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Original Article

Socioeconomic aspects and profile of fishing according to fishers of commercial edible fish in the municipality of Barcelos, middle Negro River, Amazonas, Brazil

Aspectos socioeconômicos e perfil da pesca segundo pescadores de peixes comestíveis no município de Barcelos, médio rio Negro, Amazonas, Brasil

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Abstract

Fishing plays a prominent role in the socioeconomic scope of the Negro River basin and is considered one of the main extractive activities in the region. The objective of this study was to describe the socioeconomic aspects of commercial fishers of edible fish who work in the municipality of Barcelos, in the middle Negro River region, as well as to highlight the scenario of the fishing activity from the point of view of the fishers. The information was collected between January and December 2016 in the municipality of Barcelos, state of Amazonas, via semi-structured questionnaires. Most interviewees were male (71.14%), aged between 18 and 82 years and a mean age of 48 years. With a low level of education, 45.0% had only incomplete elementary education and 15% were illiterate. The fishing tackle most used by fishermen was the gillnet, especially by urban fishermen (70%). Among the fishing sites, the main one was the Demeni River (50%). Commercial fishing for edible fish in Barcelos focused on Characiformes, Perciformes and Siluriformes fish. The main difficulties faced by the activity are related to the seasonality of the level of rivers and local tributaries, as well as the lack of buyers and low selling price of fish, in addition to conflicts over the use of fishing resources. Commercial fishing for edible fish is an activity of great socioeconomic importance for riverside families in the Middle River Negro basin, which needs greater attention from the public authorities. Therefore, it is expected that the information contained in this study can help in the decision-making process for the management of local fisheries resources and contribute to the resumption of growth and sustainability of commercial edible fish fisheries.

Keywords: ethnoknowledge, ethnoictiology, commercial fishing, fishers.

Resumo

A pesca desempenha papel de destaque no âmbito socioeconômico da bacia do rio Negro e é considerada uma das principais atividades extrativistas da região. O objetivo deste estudo foi descrever os aspectos socioeconômicos dos pescadores comerciais de peixes comestíveis que atuam no município de Barcelos, região do médio rio Negro, bem como destacar o cenário da atividade pesqueira sob o ponto de vista dos pescadores. As informações foram coletadas entre janeiro e dezembro de 2016 no município de Barcelos, estado do Amazonas, por meio de questionários semiestruturados. A maioria dos entrevistados era do sexo masculino (71,14%), com faixa etária entre 18 a 82 anos e média de idade de 48 anos. Apresentando baixo nível de escolaridade, 45,0% apenas com ensino fundamental incompleto e 15% analfabetos. O apetrecho de pesca mais utilizado pelos pescadores foi a malhadeira, especialmente pelos pescadores urbanos (70%). Entre os locais de pesca, o principal foi rio Demeni (50%). A pesca comercial de peixes comestíveis em Barcelos concentrou-se sobre peixes Characiformes, Perciformes e Siluriformes. A principais dificuldades enfrentadas pela atividade estão relacionadas à sazonalidade do nível dos rios e afluentes locais, assim como a carência de compradores e baixo preço de venda do pescado, além de conflitos pelo uso dos recursos pesqueiros. A pesca comercial de peixes comestíveis é uma atividade de grande importância socioeconômica para as famílias ribeirinhas da bacia do Médio Rio Negro que carece de maior atenção por parte

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do poder público. Diante disso, espera-se que as informações contidas nesse estudo possam auxiliar no processo de tomada de decisão para a gestão dos recursos pesqueiros locais e contribuir para a retomada do crescimento e sustentabilidade da pesca de peixes comestíveis comerciais.

Palavras-chave: etnoconhecimento, etnoictiologia, pesca commercial, peixes.

1. Introduction

In the Amazon basin, fishing is considered one of the main local extractive activities, being of great social and economic importance, representing the main source of income and livelihood for many riverside communities (Barthem and Fabré, 2004; Inomata and Freitas, 2015a; Albuquerque et al., 2015; Ladislau et al., 2020). Furthermore, this activity is favored by the rich set of existing water bodies (such as rivers, lakes and streams), by the type of water [white, clear or black, according to Sioli (1985)], by the dynamics of the rivers (Santos et al., 2006) and the diversity of environments (e.g., flooded forests, flooded plains, sandbanks, among others), which harbor a diversity of fish species.

Human Ecology, sub-branch of Ecology, seeks to understand the various interactions of human beings with natural resources (Begossi, 2013). In the Amazon, riverside communities have demonstrated a deep knowledge of natural resources, due to direct contact with the local fauna and flora (Begossi, 2013; Barroso and Moura, 2016; Silva and Braga, 2018). Studies in the region show that artisanal fishermen, through their ecological knowledge, provide important information about the biological and ecological aspects of local fish species, for example ornamental fish species (Ladislau et al., 2020), freshwater stingrays Potamotrygonidae (Oliveira et al., 2020), pirarucu *Arapaima gigas* (Lima and Batista, 2012), tucunaré *Cichla* spp. (Lima et al., 2021) and jaraqui *Semaprochilodus* spp. (Batista and Lima, 2010).

