | *Narcine* spp.                | Lesser electric ray           |    |    |    |      |
| Ophichthidae         | *Ophichthus gomesii* (Castelnau, 1855) | Shrimp eel                   |    |    |    |      |
| Family                  | Species                                                                 | Common Name                     | Country                                              | Status | Recovery | Code |
|------------------------|-------------------------------------------------------------------------|---------------------------------|------------------------------------------------------|--------|----------|------|
| Ophichthidae           | Myrichthys ocellatus (Lesueur, 1825)                                     | Goldspotted eel                 | Mututuca                                             | NE     | x        | 0,05 |
| Ostraciidae            | Acanthostracion spp.                                                    | Honeycomb cowfish               | Baiacu-de-chifre; Baiacu-boim                       | NE     | x        | 0,62 |
| Ostraciidae            | Lactophrys trigonurus (Linnaeus, 1758)                                  | Buffalo trunkfish               | Baiacu-caixão; Boim; Baiacu-pardalzinho             | NE     | x        | 0,28 |
| Polynemidae            | Polydactylus oligodon ( Günther, 1860)                                  | Littlescale threadfin           | Barbudo                                             | NE     | x        | 0,95 |
| Polynemidae            | Polydactylus virginicus (Linnaeus, 1758)                               | Barbu                           | Barbudo                                             | NE     | x        | 0,95 |
| Pomacanthidae          | Pomacanthus paru (Bloch, 1787)                                          | French angelfish                | Jandáia; Mocinha; Cará-manissoa; Parum-dourado     | LC     | x        | 0,54 |
| Pomacanthidae          | Pomacanthus arcuatus (Linnaeus, 1758)                                  | Gray angelfish                  | Parum-preto; Peixe-vidro; Jandáia; Quebra-pedra    | LC     | x        | 0,31 |
| Pomacentridae          | Abudelfduf saxatilis (Linnaeus, 1758)                                  | Sergeant-major                 | Zefinha                                             | NE     | x        | 0,05 |
| Pomacentridae          | Stegastes pictus (Castelnau, 1855)                                      | Yellowtip damselfish            | Patriota                                            | NE     | x        | 0,05 |
| Pomatomidae            | Pomatotinus saltatrix (Linnaeus, 1766)                                 | Bluefish                        | Enchova; Anchova                                     | NE     | x        | 0,23 |
| Priacanthidae          | Priacanthus arenatus (Cuvier, 1829)                                     | Atlantic bigeye                 | Olho-de-boi; Oláo; Olhão                           | NE     | x        | 1,18 |
| Priistidae             | Pristis spp.                                                             | Smalltooth sawfish             | Cação-espadarte                                     | CR     |          | 0,00 |
| Priistignasteridae     | Pellona harroweri (Fowler, 1917)                                        | American coastal pellona        | Sardinha-da-noite                                   | NE     | x        | 1,79 |
| Rachycentridae         | Rachycentron canadum (Linnaeus, 1766)                                   | Cobia                           | Beijupirá; cação-de-escama                          | NE     | x        | 1,38 |
| Rhicodontidae          | Rhinodon typus (Smith, 1828)                                            | Whale shark                     | Tubarão-baleia; Tubarão-cachalote                    | VU     |          | 0,00 |
| Rhinobatidae           | Rhinobatos percellens (Walbaum, 1792)                                   | Chola guitarfish                | Cação-violia; Viola                                 | NT     | x        | 0,69 |
| Scaridae               | Sparisoma axillare (Steindachner, 1878)                                | Gray parrotfish                 | Batata; Boboa; Budião                               | DD     | x        | 0,62 |
| Scaridae               | Sparisoma radians (Valenciennes, 1840)                                 | Bucktooth parrotfish            | Batata; Boboa; Budião                               | LC     | x        | 0,62 |
| Scaridae               | Scarus taeniocerus (Lessson, 1829)                                      | Princess parrotfish             | Budião                                              | LC     | x        | 0,15 |
| Scaridae               | Scarus zelindae (Moura, Figueiredo & Sazim, 2001)                       | Zelinda’s parrotfish            | Budião                                              | DD     | x        | 0,15 |
| Scaridae               | Sparisoma frenadus (Agassiz, 1831)                                      | Agassiz’s parrotfish            | Budião                                              | DD     | x        | 0,15 |
| Scaridae               | Scarus trispinosus (Valenciennes, 1840)                                | Greenback parrotfish            | Budião-verde; Bobó-bico-verde                       | EN     | x        | 0,05 |
| Sciaenidae             | Cynoscion leachiurus (Cuvier, 1830)                                     | Smooth weakfish                 | Pescada-branca                                      | NE     | x        | 1,18 |
| Sciaenidae             | Cynoscion acoupa (Lacepède, 1801)                                       | Acoupa weakfish                 | Pescada-cutipa; Pescada-ticupa; Pescada-amarela    | LC     | x        | 1,10 |
| Sciaenidae             | Paralichthys brasiliensis (Steindachner, 1875)                          | Banded croaker                  | Judeu                                               | NE     | x        | 0,72 |
Table 2 Fish species recorded through interviews with marine artisanal fishermen of the Extractive Reserve Batoque, Ceará, Brazil (Continued)

