sociedade & natureza

DOI: http://dx.doi.org/10.14393/SN-v31-2019-45133

Papers

Traditional knowledge of fishermen of the reproductive behavior of fish in a flood lake in western Pará, Brazil

Elizabete de Matos Serrão[1]
Tony Marcos Porto Braga[2]
Yana Karine da Silva Coêlho[3]
Diego Patrick Fróes Campos[4]
Anderson Araújo dos Santos[5]
Luan Campos Imbiriba[6]
Diego Maia Zacardi[7]

Abstract
In this study we analyzed traditional knowledge of fishermen on the reproductive behavior of the 10 most important fish species captured in the region of Maicá, Santarém-Pará - Brazil. Between March-December 2017 we interviewed 88 fisherman who have ten or more years of fishing experience in the region, using standardized and semi-structured forms. The knowledge possessed by fisherman in the region of Maicá was consistent among them and was also detailed and in agreement with concepts established in the scientific literature. Information related by the fishermen for which there were no theoretical references or that differed from the scientific literature can serve as a base for hypotheses for future studies in the region. We suggest that managers of fishing resources in the region take into consideration traditional local knowledge of these fishermen in the elaboration of management plans and future studies, and also apply it to the shared management plan of the future APA-Maicá once it is officially established and regulated.
Keywords: Maicá Lake. Artisanal fishermen. Ethnoichthyology. Fish reproduction.

[1] Universidade Federal do Oeste do Pará, Santarém, PA, Brasil. email: elizabetematos.stm@hotmail.com
[2] Universidade Federal do Oeste do Pará, Santarém, PA, Brasil. email: tony.braga@gmail.com
[3] Universidade Federal do Oeste do Pará, Santarém, PA, Brasil. email: yanacoelho10@gmail.com
[4] Universidade Federal do Oeste do Pará, Santarém, PA, Brasil. email: diegofroes.campos@gmail.com
[5] Universidade Federal do Oeste do Pará, Santarém, PA, Brasil. email: arasantos747@gmail.com
[6] Universidade Federal do Oeste do Pará, Santarém, PA, Brasil. email: luancmps93@gmail.com
[7] Universidade Federal do Oeste do Pará, Santarém, PA, Brasil. email: dmzacardi@hotmail.com
Article received in: 26/09/2018. Accepted for publication in: 06/09/2019.

Introduction

Traditional knowledge, also frequently referred to as local ecological knowledge (LEK) or traditional or indigenous knowledge, refers to the accumulated knowledge of practices, experience and beliefs of groups or individuals about their environment and natural resources that they use (DIEGUES; ARRUDA, 2001; HAMILTON et al., 2012).

Direct contact with fishery resources allows fishermen to gain ample and detailed knowledge of the biology and the state of conservation of species through years of experience of fishing activity (SILVANO; VALBO-JØRGENSEN, 2008; SERRA-PEREIRA et al., 2014). Such information can result in the adoption of management practices that favor the conservation of fishery resources through participative management (SILVANO; BEGOSSI 2010, 2012).

Local knowledge can provide a historical perspective on the state of fish communities, and this is especially important when there is no monitoring or availability of data from long-term observations, as is the case for the majority of artisanal fishing communities in tropical and subtropical environments (LE FUR et al., 2011; HALLWASS et al., 2013). This knowledge is, therefore, able to complement scientific knowledge in the establishment of ecologically sound and socially correct management of fishing activities (MACKINSON; NØTTESTAD, 1998; MATHOOKO, 2005).

In the region around Maicá lake, located in the municipality of Santarém, State of Pará – Brazil, for example, there are dozens of communities that make their living from agriculture and principally extractivist activities such as fishing. In this region, there is currently a state of intense socio-environmental conflict stemming from the possibility of construction of a new port for the export of grains which could cause important environmental changes to the aquatic ecosystem. This construction could compromise the viability of fishing activities and

negatively impact the economic activities of approximately 1,500 artisanal fishermen that depend almost exclusively on fishing activities in this region (SOUSA et al., 2017; VAZ et al., 2017).