Although artisanal fishermen are the main contributors to studies aimed at understanding the use and meanings of fish among different human groups in the country, the concentration of studies on this topic is still incipient in the North region (Ladislau et al., 2020). Thus, it is necessary to carry out studies aimed at investigating the socioeconomic importance of aquatic resources and their different uses and meaning for human populations residing in the Brazilian Amazon, in order to generate data that can assist managers in the construction of public policies aimed at management and conservation of local fisheries resources.

That said, the present study evaluated the socioeconomic aspects of fishing for edible fish in the Middle Negro River from the point of view of artisanal fishermen. In order to assist the management and conservation actions of local fish species exploited by the activity, as well as providing the sustainability of fishing.

2. Materials and Methods

2.1. Study area

The study was conducted in the urban and rural areas of the municipality of Barcelos (Figure 1), which is considered the largest municipality in the state of Amazonas (122.461,086 Km²) (IBGE, 2021). Its municipal seat is located on the right bank of the Negro River about 396 km in a straight line and 496 km via fluvial from Manaus,the capital of the state of Amazonas (Inomata and Freitas, 2015b). In this area, the Mariuá archipelago is found, which is constitutes a set of islands in what is known as the largest freshwater river archipelago in the world (Goulding et al., 1988; Inomata and Freitas, 2015a).

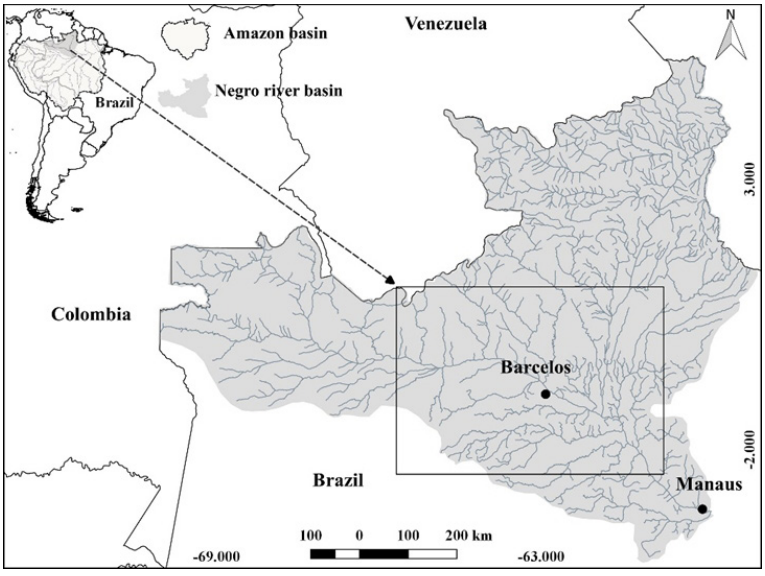

Figure 1. Demonstrative map of the region of the Municipality of Barcelos in the middle Negro River basin, State of Amazonas.

In the rural area, the members of the following six communities were interviewed: Ponta da Terra, Santa Inês, Daracuá, Bacabal, Romão and Elesbão. The criteria used to choose the respective communities visited were the level of involvement of fishing families in commercial fishing for edible fish in Barcelos, as well as the social and economic representation of commercial fishing for the livelihood of local riverside families.

2.2. Data collection

The data came from a primary database, created by the project "Socioeconomic Profile and Ethnoictiological Knowledge of Fishers of the Middle Rio Negro, Amazonas: Implications for Orderly Use and Sustainability", which was funded by the Amazonas State Research Support Foundation (FAPEAM, Call 010/14, process 062.00933/2015).

The "*snowball*" method was used, according to the study of Biernacki and Waldorf (1981). Data collection was carried out between January and December 2016, in the urban and rural area, via interviews that used semi-structured questionnaires with open and closed questions.

The questions addressed the socioeconomic aspects of artisanal fishermen of edible fish (gender, age, education, place of birth and length of residence), aspects of commercial fishing (main target fish species, fishing gear, types of bait, vessel, methods of fishing and fishing locations) and main challenges of local commercial artisanal fishing (perception of artisanal commercial fishermen on the role of institutions linked to the regional fishing sector, knowledge of the current legislation on commercial fishing and the problems faced by the activity).

Individual interviews were conducted with commercial fishermen of edible fish with an average duration of 30 minutes each. Before the interviews, the free and informed consent form (ICF) was presented to the fishermen, as well as the proposals and objectives of the present study and the rights of the interviewees. It is noteworthy that the present study met all the requirements established by the Ethics Committee in Research with Human Beings (CEP) and is registered with Plataforma Brasil under protocol n°53847316.6.0000.5015.

2.3. Data analysis

The collected information was digitized and stored in digital spreadsheets. These were later analyzed by means of descriptive statistics, with the calculation of absolute frequency (*ni*) and relative frequency (*fi*), and then organized into descriptive categories and represented in tables according to methodologies described in the relevant literature (Ladislau et al., 2020; Sobreiro, 2007; Inomata and Freitas, 2015a; Ribeiro et al., 2020).

Ethnospecies, fish species identified according to the ethnological criteria of the fishermen themselves, which gather groups according to morphological, aesthetic and ethological characteristics (Marques, 1991), were grouped into categories when similar according to Cerdeira et al. (2000).