| Family          | Genus and Species                      | Common Name(s)                                      | Notes                  | Conservation Status | Length |
|-----------------|----------------------------------------|----------------------------------------------------|------------------------|---------------------|--------|
| Sciaenidae      | Cynoscion virescens (Cuvier, 1830)      | Green weakfish                                     | Pescada-curuvina; Pescada-cabeça-de-cobra; Pescada-cururuca | NE      | x x 0,62 |
| Sciaenidae      | Larimus breviceps (Cuvier, 1830)        | Shorthead drum                                      | Boca-mole              | NE                  | x x 0,36 |
| Sciaenidae      | Micropogonias furieri (Desmarest, 1823) | Whitemouth croaker                                  | Curiça; Curiuruca; Corvina | NE x x x           | 0,36   |
| Sciaenidae      | Cynoscion microlepidotus (Cuvier, 1830) | Smallscale weakfish                                 | Pescada-de-dente       | NE                  | x x 0,33 |
| Sciaenidae      | Stellifer rastrifer (Jordan, 1889)      | Rake stardrum                                       | Pescada-cascuda        | NE                  | x x 0,10 |
| Sciaenidae      | Stellifer microps (Steindachner, 1864)  | Smalleye stardrum                                   | Pescada-cascuda; Pescada-curuvina; Pescada-cabeça-de-cobra; Pescada-cururuca | NE x x x | 0,05   |
| Scombridae      | Scomberomorus regalis (Bloch, 1793)     | Cero                                               | Serra                  | LC                  | x x 1,74 |
| Scombridae      | Auxis rochei (Risso, 1810)             | Bullet tuna                                         | Atum; Bonito           | LC                  | x x 1,54 |
| Scombridae      | Auxis thazard (Lacepède, 1800)         | Frigate tuna                                        | Atum; Bonito           | LC                  | x x 1,54 |
| Scombridae      | Euthynnus alletteratus (Rafinesque, 1810) | Little tunny                                       | Atum; Bonito           | LC                  | x x 1,54 |
| Scombridae      | Katsuwonus pelamis (Linnaeus, 1758)    | Skipjack tuna                                       | Atum; Bonito           | LC                  | x x 1,54 |
| Scombridae      | Sarda sarda (Bloch, 1793)              | Atlantic bonito                                    | Atum; Bonito           | LC                  | x x 1,54 |
| Scombridae      | Thunnus albacares (Bonnaterre, 1788)   | Yellowfin tuna                                      | Albacora-de-lajo       | NT                  | x x 1,33 |
| Scombridae      | Acanthocybium solandri (Cuvier, 1832)  | Wahoo                                              | Cavala-impim; cavala-impinge; cavala-preta | LC x x | 1,18   |
| Scombridae      | Scomberomorus cavalla (Cuvier, 1829)   | King mackerel                                       | Cavala-branca; cavala-perna-de-moça | LC x x | 0,87   |
| Scombridae      | Scomber colias (Gmelin, 1789)          | Atlantic chub mackerel                              | Cavalinha; Cavalinha-do-sul | LC x x | 0,15   |
| Scorpaenidae    | Scorpaena brasiliensis (Cuvier, 1829)  | Bartfish                                           | Aniquim                | NE                  | x x 0,21 |
| Scorpaenidae    | Scorpaena plumieri (Bloch, 1789)       | Spotted scorpionfish                                | Aniquim                | NE                  | x x 0,21 |
| Scorpaenidae    | Scorpaenodes spp.                      | Reef scorpionfish                                   | Aniquim                | NE                  | x x 0,21 |
| Serranidae      | Mycteroperca venenosa (Linnaeus, 1738) | Yellowfin grouper                                  | Sirigado               | NT                  | x x 1,69 |
| Serranidae      | Mycteroperca tigris (Valenciennes, 1833) | Tiger grouper                                      | Sirigado               | LC                  | x x 1,69 |
| Serranidae      | Epinephelus guttatus (Linnaeus, 1738)  | Red hind                                           | Garoupa-preta          | LC                  | x x 1,18 |
| Serranidae      | Epinephelus morio (Valenciennes, 1828) | Red grouper                                        | Garoupa-branca         | NT x x x           | 1,18   |
| Serranidae      | Cephalopholis fulva (Linnaeus, 1738)   | Coney                                              |                        | LC                  | x x 1,05 |
Table 2 Fish species recorded through interviews with marine artisanal fishermen of the Extractive Reserve Batoque, Ceará, Brazil (Continued)