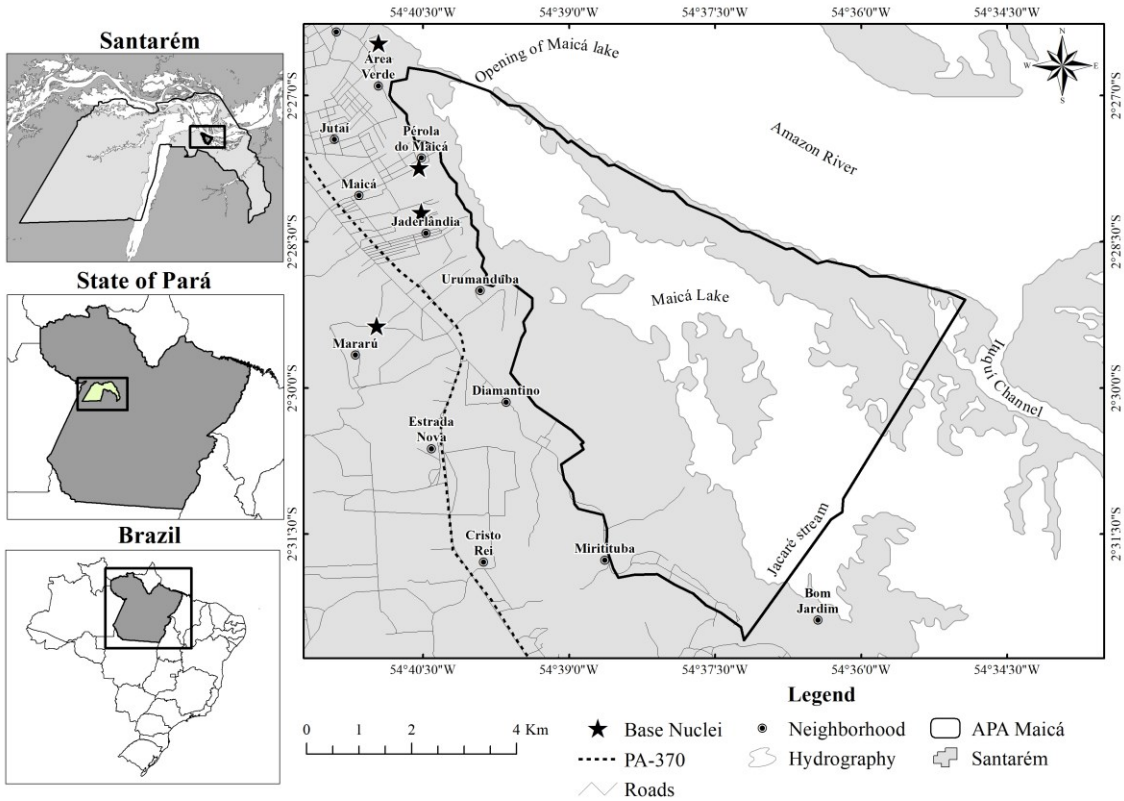
In this context, the objective of this research was to conduct an ethnoichthyological study on the reproductive behavior of the most important fish species that are captured in the region of Maicá and make a comparison between local knowledge and the available scientific literature. The ultimate goal of this work was to reinforce the aspect of complementarity between these two types of knowledge in order to contribute to fishery resource management policies and to aid in the creation of essential strategies for the management, conservation and sustainability of fish species and consequently of local fishing activities.

Material and Methods

Study area

This study was conducted in an area recommended for establishment of an Environmental Protection Area (Área de Proteção Ambiental—APA) denominated APA-Maicá, proposed in the Master Plan of the Municipality 18.051/2006, Art.137, item VI, but which currently is not legally established and regulated. This area is in the larger area of Maicá situated between latitudes 54° 35'49" S and longitudes 02° 43'79" W and partially located in the urban perimeter of the city of Santarém in the state of Pará. According to the proposed legislative bill to create the APA that was proposed by popular initiative by the local population and presented in 2016, the APA would be composed of neighborhoods and communities along its borders from the opening of Maicá lake to the Jacaré stream, located near the edge of the Castela and Bom Jardim communities (Figure 1).

Figure 1 - Map showing the proposed delimitation of the area of the Maicá APA, Santarém, Pará – Brazil.



Source: the authors, 2018

Maicá lake is about 161 km² in aquatic area and is inserted in a region of floodplains (várzea) that is periodically inundated from December to June, and is formed by a system of lakes, the water of which comes from the Tapajós River, and also with a strong influence from the Amazon River (CERDEIRA, 2002). Fishing and tourism are the main activities in the region, due to the exuberant natural scenery with a large extension of flora and fauna that are typical of the Amazon várzea.

Data collection

We collected between April and December of 2017 with authorization of the Fishing Colony Z-20 (Colônia de Pescadores e Pescadoras (CPP) Z-20)

and license no. 1.999.965 from the Committee for Ethics in Research Using Human Beings from the State University of Western Paraná (CEP-UNIOESTE) in order to conduct this study in the communities around Maicá lake.

Initially, we conducted participatory observations which consisted of accompanying the fishermen on their daily routines and participating in their activities in order to engage them in informal and formal conversations. Authorization was also given to participate in meetings and assemblies of the groups that form the nucleus or base of the Z-20. On these occasions, photographs were taken to illustrate information deemed most relevant to this research, such as cultural scenes, social actors, and biological resources exploited, as discussed by Verdejo (2010). During this phase, we identified influential leaders or key informants for each community based on the "snowball" technique (BAILEY, 1982), in order to generate a list with the names of fishermen that should be interviewed, as indicated by their peers.

Fishermen associated with the CPP Z-20 who reside in the communities and/or neighborhoods that are inserted into the proposed area of the APA-Maicá were interviewed using standardized and semi-structured forms. Additionally, we added to the interview list those fishermen formally linked to one of the four Z-20 base nuclei (in Portuguese, Núcleo de base, or NB) that exist in the area: Área Verde -NBAV, Pérola do Maicá - NBPM, Jaderlândia - NBJ and Mararú - NBM. The goal of these interviews was to obtain information about socioeconomic aspects as well as to generate an ethnoichthyological inventory about the reproduction of the main species of fish captured in the area. The duration of each interview depended on the disposition of each interviewee, but on average these lasted about 1 hour.

To collect the ethnoichthyological data, fishermen were selected based on the following criteria: most experienced with ≥10 years fishing and an

indication from other fishermen involved in this study. Based on these criteria, we conducted 88 interviews.

Concerning the issues of fish biology, such as the size at which fish are carrying eggs, we used the method employed by Hallwass (2015), wherein researchers use a metric tape to obtain fish size as indicated by the fisherman's hands during the interview. At the beginning of each interview an Informed Consent form (Termo de Consentimento Livre e Esclarecido – TCLE) was read and given to the interviewed fisherman to explain, inform, and secure the rights of each participant. We wrote notes on paper during the interview process, and when permitted, we electronically recorded the interviews and subsequently transcribed them.

Ethnospecies are popular names for fish that are established through the ethnological criteria of the fishermen, and are grouped based on morphological, aesthetic, and ethological characteristics that the fishermen perceive during their daily fishing activities (MARQUES, 1991). In this research, we grouped these ethnospecies into categories based on perceived similarities as in Cerdeira et al. (2000). For example, within a category denominated "*pacu*" all the ethnospecies of the genera *Mylossoma*, *Myleus*, *Metynnis* and *Myloplus* were included, and for the category called "*aracu*" we grouped various ethnospecies of the genera *Leporinus* and *Schizodon*.