3. Results

3.1. Socioeconomic aspects of fishermen

In all, 97 artisanal fishermen from commercial fishing for edible fish were interviewed. Of these, 71.14% were male aged between 18 and 82 years, with a mean age of 48 years (Figure 2). The fishermen in the urban area had a higher mean age (between 50 and 57 years old; 11.0%) than those who lived in the rural area (42 to 49 years old; 10.0%) (Figure 2).

Most of the interviewees were born in the city of Barcelos. However, the presence of people from other locations was noted, such as Novo Airão, Santa Isabel do Rio Negro, Manaus and São Gabriel da Cachoeira, as well as from other states in the North region, such as the state of Pará. The average time of residence of fishermen in Barcelos was 23 years (Figure 3).The fishermen had a low level of education, with the majority having only incomplete primary education (45.0%) or illiterate (15.0%) (Figure 4). We observed that the majority of fishermen started in the activity at a very young age, under eighteen years old (Figure 5). Many of these learned the craft of the activity through the influence of family members, such as their father (52.0%).

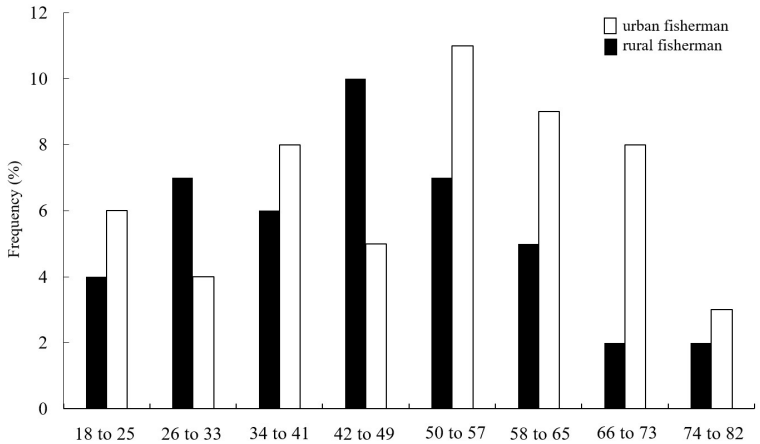

Figure 2. Age range of commercial fishermen in the municipality of Barcelos, in the middle Negro River basin, Amazonas.

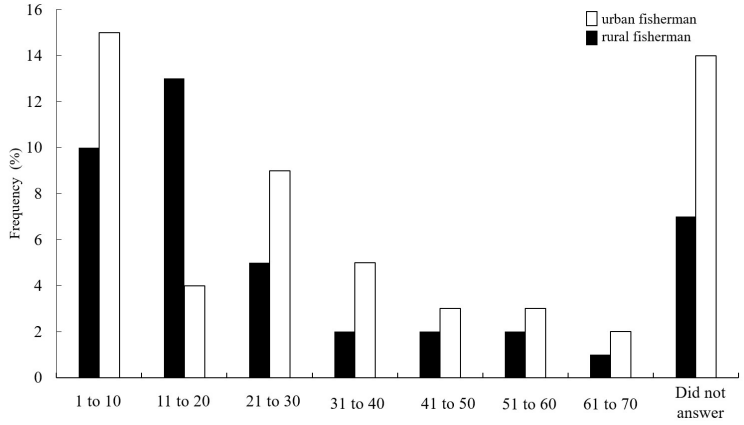

Figure 3. Length of residence of commercial fishermen in the municipality of Barcelos, in the middle Negro River basin, Amazonas.

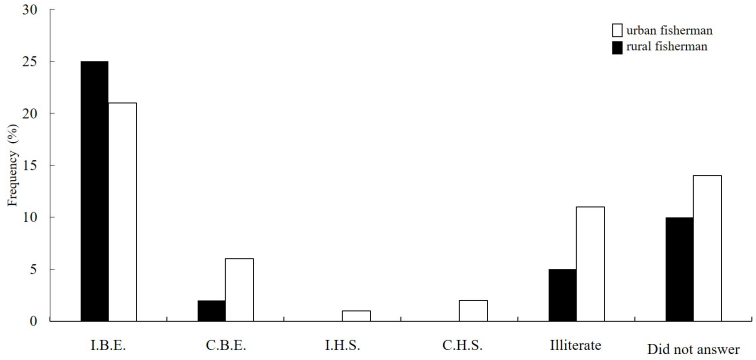

Figure 4. Schooling of commercial fishermen in the municipality of Barcelos, in the middle Negro River basin, Amazonas. I.B.E.: incomplete basic education; C.B.E.: complete basic education; I.H.S.: incomplete high school and C.H.S.: complete high school.