| Family          | Species Name                                      | Common Name                   | Status | Abundance |
|-----------------|---------------------------------------------------|--------------------------------|--------|-----------|
| Serranidae      | Mycteroperca microlepis (Goode & Bean, 1879)      | Gag grouper                    | LC     | x         | 0,85     |
| Serranidae      | Mycteroperca bonaci (Poe, 1860)                   | Black grouper                  | NT     | x         | 0,85     |
| Serranidae      | Epinephelus itajara (Lichtenstein, 1822)          | Atlantic goliath grouper       | CR     | x x       | 0,38     |
| Serranidae      | Rhytichthys saponaceus (Bloch & Schneider, 1801)  | Greater soapfish               | NE     | x x       | 0,28     |
| Serranidae      | Diplectrum formosum (Linnaeus, 1766)              | Sand perch                     | NE     | x x       | 0,18     |
| Serranidae      | Epinephelus adscensionis (Osbeck, 1771)           | Rock hind                      | LC     | x x       | 0,13     |
| Serranidae      | Aptychus afer (Bloch, 1793)                       | Muttom hamlet                  | LC     | x x       | 0,08     |
| Sparidae        | Calamus pennatus (Valenciennes, 1830)             | Sheepshead porgy               | NE     | x x       | 0,41     |
| Sparidae        | Calamus peniculatus (Guichenot, 1868)             | Pluma porgy                    | NE     | x x       | 0,41     |
| Sparidae        | Archosargus probatocephalus (Walbaum, 1792)       | Sheepshead                     | NE     | x x       | 0,26     |
| Sparidae        | Archosargus rhomboideal (Linnaeus, 1738)          | Western Atlantic seabream      | NE     | x x       | 0,23     |
| Sphyraenidae    | Sphyraena barracuda (Edwards, 1771)               | Great barracuda                | NE     | x x       | 0,56     |
| Sphyraenidae    | Sphyraena guachancho (Cuvier, 1829)               | Guachancho barracuda           | NE     | x x       | 0,56     |
| Sphyraenidae    | Sphyraena spiraena (Linnaeus, 1738)               | European barracuda             | NE     | x x       | 0,56     |
| Sphyromidae     | Sphyraena lewini (Griffith & Smith, 1834)         | Scalloped hammerhead           | EN     | x x x     | 1,36     |
| Sphyromidae     | Sphyraena mokarran (Rüppell, 1837)                | Great hammerhead               | EN     | x x x     | 1,36     |
| Sphyromidae     | Sphyraena zygaena (Linnaeus, 1758)                | Smooth hammerhead              | VU     | x x x     | 1,36     |
| Sphyromidae     | Sphyraena rubra (Linnaeus, 1758)                  | Bonnethead                     | LC     | x x       | 0,10     |
| Squalidae       | Squalus cubensis (Howell Rivero, 1936)            | Cuban dogfish                  | DD     | x x x     | 0,08     |
Table 2 Fish species recorded through interviews with marine artisanal fishermen of the Extractive Reserve Batoque, Ceará, Brazil *(Continued)*