For the scientific identification of the ethnospecies we used the classification systems of Ferreira et al. (1998), Santos et al. (2006), Soares et al. (2008) and Queiroz et al. (2013), using photographs and field notes.

Data analysis

We organized socioeconomic data (age group, years as a fisherman, and formal education level) in a spreadsheet and analyzed them using descriptive statistics including calculations for relative frequency, averages,

and data dispersion in the form of the standard deviation (FONSECA; MARTINS, 2008).

We determined the 10 categories of fish to be used in this study according to the scale employed by Zacardi et al. (2014). We considered only ethnospecies that fit in to the following scales: > 70% (very frequent) and 70% - 40% (frequent). This allowed for the identification of the most frequently ethnospecies captured in fishing activities in the study area.

We used the same scale to determine the reproductive period of the fish species according to the LEK of the fishermen. Therefore, we used the months that were most cited in the interviews and called them very frequent and frequent. The level of agreement between the data registered in the interviews and those from the scientific literature were qualitatively classified (yes, partially, no) according to Hallwass (2015).

We grouped the reproductive periods by taking into consideration fluviometric data from 2017, obtained from the Administration for Hydrographic and Navigation Information of the Brazilian Navy in the city of Santarém. These groups were: flood stage (December to March), high water (May to June), ebb (July to September), and low water (October and November).

We analyzed data on the reproductive behavior of the fish species, whenever possible, by constructing comparative cognition tables, comparing ethnological results with those from the scientific literature, as described by Moura and Marques (2007) and Braga and Rebelo (2017).

The Spearman correlation analysis (r_s) was used to verify a relationship between the average reproductive size of the principal fish species cited by the fishermen and the average size at sexual maturation of these species as established in the scientific literature. For this, the average size at initial sexual maturation was taken to be the estimates of the size at which half the population of a species reaches its first gonadal maturation

(L_{50}) (VAZZOLER, 1996). The correlation analyses were done using the software BIOESTAT, version 5.0 (AYRES et al., 2007).

Results

Profiles of the fishermen

The majority of the interviewed fishermen were male (61%), with an average age of 49 years (± 9 years) (minimum = 26 and maximum = 67 years), average years of experience fishing of 36 years (± 10 years) (minimum = 15 and maximum = 60 years). They have initiated fishing activities when in childhood at an average age of 14 years (± 7 years), accompanied by parents or grandparents.

These fishermen today have as partners in their fishing activities their spouses, brothers, brothers-in-law, and friends. Concerning the level of formal education, the majority (71.6%) did not finish primary school, and 5.7% did not complete high school. Additionally, just 13.6% declared that they completed both primary and high school (6.8% completed each level), 8% stated that they never went to school, and 1.1% did not respond. The majority of the fishermen (70%) were born in Santarém and are from various communities in the region, 10% were born in Alenquer, and the rest were born in 12 other municipalities in the state of Pará. Fishing is the principal source of income for these fishermen, even during seasonal periods when they can engage in other activities such as civil construction as a mason's assistant, agriculture by raising chickens and planting fruits and vegetables, and general services such as vegetation removal for land clearing and fence building.

Traditional Local Knowledge (TLK) and scientific knowledge of fish

There was a positive correlation between the average reproductive size of the most captured fish as cited by fishermen, and the reproductive size as established in the scientific literature (r_s = 0.91; n = 9 species; $p < 0.01$, Table 1). Only *surubim* (*Pseudoplatystoma punctifer* (Castelnau, 1855)) had data that did not correlate and showed a large standard deviation between the sizes. For the *pirapitinga* (*Piaractus brachypomus* (Cuvier, 1818)), we found no information in the literature about its reproductive size.

Table 1. Traditional local knowledge (TLK) on size at first reproduction (standard length in cm) of the 10 principal ethnospecies of fish captured in the region of Maicá Lake, Santarém, Pará. The confirmed values are in bold.

Category name	Common name	Scientific name	Fishermen		Literature	Agreement between data from interviews and literature
			N responses	Reproductive size (cm)	First sexual maturation (cm)	
Acarás	cará, acará, acará-açu, carauaçu, acará-roxo, acaratinga	Cichlidae incluído *Astronotus ocellatus* (Agassiz, 1831), *Chaetobranchopsis orbicularis* (Steindachner, 1875), *Heros* sp., *Geophagus proximus* (Castelnau, 1855) among others.	45	17.1 ± 3.9	25 (1); **13.7** (2)	Yes
Aracus	Aracu	*Leporinus* spp., *Schizodon* spp.	67	22.7 ± 5.3	**19** (3); 16 (2)	Yes
Curimatá	Curimatá	*Prochilodus nigricans* Agassiz, 1829	47	27.4 ± 7.1	**26** (1)	Yes Yes
Pacus	Pacu	Myleinae incluindo *Myleus*, *Metynnis*, *Mylossoma aureum* (Agassiz, 1829), *M. albiscopum* (Cuvier, 1818) among others.	67	17 ± 3.9	**19** (1)	Yes Yes
Jaraquis	Jaraqui	*Semaprochilodus insignis* (Jardine, 1841) and *S. taeniurus* (Valenciennes, 1821)	22	19.3 ± 4.3	26 (1); **16.5** (2)	Yes Yes
Matrinxã	matrinxã, jatuarana	*Brycon amazonicus* (Spix & Agassiz, 1829)	12	32.4 ± 9.5	**32** (1)	Yes Yes
Pirapitinga	Pirapitinga	*Piaractus brachypomus* (Cuvier, 1818)	20	32.5 ± 11.9	No information	No information
Surubim	Surubim	*Pseudoplatystoma punctifer* (Castelnau, 1855)	24	67.5 ± 20.3	45 (1); 72.5 female (5) 72 male (5)	Partial
Tambaqui	tambaqui ou bocó (juvenile phase)	*Colossoma macropomum* (Cuvier, 1818)	10	61.6 ± 19.1 (adult)	**61** (1); **60.69** (4)	Yes
Tucunarés	Tucunaré	*Cichla* spp.	50	29.8 ± 9.0	**23 and 27** (1)	Yes