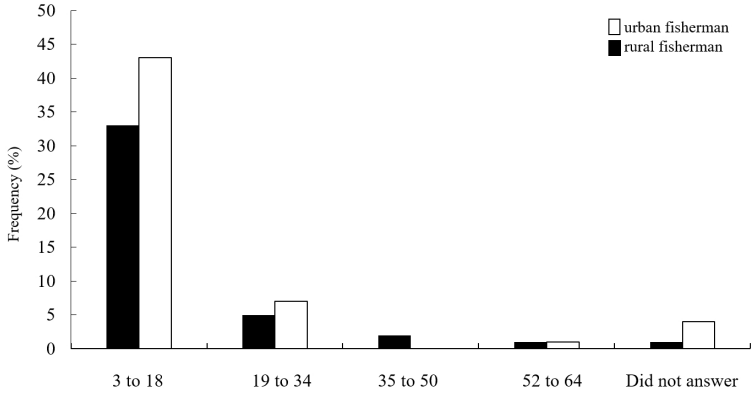

Figure 5. Age of onset in the commercial fishing activity of fishermen in the municipality of Barcelos, in the middle Negro River basin, Amazonas.

3.2. Aspects of commercial fishing

Altogether, 33 ethnospecies were cited as targets of commercial fishing for edible fish, corresponding to 15 ethnogenera, eight families and four orders (Table 1). Given the variety of ethnospecies mentioned during the interviews, we observed that a species may have received more than one popular name in different locations.

Artisanal fishermen used different fishing gear, with the fishing rod/hand line and gill nets being the most used in fisheries (Figure 6). Regarding the fishing methods/

Table 1. Ethnospecies cited by fishers of commercial of edible fish in the municipality of Barcelos, middle Negro River, Amazonas state, Brazil.

Category	Ethnospecies	Order	Family	Scientific name	N	Rural Area		Urban Area	
						AF	RF (%)	AF	RF (%)
Aracu	Aracu branco, aracu camatí, aracu pinima or flamenguista, aracu camunário and aracu domé/dumé	Characiform	Anostomidae	*Leporinus* spp. and *Schizodon* spp.	87	39	38.14	48	49.48
Pacu	Pacu-branco, pacu-galo, pacu-vermelho, pacu riscado/listrado, pacu tiuí, pacu boala/buala, pacu erudá and pacu paçuir.	Characiform	Characidae	*Myleinae* includes, *Myleus* spp., *Metynnis* spp., *Mylossoma aureum*, *M. albiscopum,* among others.	75	37	40.20	38	39.17
Tucunaré	Tucunaré-açu, tucunaré-paca, and tucunaré-tauá.	Perciform	Cichlidae	*Cichla* spp.	61	30	30.92	31	31.95
Surubim	Surubim	Siluriform	Pimelodidae	*Pseudoplatystoma, punctifer*	52	24	24.74	28	25.50
Filhote/ Piraíba	Filhote	Siluriform	Pimelodidae	*Brachyplatystoma , filamentosum*	37	17	17.52	20	20.61
Pirarara	Pirarara	Siluriform	Pimelodidae	*Phractocephalus , hemioliopterus*	30	18	18.55	12	12.37
Acará/Cará	Cará-preto, cará baru, cará-peneira, cará-açu, cara-azulão	Perciform	Cichlidae	Cichlidae include *Astronotus ocellatus*, *Chaetobranchopsis orbicularis*, *Heros* spp., *Geophagus proximus,* among others	21	09	9.27	12	12.37
Piranha	Piranha preta Piranha branca	Characiform	Characidae	*Serrasalmus* spp., among others	15	04	4.12	11	11.34

AF: Absolute frequency; RF: Relative frequency.

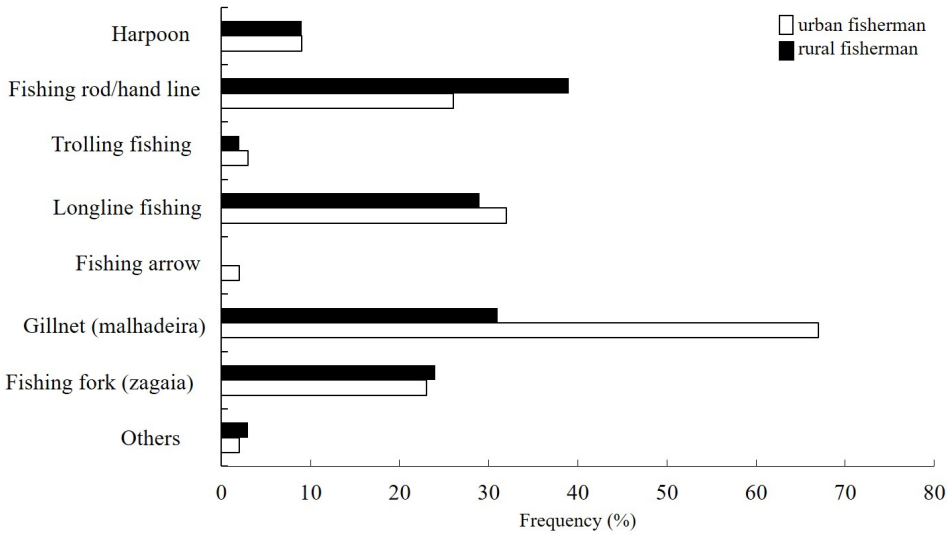

Figure 6. Fishing instruments used by commercial fishermen in the municipality of Barcelos, in the middle Negro River basin, Amazonas. Harpoon: long instrument, similar to a spear, used in fishing to catch larger fish; Trolling fishing: hook fishing which consists of casting the line while the boat is drifting in the river; Longline fishing: fishing line composed of a main line and secondary lines that are registered at regular intervals with hooks at the ends and Fishing fork (zagaia): harpoon consisting of three to five teeth fixed to a wooden pole.