| Family             | Species Name                  | Common Name                        | Status | F | Co | Med | H | S-R | Aq |
|--------------------|--------------------------------|------------------------------------|--------|---|----|-----|----|-----|----|
| Syngnathidae       | *Hippocampus reidi* (Ginsburg, 1933) | Longsnout seahorse Cavalo-marinho | DD     | x | x  | x   | x  | 0.13|
| Synodontidae       | *Trachinocephalus myops* (Forster, 1801) | Snakefish Traira | NE     | x | x  |     |    | 0.33|
| Synodontidae       | *Synodus foetens* (Linnaeus, 1766) | Inshore lizardfish Lagartixa; Lagarto | NE     |    |    |     |    | 0.00|
| Tetraodontidae     | *Lagocephalus spp.* | Smooth puffer Baiacu-guarajuba; Baiacu-garajuba; Baiacu-arara | NE     |    |    |     |    | 0.74|
| Tetraodontidae     | *Sphoeroides spp.* | Bandtail puffer Baiacu-pintadinho; Baiacu-pintado; Baiacu-da-costa; Baiacu-pardalzinho; Baiacu-listrado | NE     |    |    |     |    | 0.74|
| Trichiuridae       | *Trichiurus lepturus* (Linnaeus, 1758) | Largehead hairtail Espada; Peixe-espada | NE     |    |    |     |    | 0.41|

*Font: fishbase.org*

Legend: NE – Not Evaluated; DD – Data Deficient; LC – Least Concern; NT – Near Threatened; VU – Vulnerable; EN – Endangered; CR – Critically Endangered.

F – Food; Co – Commercial; Med – Medicinal; H – Handicrafts; S-R – Spiritual-religious; Aq – Aquarium.
endangered according to the IUCN Red List [31] (Figure 2). Among the fish sold, the Batoque fishermen cited the “mero” (*Epinephelus itajara*), which has a conservation status of critical [31].

The specie *Lutjanus analis*, known locally as “cioba”, is one of the main commercial fish at Batoque Beach and is classified as vulnerable [31]. The “cação-lixia” (*Ginglymostoma cirratum*), an elasmobranch used for food and sold by the fishermen in both areas is categorized as data deficient by the IUCN [31] and is classified as vulnerable on the IBAMA national red list [32]. It was also found that nine species with commercial use in both areas surveyed (Tables 1 and 2) are present on the national list of species of aquatic invertebrates and overexploited fish or fish threatened by overexploitation [33].

In Tamandaré, some fishermen mentioned that currently the fishing of “mero” (*Epinephelus itajara*) is prohibited, although it was very common more than 10 years. In Batoque, fishermen were unaware that “mero” was a nationally protected fish, as established by IBAMA Ordinance No. 121 of September 20, 2002 [34], regulated by the “Instrução Normativa Interministerial” No. 13, dated October 16, 2012 [35], which prohibits for a period of three years the capture in Brazilian waters of *E. itajara*, popularly known as “mero”, “canapu”, “bodete”, “badejão”, “merete” and “merote”.

The fact that the Tamandaré fishermen stated that “mero” fishing was prohibited was explained by the actions of the federal agency Chico Mendes Institute for Conservation of Biodiversity (ICMBio) and Mere Project in Brazil, both based in the city. This project develops conservation policies for the “mero” fish (*E. itajara*) and associated marine environments in several areas on the Brazilian coast, through a network of institutions. At Batoque Beach, ignorance of the law was due to the lack of supervision on site and of any campaign to raise awareness about the ban on fishing of “mero”. It is noteworthy that the capture of this fish, when it occurs at Batoque, is accidental, according to the fishermen.

Regarding fish used for medicinal purposes, six species were recorded in Tamandaré and 26 in Batoque. The fishermen described different ways of preparing fish for medicinal purposes according to the disease being treated (Table 3). Among the fish with the highest number of citations for that purpose, in both communities, was the “baicau-espinho” (*Chilomycterus antillarum*) and “cavalo-marinho” (*Hippocampus reidi*).

Another mode of use of the fish fauna recorded is related to making crafts (Table 4), for which three species were recorded in Tamandaré and 13 in Batoque, among which the “camurupim” (*Megalops atlanticus*) (Figure 3a) showed a higher number of citations (n = 10). Fishermen acknowledged the use of the scales of this fish to make earrings, curtains and decorative objects, but they claimed that they did not do those themselves. In some cases, the whole fish was used for crafts, such as the “cavalomarinho” (*H. reidi*), which was killed by asphyxiation, sun-dried and used for decoration, as pendant (Figure 3b) or keychain. The “baicau-caixão” (*Lactophrys trigonus*), also used whole for making crafts, was killed by asphyxiation and then taxidermied, where the internal organs were removed and the body cleaned with water.