Source: authors, 2018

The reproductive period indicated by the fishermen and that described in the scientific literature did not overlap much, and there were just two instances when there was a full consensus (yes) between the two groups and eight with partial consensus (Table 2). Concerning the reproductive period of *tambaqui* (*Colossoma macropomum* (Cuvier, 1818)), the majority of fishermen (60%) stated that they did not know, and those that responded yes were unsure of the exact period. According to the latter, "we are only catching *tambaqui* in a juvenile phase" (related by fisherman M. NBPM, 61 years) and "it's been a while since anyone saw these fish carrying eggs" (related by fisherman E. NBAV, 52 years). In general, information about reproductive size is thought to come from the experience of parents and grandparents and also from other fishermen who relate what they have seen to those with less experience.

Table 2. Traditional local knowledge (TLK) of the periods of reproductive activity of the 10 principal ethnospecies of fish captured in the region of Maicá lake, Santarém, Pará and information from the scientific literature (SL).

Category		Flooding	High water	Ebb	Low water	Flooding	Agreement between data from interviews and literature
		Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov	Dec	
		Closed season			Closed season		
Acarás	TLK						Partial
	SL						
Aracus	TLK						Yes
	SL						
Curimatá	TLK						Partial
	SL						
Pacus	TLK						Partial
	SL						
Jaraquis	TLK						Partial
	SL						
Matrinxã	TLK						Partial
	SL						
Pirapitinga	TLK						Partial
	SL						
Surubim	TLK						Partial
	SL						
Tambaqui	TLK						Partial
	SL						
Tucunarés	TLK						Yes
	SL						

Source: authors, 2018

The interviewed fishermen affirmed that the majority of these ethnospecies of fish that are targets for capture spawn in the river (*matrinxã, curimatá, pirapitinga, surubim, aracus* and *jaraquis*), but there were some disagreements about which species spawn in the lake, with just two ethnospecies (acarás and tucunarés) being in agreement with the literature. When questioned about parental care and type of spawning the information between the two groups agreed (Table 3). Information on sexual dimorphism in the *carauaçu* ethnospecies and the ethology of *curimatá* (Table 3) was not found in the literature and could not be analyzed.

The tucunarés (N=55) and the acarás (N=34) are the only ethnospecies cited that make nests and take care of offspring, and that engage in partial spawning. The fishermen informed that these species had been seen carrying eggs and taking care of offspring during different periods of the year. For example, fisherman C. NBM, 50 years, explains that "I think that the *tucunaré* spawns more than once… because I have found them in April with offspring and once again in September". For the *acará* "when the closed period is over there are still some of them carrying eggs" (related by fisherwoman S. NBJ, 47 years).

When questioned about sexual dimorphism, for the fishermen the only ethnospecies that shows this characteristic is the tucunaré (N=12), with the appearance of a "backpack" near the head of the male during the reproductive period. Other ethnospecies such as the *aracus* (N=7) and the curimatá (N=19) were cited as being those in which the "males are narrow and long and the females are wide" (related by fisherman R. NBAV, 54 years). For the ethnospecies such as *pacus*, *tambaqui*, *pirapitinga*, *surubim*, *acarás*, *matrinxã* and *jaraquis*, the fisherman declared that they did not have information and identify the reproductive period simply by noting that "the female has a belly full of eggs but the male doesn't, the male doesn't carry eggs in his belly, he just has that sack in his belly that is full of milk" (related by fisherwoman A. NBPM, 51 years).

Table 3. Cognitive table on reproductive behavior of the 10 principal ethnospecies of fish captured by fishermen in the region of Maicá Lake, Santarém, Pará and information from the scientific literature. The confirmed values are in bold.

Behavior	Fishermen information	Categories	Agreement between data from interviews and literature
Spawning location	*Spawn in the lake in tree trunks, weeds, bunches of sticks and branches...its full of offspring there*	aracus, **acarás (1),** curimatá, pacus, pirapitinga	Partial
	Go up the Amazonas River to spawn	**aracus (1), matrinxã (1)**, **curimatá (1)**, **jaraquis (1)**, **pirapitinga (1), surubim (2)**	Yes
	Spawn in the lake, the eggs stick to sticks and branches	**tucunaré (1)**	Yes
Parental care	*Don't take care of offspring, have never seen them with offspring*	**aracus (2), matrinxa (2), jaraquis (2), pacus (2), pirapitinga (2), surubim (2), tambaqui (2)**	Yes
	...keep offspring under their gills, when they get larger offspring hide in the mouth and afterward swim around the parent's head; offspring are kept in the mouth in January to March	**acarás (1)**	Yes
	Take care of offspring, they swim around the father's head	**acarás (1), tucunaré (1)**	Yes
	...they carry offspring in the mouth when they are threatened	**tucunaré (1)**	Yes
Type of spawning	*I think they spawn just once*	**aracus (2), curimatá (2), about (2), pacus (2), pirapitinga (2), surubim (2)**	Yes
	I think they spawn more than once/year	**acarás (1), tucunaré (1)**	Yes
Sexual dimorphism	*Male long and thin and female wider and fatter*	**aracus (3), curimatá (3)**	Yes
	Female turns redder in color during the reproductive phase	Carauaçu	No information
	Male has a "backpack" on its back	**tucunaré (4)**	Yes
Ethology	*…father makes a hole and sits in it on the soil or on a stick or branch and the offspring stay near him...*	**acarás (1), tucunaré (1)**	Yes
	...spawns on his scales and he stays hidden behind and makes a noise like snoring at the moment of spawning. …they are always together as a couple	Curimatá **acarás (1)**	No information Yes