techniques used by the fishermen, we noticed that their use was subjectively associated with the behavior of the fish, the different periods of the day and climatic factors (Table 2). Commercial fishing for edible fish takes place in different types of aquatic environments, such as rivers, lakes and "igarapés" (streams that are born in the forest) (Figure 7). Among these places, the most preferred by fishermen was the Demeni River (30.0% and 20.0% of fishermen in urban and rural areas respectively) (Figure 8).

According to the fishermen interviewed, the best period for fishing was dawn/morning (35.0%) (Table 2). This is represented in the fishers statements: "*Early in the morning, the fish are hungry and go out to feed*"; "*Early in the morning, the fish goes out to eat, there is silence*"; "*Early in the morning, there are more fish*"; "*Early in the morning, the fish come up because they are hungry*"; "*Early in the morning, is when the fish come to the surface, in late afternoon you can see where he sleeps*"; "*Earlier on, the fish are more grouped together*"; *"In the morning, the weather is better*".

Table 2. Fishing methods most used by fishers of commercial edible fish in the rural and urban areas of the municipality of Barcelos, middle Negro River, Amazonas state, Brazil.

Method grouped into categories	Method described	N	Rural Area		Urban Area	
			AF	RF (%)	AF	RF (%)
Associated with day or night or during the small hours	- Dawn: early morning; better weather; more fish available; Fish come out to feed	34	22	22.69	12	12.37
	- Night: quieter; fish are sleepy or distracted	7	2	2.06	5	5.16
	- During the small hours	3	1	1.03	2	2.06
	- End of the afternoon	3	1	1.03	2	2.06
	- All day	1	1	1.03	0	0
Associated with fishing gear or environment or fish species	- Fixed net	11	5	5.16	6	6.18
	- Hook	1	0	0	1	1.03
	- Spot light	1	0	0	1	1.03
	- Lake	1	0	0	1	1.03
	- Distance of the place where fishing will occur	1	1	1.03	0	0
	- Species to be caught	1	1	1.03	0	0
Directly associated with the fish	Observation of the fish: where it surfaces	9	1	1.03	8	8.25
Did not answer/does not use any method		24	10	10.30	14	14.44

AF: Absolute frequency; RF: relative frequency.

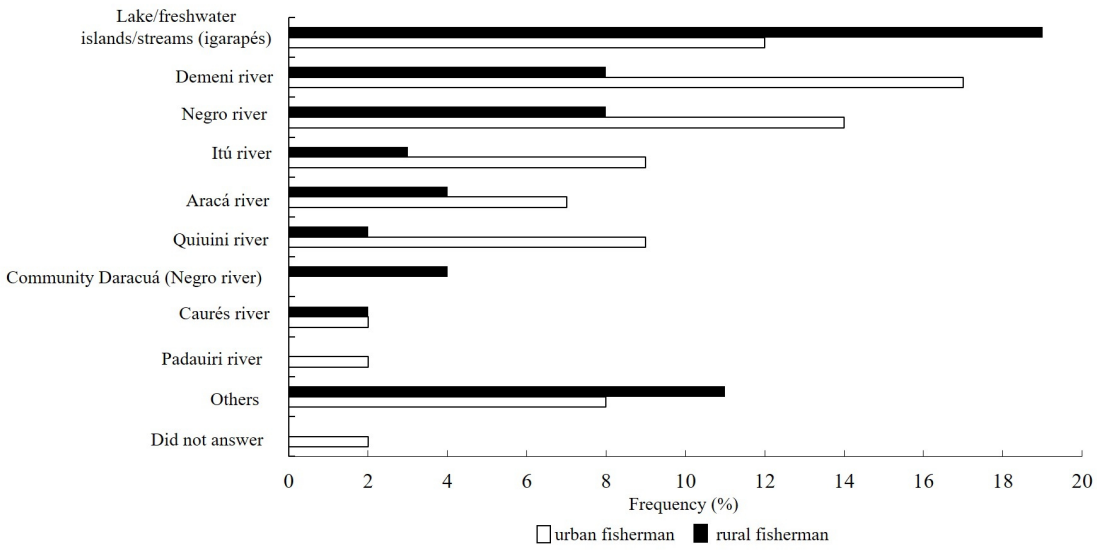

Figure 7. Aquatic environment where commercial fishing takes place in the municipality of Barcelos, in the middle Negro River basin, Amazonas.