![Figure 2 Conservation status according to IUCN, fish commercialized in Tamandaré (PE) and Batoque (CE). Legend: NE – Not Evaluated; DD – Data Deficient; LC – Least Concern; NT – Near Threatened; VU – Vulnerable; EN – Endangered; CR – Critically Endangered.](image-url)
Table 3 Fish used for medicinal purposes by fishermen Beach Tamandaré (PE) and Batoque (CE)

| Family/Species | Local name | Number of citations | Part used | Mode of preparation | Illness |
|----------------|------------|---------------------|-----------|---------------------|---------|
| **Balistidae** |            |                     |           |                     |         |
| Balistes vetula (Linnaeus, 1758) |            |                     |           |                     |         |
| **Monacanthidae** |            |                     |           |                     |         |
| Monacanthus ciliatus (Mitchell, 1818) | Cangulo | 02 | Head | Ingestion | Asthma |
| Cantherhines macrocerus (Holland, 1853) |            |                     |           |                     | Sexual impotence |
| **Carcharhinidae** |            |                     |           |                     |         |
| Carcharhinus sp. (Blainville, 1816) |            |                     |           |                     |         |
| Carcharhinus falciformis (Müller&Henle, 1839) |            |                     |           |                     |         |
| C. leucas (Müller&Henle, 1839) |            |                     |           |                     |         |
| C. obscurus (LeSueur, 1818) |            |                     |           |                     |         |
| C. limbatus (Müller&Henle, 1839) |            |                     |           |                     |         |
| Galeocerdo cuvier (Péron&Lesueur, 1822) |            |                     |           |                     |         |
| Rhizoprionodon spp. (Whitley, 1929) |            |                     |           |                     |         |
| R. porosus (Richardson, 1836) |            |                     |           |                     |         |
| R. lalandii (Valenciennes, 1839) |            |                     |           |                     |         |
| Negaprion brevirostris (Poey, 1868) |            |                     |           |                     |         |
| **Ginglymostomatidae** |            |                     |           |                     |         |
| Ginglymostoma cirratum (Bonnaterre, 1788) | Caçao | 01 | Vertebrae | Tea | Osteoporosis |
| **Lamnidae** |            |                     |           |                     |         |
| Carcharodon carcharias (Linnaeus, 1758) |            |                     |           |                     |         |
| Isurus oxyrinchus (Rafinesque, 1810) |            |                     |           |                     |         |
| **Rhinobatidae** |            |                     |           |                     |         |
| Rhinobatos percellens (Walbaum, 1792) |            |                     |           |                     |         |
| **Sphyridae** |            |                     |           |                     |         |
| Sphyra lewini (Griffith & Smith, 1834) |            |                     |           |                     |         |
| S.mokarran (Rüppell, 1837) |            |                     |           |                     |         |
| S. zygaena (Linnaeus, 1758) |            |                     |           |                     |         |
| **Squalidae** |            |                     |           |                     |         |
| Squalus cubensis (Howell Rivero, 1936) |            |                     |           |                     |         |
| **Megalopidae** |            |                     |           |                     |         |
| Megalops atlanticus (Valenciennes, 1847) | Camurupim | 06 | Scales | Tea | Asthma |
| **Clupeidae** |            |                     |           |                     |         |
| Opisthonema oglinum (Lesueur, 1818) | Sardinha | 01 | Whole body | Ingestion | Osteoporosis |
| Harengula jaguana (Poey, 1865) |            |                     |           |                     |         |
| **Diodontidae** |            |                     |           |                     |         |
| Chilomycterus antillarum (Jordan &Rutter, 1897) | Baiacu-espinho | 08 | Liver | External use | Wound, Lump |
| C.spinosus spinosus (Linnaeus, 1758) |            |                     |           |                     |         |
| **Echeneidae** |            |                     |           |                     |         |
| Echeneis naucrates (Linnaeus, 1758) | Piolho | 01 | Suction cup (hat) | Tea | Asthma |
| Remora remora (Linnaeus, 1758) |            |                     |           |                     |         |
| **Myliobatidae** |            |                     |           |                     |         |
| Aetobatus narinari (Euphrasen, 1790) | Arraia-pintada | 06 | Tongue | Tea | Asthma |
and internally stuffed with paper or foam. Finally, the fish was sewn and sun-dried, and later, it could be painted and used for decoration (Figure 3c).