(1) (SANTOS et al., 2006); (2) (BARTHEM; FABRÉ, 2004); (3) (VAZZOLER, 1996); (4) (CHELLAPPA et al., 2003).
Source: authors, 2018

Discussion

The necessity to directly exploit natural resources to support a family and economically survive has contributed to the construction of an accurate body of traditional knowledge by Amazonian communities, accumulated during several generations in diverse environments through the exploitation of animals and plants in these areas. The construction of this knowledge by fishing communities, according to Doria et al. (2008) happened through daily contact of *ribeirinhos* (people living in communities on the edges of rivers) with the aquatic environment with the necessity of exploiting fishery resources. This turned these *riberinhos* into specialists capable of providing accurate information about their environment and its resources.

In this context, good knowledge of local aquatic ecosystems, including environmental and bioecological factors that influence reproduction, feeding, distribution and abundance of fishery resources is fundamental for the creation of fishing strategies, which also implies different spatial and temporal scales.

Therefore, traditional knowledge possessed by fishermen indicates that these social actors have the potential to share knowledge, participate in dialogues and help in decision-making with respect to management of local fisheries. Furthermore, other authors can construct new hypotheses for based on this knowledge, and these could have potential to provide important data and insights on specific local environmental conditions (SILVA; BRAGA, 2017).

The *acarás, aracus, pacus, jaraquis, tucunarés, curimatá, matrinxã, pirapitinga, surubim* and *tambaqui* are important species to the community of fishermen around Maicá lake. For two main reasons: the high frequency of fishing trips needed to provide food to the majority of the population that uses the lake and the high commercial value of some species that local consumers sought after. It is common that the knowledge of fishermen with

respect to species that are more abundant and useful will be more developed and profound, especially for those that are commercially more valuable (SILVANO; BEGOSSI, 2002), a reality that has also been shown for fishermen in other regions in Brazil (RAMIRES et al., 2007; SILVANO; BEGOSSI, 2012; SILVA et al., 2014; HALLWASS, 2015; BRAGA; REBELO, 2017).

Of the species evaluated concerning the knowledge of reproductive size, the *surubim* (*P. punctifer*) presented a large standard deviation of sizes cited by the fishermen. This could reveal a lack of consensus among them about this parameter, principally due to the difficulty of capturing this species during the reproductive period. However, it is common that new doubts and questions arise when research that has an emic and/or ethics approach is undertaken (MARQUES, 1991), which consists of a comparison between traditional/emic knowledge and that obtained from the academic literature (ethics) (FELEPPA, 1986).

For the *pirapitinga*, we found no scientific data on size at first sexual maturation. The lack of scientific information illustrates a global problem faced by fisheries scientists that work in tropical regions that are rich in species but poor in data, and where information on the life cycle of species is frequently scarce, missing, or onerous to acquire (FROESE; PAULY, 2017; MCLEAN; FORRESTER, 2017). Knowledge of this population parameter is of fundamental importance for the adequate management of fish stocks (VAZZOLER, 1996). It is through this information, together with that of biology and reproduction of species, that the responsible administrative agencies can formulate organization and management plans for fisheries in specific regions, taking into consideration regional variation of fish populations imposed by local environmental conditions (DORIA et al., 2008).

Fishermen customarily relate the information on the reproductive period of species to the level of the river, and also to the period closed to fishing, which goes from November 15 to March 15, even for species that are

not protected by this period of closure. For the fishermen, it is important to consider that November is the reproductive period because "it's when the fishes are preparing to spawn in December" (related by fisherman D. NBAV, 54 years), which is the beginning of the period of flooding (December to April).

Studies on ichthyoplankton in the Lower Amazon River region have shown that reproductive peaks of the principal migratory species exploited by commercial fishing and that have the highest local economic interest occur during the period of closure established by the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA) for the Lower Amazon River region. This indicates that the period of highest reproductive activity happens during the high-water period (CHAVES et al., 2017; ZACARDI et al., 2017; PONTE et al., 2017).

However, local traditional knowledge of fishermen about the reproductive period of the majority of species (8 species) was only partially in agreement with the literature and there were varied opinions about the exact months of reproduction. Some of these opinions were incompatible with the period of closure for fishing, as related by a fisherman for the ethnospecies *acará* when the period of closure ends there are still some carrying eggs" (related by fisherwoman S. NBJ, 47 years).

These examples of diverging information can and should contribute to a larger discussion of the closure period in the region, favoring a dialogue between the Z-20 fishing cooperative and government agencies in order to contemplate a revision of this policy to create a closure period that is adequate to local reality.

The active participation of people and traditional communities in the social control of decision-making processes related to their rights and interests is one of the main principles of the National Policy on Sustainable Development of People and Communities, under decree no. 6.040, of February 7, 2007. This decree has the objective of promoting the sustainable

development of people and traditional communities, with an emphasis on recognizing, strengthening and guaranteeing their territorial, social, environmental, economic, and cultural rights, respecting and valuing their identities their forms of organization and their institutions.