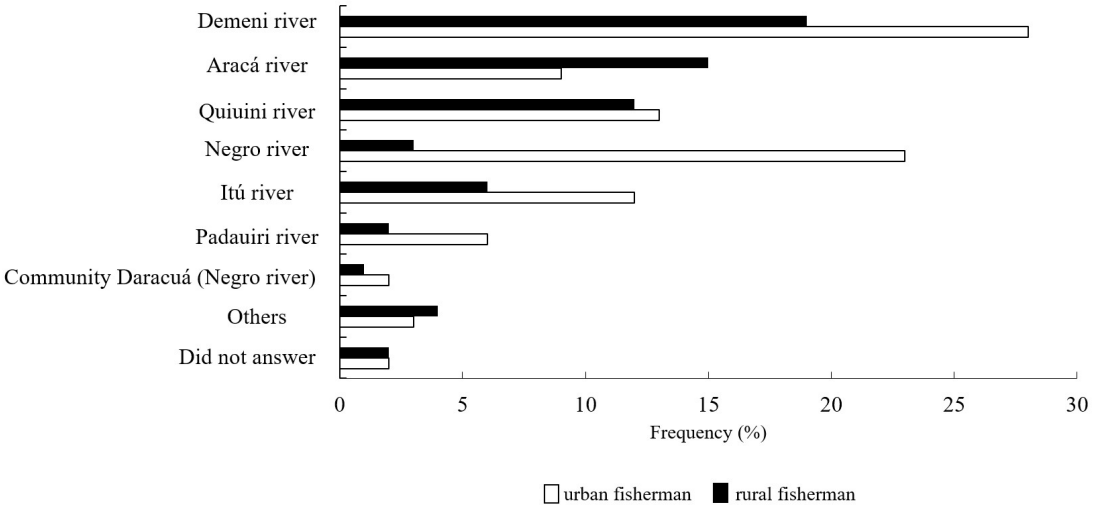

Figure 8. Most preferred places for fishing by commercial fishermen in the municipality of Barcelos, in the middle Negro River basin, Amazonas.

Table 3. Baits used by fishers of commercial edible fish in the rural and urban areas of the municipality of Barcelos, middle Negro River, Amazonas state, Brazil.

Category of bait used	Types of baits	N	Rural Area		Urban Area	
			AF	RF (%)	AF	RF (%)
Fish	Aracu (Family Anostomidae)	5	2	2.06	3	3.09
	Piranha (Family Characidae)	3	0	0	3	3.09
	Tucunaré (*Cichla* sp.)	1	0	0	1	1.03
	Traíra (Family Erythrinidae)	1	0	0	1	1.03
	Mandi (Family Pimelodidae)	1	1	1.03	0	0
	spp. not cited	41	17	17.52	24	24.70
Invertebrates	Worms	41	24	24.70	17	17.52
	Spiders	5	3	3.09	2	2.06
	Grasshoppers	5	5	5.15	0	0
	Crickets	1	0	0	1	1.03
	Insects	4	4	4.12	0	0
Plant material	Fruit "careca"	34	14	14.43	20	20.61
	Fruit	4	2	2.06	2	2.06
	Peels	2	0	0	2	2.06
	Grass	1	0	0	1	1.03
	Tucumã palm hearts	1	0	0	1	1.03
Others	Red cloth	1	0	0	1	1.03
Did not answer		38	18	18.55	20	20.61

AF: Absolute frequency; RF: Relative frequency.

The use of bait by fishermen was diverse, with most using more than one type of bait per fishery (Table 3). However, most fishermen showed a preference for the use of fish baits (42.22%) or "worms" Oligochaetes (42.22%) (Table 3). The "canoe" represented the main means of transport for fishermen to the fishing grounds, especially among residents of rural areas (27.5%) (Figure 9). In addition to the canoe, the boats while in the urban area, the use of boats (15.0%) was predominant (Figure 8).

3.3. Main challenges

Overall, 39.17% of the fishermen demonstrated that they had some kind of knowledge or information about the laws that govern local fishing, especially in relation to the closed season for the target fish species of commercial fisheries for edible fish in the region (25, 77% and 13.40% in urban and rural areas respectively) (Table 1). However, we observed a significant percentage of fishermen who are unaware of the fishing legislation (34.0%) (Table 1).

Especially in rural areas (17.52%) (Table 1). Regarding the role of the Barcelos Fishermen's Colony, 28.85% of the fishermen reported that they benefit from the colony's actions, through access to information, whether on fish species during the closed season, as well as documentation and regularization of fishing vessels, as well as issues related to retirement (Table 2).

In the view of 76.26% of fishermen, the category can contribute to the conservation of local fishing resources, acting as "nature inspectors", monitoring and reporting irregular fishing activities (Table 4). Furthermore, they consider that for commercial fishing in the region to be sustainable, it is necessary for fishermen to capture only essential quantities (19.58% and 9.27% in urban and rural areas respectively) (Table 5).

In the Middle Rio Negro region, it was observed the occurrence of several types of obstacles around the practice of commercial fishing (Table 6). Such as: natural events (e.g. seasonal floods and droughts of rivers), competition for the use of fisheries resources and low fish commercialization values (see Table 6). For fishermen in the urban area, the main problem is the period when the rivers are full (16.49%), pointed out as the main responsible for the decrease in the abundance of fish in this period, in addition to the absence of buyers or low trade value of local fish. (9.27%) (Table 6). While, in rural areas, the dry season (time when there is a reduction in the levels of rain in the Amazon) is considered to be of greater difficulty, as it makes access to fishing places and the transport of fish to sales centers difficult (9.27%) (Table 6). In addition, in rural areas there were reports of competition with "geladores" (larger fishing vessels) (7.21%), considered by fishermen as responsible for the reduction of fish (Table 6).