In addition, the fishermen of the two areas studied mentioned the use of “cavalo-marinho” (H. reidi) for magical-religious purposes, where they were sun-dried and used whole as a pendant or kept in the pants pocket. In Tamandaré, one fisherman kept in a small pouch the bony structures from inside the head of the “cavala” (Acanthocybium solandri), called “pebbles” (otoliths), which he took while fishing. According to the fishermen, these fish are used as amulets because they bring good luck and good fishing.

When evaluating the relationship between the types of use of fish cited by the Tamandaré and Batoque fishermen (Figures 4 and 5), there was a cluster of a greater number of species used for food and trade, to the detriment of species used for other purposes. It was found that this difference in grouping was mainly in Batoque, where the Euclidean distance was 35 (Figure 5), while in Tamandaré, it was less than 30 (Figure 4). This fact is probably due to the greater use of different species in Batoque for food and trade.

In summary, the use of fish cited by fishermen was according to the following standards: i) the fishermen had multiple uses for fish; ii) the primary use was for food; iii) relationships existed between different uses, but the fish used for medicinal purposes, handicrafts, magical-religious purposes and aquariums were not necessarily those used for food and trade.

Discussion
Socioeconomic data of the fishermen in the areas surveyed were similar to those that have been recorded in other coastal areas of the world and Brazil, where artisanal fishermen are predominantly male, are generally older, and have low levels of education and income [36].

The small number of fishermen under 30 years of age is a trend observed throughout Brazil, where only 22% of the fishermen are under 30 years of age [36].

Table 3 Fish used for medicinal purposes by fishermen Beach Tamandaré (PE) and Batoque (CE) (Continued)

| Family/Species          | Local name   | Number of citations | Part used  |
|-------------------------|--------------|---------------------|------------|
| Narcinidae              |              |                     |            |
| Narcine bancrofti       | Puraquê      | 01                   | Lard       | External use | Pain, sore |
| N. brasiliensis         |              |                      |            |             |            |
| Syngnathidae           |              |                     |            |
| Hippocampus reidi       | Cavalo-marinho | 0,12                 | Whole body | Tea          | Asthma     |

Table 4 Fish used for making handicrafts by fishermen Beach Tamandaré (PE) and Batoque (CE)

| Family/Species          | Local name   | Number of citations | Part used   |
|-------------------------|--------------|---------------------|-------------|
| Balistidae              |              |                     |             |
| Balistes vetula         |              |                     |             |
| Balistes capriscus      |              |                     |             |
| Canthidermis sufflamen  |              |                     |             |
| Melichthys niger        |              |                     |             |
| Monacanthidae           |              |                     |             |
| Monacanthus ciliatus    | Cangulo      | 1                    | Whole body  |
| Cantherhines spp.       |              | 1                    |             |
| Aluterus heudeletii     |              |                     |             |
| Aluterus schoepfl       |              |                     |             |
| Aluterus monaceros      |              |                     |             |
| Aluterus scriputus      |              |                     |             |
| Stephanolepis hispidus  |              |                     |             |
| Ginglymostomatidae      |              |                     |             |
| Ginglymostoma ciratum   | Caçao-lixa   | 1                    | Lard        |
| Haemulidae              |              |                     |             |
| Haemulon plumieri       | Biquara      | 1                    | Whole body  |
| Lutjanidae              |              |                     |             |
| Lutjanus griseus        | Caranha      | 1                    | Scales      |
| Megalopidae             |              |                     |             |
| Megalops atlanticus     | Camunupim    | 10                   | Scales      |
| Ostraciidae             |              |                     |             |
| Lactophrys trigonus     | Baiaçu-caixão| 1                    | Whole body  |
| Syngnathidae            |              |                     |             |
| Hippocampus reidi       | Cavalo-marinho| 1                   | Whole body  |
This may be indicative of young men’s lack of interest [14,37]. On the other hand, many fishermen have been fishing for more than 10 years, highlighting the economic and social importance of this activity, especially in communities with low social indicators, as the case in the study areas. A similar situation was reported elsewhere among the fishermen of Pernambuco State [38] as well as in other fishing communities in Brazil [39-41].