There was a difference between the information related by the fishermen and that in the literature about spawning locations for migratory species (*aracus*, *curimatá*, *pacus* and *pirapitinga*). The fishermen stated that the lakes are more important places of reproduction compared to the rivers, possibly because fishermen can spot the juvenile phase of these species in the lake under mats of floating vegetation, aquatic macrophytes, vegetation on the edge of the water and/or in inundated forest. One of the fishermen confirmed this hypothesis: "All these fish that I have just mentioned to you (*aracus*, *curimatá*, *pacus* and *pirapitinga*) spawn in the lake in tree trunks, weeds, bunches of sticks and branches... it's full of offspring there) (related by fisherman A. NBJ, 53 years) which to them means that this is the place of reproduction of these species.

Zacardi (2014) studied the ecology of fish eggs and larvae in the region of the Middle Solimões River and the Lower Japurá River, near the Mamirauá Sustainable Development Reserve. This author observed that the vast majority of larvae captured in the principal canal of the rivers were in initial stages of development and that the subsequent phases (postflexion and juvenile) were present in flooded areas of várzea such as canals and lakes. The author concluded that these regions are used as nurseries for development and growth by a large portion of the regional ichthyofauna. This demonstrates that in the initial stages of life of these species they use a wide range of habitats for refuge, protection and feeding during their entire development period. Therefore, these periodically flooded regions are adequate for growth of diverse migratory and sedentary species that have an economic interest for fishermen because there will be a high concentration of these fish in these areas (ZACARDI et al., 2017). This

justifies the comment of the fisherman associating the presence of juveniles in the lake with their spawning location.

The information related by the fishermen that *tucunarés* and *acarás* are the only ethnospecies that make nests, protect their offspring and engage in partial spawning is confirmed by Santos et al. (2006), in a study that relates detailed information on the family Cichlidae. The presence of sexual dimorphism was cited only for *tucunarés*, and mature males do have a post-occipital cephalic protuberance that is a secondary, extragenital sexual characteristic that has a reserve of lipids, and that disappears after the reproductive period (CHELLAPPA et al., 2003).

Final Considerations

Artisanal fishing is the principal source of income of the fishermen researched in the area proposed for the implantation of the APA-Maicá. They have been engaged in this activity since they were children, accompanied by parents or grandparents, and this has given a wealth of experience and a high level of ethnoichthyological knowledge, which we observed in this study.

These fishermen described, with a high level of detail the reproductive cycles of different fish species, and generally associate the annual variation in the water level of the rivers to the period of closure for fishing, even for species of fish that are not protected by this closure. They also accurately indicated the size of the fish at first sexual maturity, information that is extremely important for the creation of organization and management plans for fisheries in the region.

The fishermen also related that there is a large presence of juvenile fish in the Maicá lake, which emphasizes the importance of this environment as key for conditions that are adequate for the growth of diverse migratory and sedentary species that have an economic interest for

fishermen. This supports the necessity of conservation of this area to maximize fish populations.

The agreement between fishermen's knowledge and the concepts established in the scientific literature, as shown in this research, demonstrates the increasing importance of ethnoecology. However, diverging information can be used to generate hypotheses for future scientific studies. These future studies could provide important data and insights on specific environments, which can create or modify public policies as strategies for adequate conservation of biodiversity in the region.

Using these data as a reference base, we recommend that fisheries managers recognize and take into consideration the TLK of these fishermen and use this information in the formulation of participative environmental policies and for the elaboration of a shared management plan for the future APA-Maicá.

References

AYRES, M.; AYRES JUNIOR, M.; AYRES, D. L.; SANTOS, A. S. *BIOESTAT:* **Aplicações estatísticas nas áreas das ciências biológicas e médicas**. Versão 5.0, Belém: Sociedade Civil Mamirauá; Brasília: CNPQ, 2007.

BAILEY, K. D. **Methods of Social Research**. McMillan. Nova York: EEUU, 1982. 553p.

BARTHEM, R. B.; FABRÉ, N. N. Biologia e diversidade dos recursos pesqueiros na Amazônia. In: RUFFINO, M. L. **A pesca e os recursos pesqueiros na Amazônia.** Manaus: IBAMA, 2004. p. 17-62.

BRAGA, T. M. P.; REBÊLO, G. H. Traditional Knowledgeofthe Fishermen of the Lower Juruá River: Understanding the Reproductive Patterns of the Region's Fish Species. **Desenvolvimento e Meio Ambiente**, v. 40, n. 1, p. 385-397. 2017. https://doi.org/10.5380/dma.v40i0.44776

BRASIL. **Decreto nº 6.040, de 7 de fevereiro de 2007**. Política Nacional de Desenvolvimento Sustentável dos Povos e Comunidades Tradicionais. Available in: http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/decreto/d6040.htm. Accessed on: 13 de agosto de 2019.

CERDEIRA, R. G. P.; ISAAC, V. J.; RUFFINO, M. L. **Captura de pescado nas comunidades do Lago Grande de Monte Alegre-PA,** IBAMA-AM/PróVárzea, 2000. 36p.

CERDEIRA, R. G. P. **Projeto "Acordos de pesca, alternativa para o manejo de recursos pesqueiros"** Relatório de atividades. Santarém: Instituto Amazônico de Manejo Sustentável dos Recursos Ambientais – IARA, 2002. 27p.

CHAVES, C. S.; CARVALHO, J. S.; PONTE, S. C. S., FERREIRA, L. C.; ZACARDI, D. M. Distribuição de larvas de Pimelodidae (Pisces, Siluriformes) no trecho inferior do rio Amazonas, Santarém, Pará. **Scientia Amazonia**, v. 6, n. 1, p. 19-30, 2017.