Different causes were pointed out for the difficulties faced by commercial artisanal fishing, especially seasonality (21.64%), followed by the large number of fishermen in the region (12.36%), the lack of opportunities and jobs (11.33%), in addition to the presence of fishing boats with greater autonomy (Table 7).

Fishermen also reported a decrease in the amount of fish available, associated with an increase in fishing intensity (68.03%) (Table 8). Mainly due to the presence of larger fishing boats known locally as "geladores" (12.37%), in addition to the coexistence of many fishermen in the same fishing places (11.34%) (Table 8).

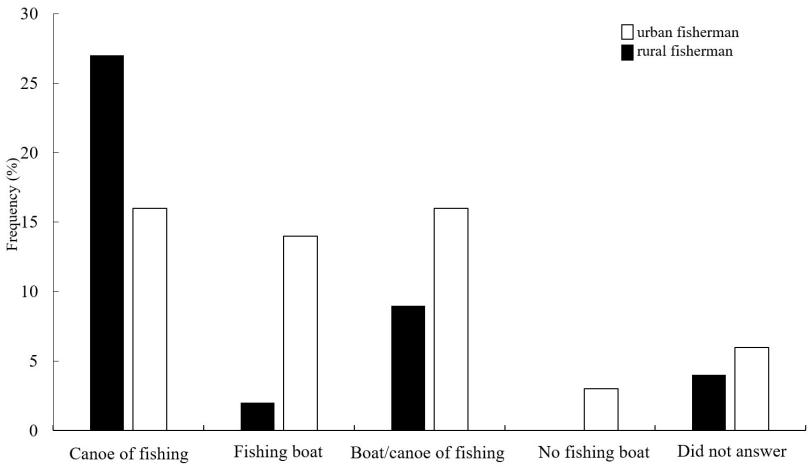

Figure 9. Transports used by fishermen in commercial fishing activities in the municipality of Barcelos, in the middle Negro River basin, Amazonas.

Table 4. Monitoring of fisheries according to fishers of commercial edible fish in rural and urban areas of the municipality of Barcelos, middle Negro River, Amazonas state, Brazil.

Can fishers act as a "supervisor" of nature?	N	Rural Area		Urban Area	
		AF	RF (%)	AF	RF (%)
Yes, by preserving it	29	08	8.24	21	21.64
Yes, preserving it/reporting ilegal activities	21	12	12.37	09	9.27
Yes	24	11	11.34	13	13.40
No	13	06	6.18	07	7.21
Did not answer/did not know	10	05	5.15	05	5.15

AF: Absolute frequency; RF: Relative frequency.

Table 5. Basis for sustainable fishing according to the knowledge of fishers of commercial edible fish in the rural and urban areas of the municipality of Barcelos, middle Negro River, Amazonas state, Brazil.

Basis for sustainable fishing	N	Rural Area		Urban Area	
		AF	RF (%)	AF	RF (%)
Fish only what is necessary	28	09	9.27	19	19.58
Releasing or not catching small fish	21	08	8.24	13	13.40
Fixed nets and/or appropriate instrument	10	05	5.15	05	5.15
Preservation	5	04	4.12	01	1.03
Fishing the big fish	5	00	0	05	5.15
Respect the fish's reproductive period	4	03	3.09	01	1.03
Share with the community	3	02	2.06	01	1.03
Ban long-range fishing boats in communities	2	02	2.06	00	0
Improve the price of fish	2	00	0	02	2.06
Did not answer/did not know	17	09	9.27	08	8.24

AF: Absolute frequency; RF: Relative frequency.

Table 6. Difficulties identified in fishing activities cited by fishers of commercial edible fish in the rural and urban areas of the municipality of Barcelos, middle Negro River, Amazonas state, Brazil.

Difficulties identified	Causes cited	N	Rural Area		Urban Area	
			AF	RF (%)	AF	RF (%)
High water	- Fish "disappear"	20	04	4.12	16	16.49
Low water	- Difficulties with transport	15	09	9.27	06	6.18
	- Carry boat/canoe					
Rain		10	04	4.12	06	6.18
Sales	- No buyer	15	06	6.18	09	9.27
	- Do not want to pay a good price for fish					
Financial	- Lack of financial conditions for purchasing of equipment/supplies	12	06	6.18	06	6.18
	- Storage of the fish					
	- Expenditure					
Low numbers of fish		4	02	2.06	02	2.06
Long-range fishing boats	- Catch too many fish/lack of respect	7	07	7.21	0	0
Others	- Fishing for certain species prohibited	6	0	0	6	6.18
	-Animals (alligators, stingrays, porpoises)					
Did not answer/has no difficulties		8	03	3.09	05	5.15

AF: Absolute frequency; RF: Relative frequency.

Table 7. Suggestions for solving the problems reported by the fishers of edible fish in the rural and urban areas of the municipality of Barcelos, middle Negro River, Amazonas state, Brazil.