The low level of education among the fishermen interviewed corroborates the numbers from the Registrar

Figure 4 Dendogram using the Euclidean distance, developed from 207 species listed by fishermen Beach Tamandaré (PE) for each category of use.
General for Fisheries (RGP) of the Ministry of Fisheries and Aquaculture in Brazil [4], which show that 8.1% of registered fishermen are illiterate and that most Brazilian fishermen (75.51%) have only finished elementary school. The results of this research suggest that fishermen who dedicated less of their life to fishing had more opportunities to study, perhaps due to access to schools, which has recently been improved in the areas surveyed. One of the main reasons for dropping out of school may be the need to help support the family, and the lack of incentive to continue studies [42], which directly affects the ability of this working class in social organization.

Although they have low educational level, several studies emphasize that fishermen have ichthyological knowledge [13,14,43]. In this study, we demonstrated the high richness of fish known by the Tamandaré (222 taxa) and Batoque (215 taxa) fishermen, consistent with what has been found in zoological and ethnozoological research conducted in the areas surveyed or in nearby areas. According to the study of marine fish fauna of the Coral Coast Environmental Protected Area, 185 species [44] have been identified. In Ceará, in an ethnotaxonomic study with fishermen of Redonda Beach, at the eastern end of Ceará, 290 species of fish [45] have been identified.

The results of this study indicated that the primary use of the fish fauna recognized by fishermen matches is food, a situation recorded in most ethnoichthyological studies [37,40,46], which are generally aimed at investigating this form of ichthyofauna use. Nevertheless, the products derived from the fish mentioned are also used for other purposes, mainly for commercial food purposes.

Similar to what has been recorded in the fishing communities of North and Northeast Brazil [47], some of the fish fauna of the study areas (30 species) are a source of products used in the preparation of traditional medicines. The number of fish species used in traditional medicine is not surprising, considering their availability and ease of access to freshwater and coastal areas [47,48]. Furthermore, the representativeness of the fish used in traditional medicine has been remarkable, as evidenced by recent reviews on the topic. In Latin America, for example, where at least 584 animals are used for medicinal purposes, 110 are fish species [49]. For this type of use, 93 fish species have been recorded in Brazil [50], of which 58 were recorded in the Northeast region [51].

There was the contrast in the number of medicinal species between the two studies areas, which can be explained by the greater ease of access to conventional medicines in Tamandaré compared to Batoque. This can lead to the replacement of traditional medicine with conventional medicine. However, the common situation in folk medicine was still found to be evident, that is, the overlap between food and medicinal uses. Many fish are consumed for health reasons to prevent or treat illnesses. In a recent review, Alves et al. [50] found that animals are used in Brazil as a source of protein and medicine simultaneously and recorded a total of 77 fish species that fit this context.
Products derived from fish populations are also utilized for making handicrafts in the areas surveyed. This practice has been reported in other places in Brazil, where products from marine animals are used for this purpose, in some cases generating income for many people [52,53]. The use of various animal taxa for handicrafts is widespread worldwide practice, which includes about 5,000 species of molluscs, 40 species of coral and unknown numbers of sponges, echinoderms and fish that are part of the global trade in marine souvenirs [54].

In the study areas, the fish fauna also featured magical-religious use. This type of use, although little studied, is widespread in Brazil [55,56]. Magical-religious use involves different animal taxa, as pointed out in recent studies, which revealed that approximately 100 species of animals are used for this purpose in Brazil [50,51,55], including 19 species of fish [50]. Since ancient times, human cultures attributed magical and religious significance to wild and domesticated animals [55-57].

Some products of magical-religious use recorded in the areas surveyed, such as “cavalas” (Acanthocybium solandri) otoliths, called “pebbles” and used as amulets by fishermen, are similar to those reported elsewhere in the world. According to a study conducted in Baía de Cádiz, Spain, “the bearer of otoliths considers the amulet as a talisman that has properties to ward off evil and curses” [58]. The author also notes that, formerly, the otoliths of the meagre (Argyrosomus regius) were carried in cloth bags or loose in pockets as an amulet and that they are currently marketed in the form of rings, earrings and pendants.

The use of fish for the aquarium was also noted by the fishermen, which is not surprising, since the aquarium hobby is enjoyed in many places around the world [59]. In the last two decades, the million-dollar market of ornamental fish showed great expansion [60], and Brazil stands out as one of the five major exporters of tropical fish for aquariums in the world. Although there are no official statistics on the marine ornamental trade, it is estimated that in Brazil, 75 fish species are caught for the aquarium trade, with 26 being endemic [61]. Among the species cited by fishermen in the present study, seahorses were distinguished by their wide use for aquarium purposes, as recorded in other places in Brazil [62]. In addition, H. reidi was noted primarily for its multiple use in various locations around the country [39,40,51].