CHELLAPPA, S.; CÂMARA, M. R.; CHELLAPPA, N. T.; BEVERIDGE, M. C. M.; HUNTINGFORD, F. A. Reproductive ecology of a neotropical Cichlidfish, *Cichla monoculus* (Osteichthyes: Cichlidae). **Brazilian Journal of Biology**, v. 63, n. 1, p. 17-26, 2003. https://doi.org/10.1590/S1519-69842003000100004

DIEGUES, A. C.; ARRUDA, R. S. V. **Saberes tradicionais e biodiversidade no Brasil.** Brasília: Ministério do Meio Ambiente. São Paulo: USP, 2001. 176p.

DORIA, C. R. C.; ARAÚJO, T. R.; SOUZA, S. T. B.; TORRENTE-VILARA, G. Contribuição da etnoictiologia à análise da legislação pesqueira referente ao defeso de espécies de peixes de interesse comercial no oeste da Amazônia Brasileira, rio Guaporé, Rondônia, Brazil. **Biotemas**, v. 21, n. 2, p. 119-132, 2008. https://doi.org/10.5007/2175-7925.2008v21n2p119

FELEPPA, R. Emics, ethics, and social objectivity. **Current Anthropology**, v. 27, n. 3, p. 243-254, 1986. https://doi.org/10.1086/203426

FERREIRA, E. J. G.; ZUANON, J. A. S.; SANTOS, G. M. **Peixes comerciais do médio Amazonas: região de Santarém, Pará**. Brasília: Edições IBAMA, 1998. 214p. ISSN 0103-9695.

FONSECA, J. S.; MARTINS, G. A. **Curso de Estatística**. São Paulo: Atlas, 2008.

FROESE, R.; PAULY, D. 2017 FishBase. World Wide Web electronic publication. Available in: http://www.fishbase.org. Accessed on: September 15, 2017.

HALLWASS, G. **Etnoecologia e Pesca: influência de Unidades de Conservação e aplicação do Conhecimento Ecológico Local de pescadores no manejo e conservação dos recursos pesqueiros no Baixo Rio Tapajós, Amazônia Brasileira**. 178p. 2015. Tese (Instituto de Biociências) - Universidade Federal do Rio Grande do Sul, Porto Alegre, 2015. Available in: https://www.lume.ufrgs.br/bitstream/handle/10183/119625/000969840.pdf?sequence=1. Accessed on: January 01, 2017.

HALLWASS, G.; LOPES, P. F.; JURAS, A. A.; SILVANO, R. A. A. Fishers' knowledge identifies environmental changes and fish abundance trends in impounded tropical rivers. **Ecological Applications**, v. 23, n. 2, p. 392-407, 2013. https://doi.org/10.1890/12-0429.1

HAMILTON, R.; SADOV, Y. de M.; AGUILLAR-PERERA, A. The role of local ecological knowledge in the conservation and management of Reef Fish Spawning Aggregations. In: SADOV, Y. de M.; COLIN, P. L. (eds.) **Reef Fish Spawning Aggregations.** Fish & Fisheries. Series 35, Springer Science, 2012. p. 331-369. https://doi.org/10.1007/978-94-007-1980-4_10

LE FUR, J.; GUILAVOGUI, A., TEITELBAUM, A. Contribution of local fishermen to improving knowledge of the marine ecosystem and resources in the Republic of Guinea, West Africa. **Canadian Journal of Fisheries and Aquatic Sciences**, v. 68, n. 1, p. 1454-1469, 2011. https://doi.org/10.1139/f2011-061

MACKINSON, S.; NØTTESTAD, L. Combining Local and Scientific Knowledge. **Reviews in Fish Biology and Fisheries**, v. 8, n. 4, p. 481-490, 1998. https://doi.org/10.1023/A:1008847106984

MARQUES, J. G. W. **Aspectos Ecológicos na Etnoictiologia dos pescadores do Complexo Estuarino-Lagunar Mundaú-Manguaba, Alagoas**. 297p. 1991. Tese-Universidade Estadual de Campinas, Campinas.

MATHOOKO, J. M. Application of traditional ecological knowledge in the management and sustainability of fisheries in East Africa: a long-neglected strategy? **Hydrobiologia**, v. 537, n. 1, p. 1-6, 2005. https://doi.org/10.1007/s10750-004-2788-8

MCLEAN, E. L.; FORRESTER, G. E. **Comparing estimates of size-at-maturity and maximum body size made by fishers and scientists as indicators of potentia lover fishing**. (*Marine Affairs Data Sets).* Paper 1. 2017. Available in: http://digitalcommons.uri.edu/maf_data/1. Accessed on: March 20, 2018.

MOURA, F. B. P.; MARQUES, J. G. W. Conhecimento de pescadores tradicionais sobre a dinâmica espaço-temporal de recursos naturais na Chapada Diamantina, Bahia. **Biota Neotropica**, v. 7, n. 3, p. 119-126, 2007. https://doi.org/10.1590/S1676-06032007000300014