The multiple use of fish in fishing communities is common, as was recorded in the study areas and in various fishing communities [39,40,45-47]. The diversity of uses of ichthyofauna reinforces the importance of fish in the culture, livelihood and economic activities of fishing communities where artisanal fishermen catch fish for different purposes. Understanding these different uses and also the meanings that fish possess within a social context is of utmost importance for the formulation of conservation measures consistent with local realities.

**Implications for conservation**

The information obtained from this research can contribute to the preparation of conservation measures directed at endangered species as well as for the creation of marine part of the Extractive Reserve of Batoque and overhaul of the management and administration of fisheries resources of the Coral Coast Environmental Protected Area.

Most fish cited by fishermen for commercial purposes were not evaluated by the International Union for Conservation of Nature and Natural Resources (IUCN), showing a significant gap related to the conservation of fish species that suffer intense fishing pressure. It is recommended to pay special attention to species of the subclass Elasmobranchii (sharks and rays) and families Serranidae (sawfishes and mackerel) and Lutjanidae (snappers), due to the large number of species that are traded and on lists of threatened species. Also, seahorses (H. reidi) deserve conservationist attention, because they are listed as data deficient by the IUCN and have been exploited for a variety of uses, which causes strong pressure on the populations of the species.

We emphasize the need for discussion between environmental agencies and fishermen on the conservation status of fish, because conservation measures that aim to ban the fishing of some species, such as the “mero” (E. itajara), or the imposition of no fishing in marine areas, has not proven effective, causing conflicts between social and environmental aspects that involve fishing.

The results presented, as well as other ethnoichthyological studies point to the need for greater involvement of fishermen in decisions about the management of fisheries resources, it is increasingly evident that the ecological knowledge of fishermen is critical to the implementation of management plans. Even greater control of illegal fishing and industrial fishing is recommended, since such activities have a known impact on marine fish populations, and have affected artisanal fishing, as pointed out by the fishermen themselves. It is believed that actions considering such recommendations can contribute to the sustainable management of fisheries resources, aimed at the conservation of exploited fishes, as well as the maintenance of coastal artisanal fishing.

As the study sites are inserted in protected areas, it is believed that the actions for the conservation of fishery resources can be more efficient. However, for this to happen, it is necessary a joint action between environmental agencies, governments, researchers and the local community.

**Conclusions**

Our results evidence the importance of including artisanal fishermen in pursuit of effectiveness and fishery resources
conservation strategies. These workers and their families depend directly on fishing for their social, economic and cultural development. Therefore, the fishing communities have an intrinsic interest in the preservation of the resources they exploit. Many of these communities are included in protected areas and, therefore, fishermen must be involved in the development and implementation of management plans and management of these areas, especially when considering that there are many examples of inefficiency in these management plans and in the conservation of protected areas in Brazil.

The ethnoichthyological studies are useful for understanding the relationship between fishermen and fish as they contain important information for managers of protected areas. Information about the most exploited species, types of uses, overfishing and population decline are essential when searching ways of sustainable management. In areas of this study, for example, we emphasize the need for adjustments in the management of certain species. As for examples, have been the “mero” (E. itajara) and the “cavalinho-marinho” (H. reidi). Beyond these species, ichthyofauna of the groups that deserve conservation attention of management and environmental agencies, sharks and rays are included and also species of Serranidae and Lutjanidae families.

The use and/or the recognition of different fish used by fishermen emphasize the importance of these animals to the culture of fishing communities. Fish are not used by artisanal fishermen and their families only for food consumption and trade, they are also important for medical purposes, for making handicrafts and magic-religious purposes. For this reason, artisanal fishing should not be understood only as a subsistence activity and commercial purposes, but also as a cultural activity. The fish used for aquarium purposes deserve also conservation attention because the aquarium is a commercial practice and that usually involves species that are most vulnerable.

Competing interests
The authors declare that they have no competing interests.

Authors’ contributions
MFP, JSM and RNRA - Analysis of taxonomic aspects, writing of the manuscript, literature survey and interpretation. MFP - Ethnozoological data collection. All authors read and approved the final manuscript.

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