PONTE, S. C. S.; SILVA, A. J. S.; ZACARDI, D. M. Áreas de dispersão e berçário para larvas de Curimatidae (Pisces, Characiformes), no trecho baixo do rio Amazonas, Brasil. **Interciência**, v. 42, n. 11, p. 727-732, 2017.
QUEIROZ, L. J.; TORRENTE-VILARA, G.; OHARA, W. M.; PIRES, T. H. S.; ZUANON, J.; DORIA, C. R. C. **Peixes do Rio Madeira**. 1. ed. -- São Paulo: Dialeto Latin American Documentary, 2013. Obra em 3 v.
RAMIRES, M.; MOLINA, S. M. G.; HANAZAKI, N. Etnoecologia caiçara: o conhecimento dos pescadores artesanais sobre aspectos ecológicos da pesca. **Biotemas**, v. 20, n. 1, p. 101-113, 2007.
RIVERA, D. S. B. **Conhecimento tradicional como instrumento para conservação e manejo do caranguejo uçá ucides cordatus (Linnaeus, 1763) na reserva extrativista marinha de São João da Ponta – Pará.** 100p. 2015. Dissertação (Mestre em Gestão de Áreas Protegidas na Amazônia) - Instituto Nacional de Pesquisas da Amazônia**.** Manaus, 2015. Available in: https://bdtd.inpa.gov.br/bitstream/tede/1783/5/Disserta%c3%a7%c3%a3o_%20Danielle%20Brigida%20Rivera.pdf. Accessed on: August 11, 2019.
SANTOS, G. M; FERREIRA, E. J. G.; ZUANON, J. A. S. **Peixes comerciais de Manaus**. Manaus: IBAMA-AM/ProVárzea, 2006. 144p. ISBN 85-7300-211-5.
SERRA-PEREIRA, B.; ERZINI, K.; MAIA, C.; FIGUEIREDO, I. Identification of Potential Essential Fish Habitats for Skates Based on Fishers' Knowledge. **Environmental Management**, v. 53, n. 5, p. 985-998, 2014. https://doi.org/10.1007/s00267-014-0257-3
SILVA, E. F.; LINS OLIVEIRA, J. E; SCHIAVETTI, A. Conhecimento ecológico local (CEL) na pesca artesanal da reserva de desenvolvimento sustentável estadual Ponta do tubarão – RN, Brasil. **Boletim do Instituto da Pesca**, v. 40, n. 3, p. 355-375, 2014.
SILVA, J. T. S.; BRAGA, T. M. P. Etnoictiologia de pescadores artesanais da comunidade Surucuá (reserva extrativista Tapajós-Arapiuns). **Amazônia Revista de Antropologia**, v. 9, n. 1, p. 238-257, 2017. https://doi.org/10.18542/amazonica.v9i1.5490
SILVANO, R. A. M.; BEGOSSI, A. Ethnoichthyology and fish conservation in the Piracicaba river (Brazil). **Journal of Ethnobiology**, v. 22, n. 2, p. 285-306, 2002.
SILVANO, R. A. M.; BEGOSSI, A. What can be learned from fishers? An integrated survey of fishers' local ecological knowledge and bluefish (*Pomatomuss altatrix*) biology on the Brazilian Coast. **Hydrobiologia**, v. 637, p. 3-18, 2010. https://doi.org/10.1007/s10750-009-9979-2
SILVANO, R. A. M.; BEGOSSI, A. Fishermen's local ecological knowledge on Southeastern Brazilian coastal fishes: contributions to research, conservations, and management. **Neotropical Ichthyology**, v. 10, n. 1, p. 133-147, 2012. https://doi.org/10.1590/S1679-62252012000100013
SILVANO, R. A. M.; VALBO-JØRGENSEN, J. Beyond fishermen's tales: contribuitions of fishers' local ecological knowledge to fish ecology and fisheries management. **Environment, Developmentand Sustainability**, v. 10, n. 5, p. 657-675, 2008. https://doi.org/10.1007/s10668-008-9149-0
SOARES, M. G. M.; COSTA, E. L.; SIQUEIRA-SOUZA, F. K.; ANJOS, H. D. B.; YAMAMOTO, K. C.; FREITAS, C. E. C. **Peixes de lagos do Médio Rio Solimões**. 2. ed. rev.– Manaus: Instituto I-Piatam, 2008. p. 160. ISBN 8574012643.
SOUSA, W. L.; MONTE, L. F. O.; SANTOS, A. O. A pesca artesanal na região Amazônica: estudo de caso dos pescadores do bairro do Pérola do Maicá em Santarém-Pará. **Raízes,** v. 37, n. 1, p. 95-104, 2017.
VAZ, E. M.; RABELO, Y. G. S.; CORRÊA, J. M. S.; ZACARDI, D. M. A pesca artesanal no lago Maicá: aspectos socioeconômicos e estrutura operacional. **Biota Amazônia**, v. 7, n. 4, p. 6-12, 2017.
VAZZOLER, A. E. A. M. **Biologia da reprodução de peixes teleósteos: teoria e prática**. Maringá: EDUEM. São Paulo. SBI, 1996. 169p.

VERDEJO, M. E. **Diagnóstico rural participativo: guia prático DRP**/por Miguel Exposito Verdejo, revisão e adequação de Décio Cotrim e Ladjane Ramos. - Brasıĺia: MDA / Secretaria da Agricultura Familiar. 2010.

ZACARDI, D. M. **Abundância e distribuição espaço-temporal de ovos e larvas de peixes de interesse econômico no médio Rio Solimões e baixo Rio Japurá, Amazônia Central, Brasil.** 121p. 2014. Tese (Programa de Pós-Graduação em Ciência Animal) - Universidade Federal do Pará, Belém, 2014.

ZACARDI, D. M.; PONTE, S. C. S.; FERREIRA, L. C. F.; LIMA, M. A. S.; SILVA, A. J. S.; CHAVES, C. S. Diversity and spatio-temporal distribution of the ichthyoplankton in the lower Amazon River, Brazil**. Biota Amazônia**, v. 7, n. 2, p. 12-20, 2017.

ZACARDI, D. M.; PONTE, S. C. S.; SILVA, A. J. S. Caracterização da pesca e perfil dos pescadores artesanais de uma comunidade às margens do rio Tapajós, Pará. **Amazônia Ciência e Desenvolvimento**, v. 10, n. 19, p. 129-148, 2014.