Suggestions	N	Rural Area		Urban Area	
		AF	RF (%)	AF	RF (%)
Sell to other cities	12	0	0	12	12.37
Increase the value of fish	12	05	5.15	07	7.21
Protect fish during spawning	5	0	0	05	5.15
Create laws regarding the use of fixed nets	3	01	1.03	02	2.06
Restrict areas exclusively for use by the community	2	02	2.06	0	0
No answer	63	34	35.05	29	29.89

AF: Absolute frequency; RF: Relative frequency.

Table 8. Quantity of fish available from the perspective of fishers of commercial edible fish in the rural and urban areas of the municipality of Barcelos, middle Negro River, Amazonas state, Brazil.

Are decreases in quantities of fish noted?		N	Rural Area		Urban Area	
			AF	RF (%)	AF	RF (%)
YES	Yes	35	12	12.37	23	23.71
	Because there are a lot of fishers	19	11	11.34	08	8.24
	Because of the long-range fishing boats	12	12	12.37	0	0
NO	No	15	04	4.12	11	11.34
	Only in the high water season	5	0	0	05	5.15
	Nature is infinite	3	01	1.03	02	2.06
	No answer	8	02	2.06	06	6.18

AF: Absolute frequency; RF: Relative frequency.

4. Discussion

In the present study, there was a predominance of male fishers, although there was also the presence of women in the activity, indicating that the activity does not have a unilateral character. The study of Ladislau et al. (2020) described the presence of men and women in the activity, although the male presence is predominant, corroborating with Sobreiro (2007), Inomata and Freitas (2015a), and Ribeiro et al. (2020). The high proportion of male fishers is related to the cultural aspect, in which the head of the family is responsible for family sustenance (Sá-Oliveira et al., 2013).

The mean age found was 48 years, thus corroborating the study by Ladislau et al. (2020), Sobreiro (2007), Inomata and Freitas (2015a) and Ribeiro et al. (2020), who reported the mean age of 42, 45, 45 and 42 years, respectively. According to the study by Zacardi et al. (2017), this trend is justified in view of the scenario that young people may be prioritizing studies and/or directing their occupations to other activities, considered by most of them of greater importance than fishing activity.

For Amorim (2018), one of the factors cited by fishers for their descendants not following in their footsteps was the low income acquired from the activity, which leads the younger generation to seek other activities.

Another point to highlight is that none of the fishers in the rural area attended high school at any level and were limited to elementary school education only. The study by Sobreiro (2007) points out that this may be due to the fact that, in rural communities, schools offer only education from 1st to 4th grade of elementary school. For Alencar and Maia (2011), low education has an influence on the ineffectiveness in the application of policies in public fisheries and is also related to the ease of contribution of people who, due to absolute lack of any other option, enter the fishing activity, and thus feed the paradigm of fishing and poverty.

In this study, the majority of fishers started their fishing activity very early, aged between 3 and 18 years. Just as in several other Amazon regions, fishers of commercial edible species learned to fish with family members, most learned from their father, followed by other family members, such as uncles, grandparents, cousins, among others. Similar data were found in the study by Amorim (2018), Zappes et al. (2016) and Meireles et al. (2017), who reported that fishers learned the practice of fishing from family members.

In the present study, the order Characiformes was the most representative; this was also observed by Farias et al. (2017) when characterizing the composition and structure of fish assemblages in the middle Negro River, and they concluded that 57.43% of the 1,985 specimens caught were of this order. Species such as pacu (subfamily Myleinae), aracu (family Anastomidae) and tucunaré (*Cichla* spp.) represent approximately 50% of landings in the Middle Rio Negro region (Inomata et al., 2018). The information obtained in the literature and in the present work indicated that the same species may have more than one popular name in different locations, that there may be synonymy, or that these names may even correspond to more than one species, which is contrary to Begossi and Figueiredo (1995) who noted synonyms for fish species in a fishing community located in São Paulo. The study of Souto and Marques (2006) justifies that synonymy is a common phenomenon in fishing communities.

Previous studies carried out in the Middle Negro River Basin region show that the local fishing fleet is basically composed of fishing boats with an average length of 10.8 meters and a capacity of 2.8 tons, in addition to motorized canoes of 7 meters in length (Inomata and Freitas, 2015a); characteristics similar to those observed in the present study. According to Inomata and Freitas (2015a), fishing boats in Barcelos tend to act mainly as fish storage, while motorized canoes are used by fishermen to catch fish. Canoes are vessels widely used by riverine populations in the Amazon, being one of the most used means of transport in regional artisanal fishing (Vasconcelos et al., 2014).

Still regarding the type of vessel, we note that the use of canoes was predominant among fishermen in rural areas, while fishing boats were more used by those in urban areas. This may be associated with the type of fishing practiced in the different areas, since in rural areas subsistence fishing is generally practiced, with the purpose of family feeding (Sobreiro et al., 2006; Freitas and Rivas, 2006; Barra et al., 2012; Albuquerque et al., 2015). Meanwhile, fishermen from urban areas practice artisanal fishing of a commercial nature, aiming more at the commercialization

of fish (Sobreiro et al., 2006; Freitas and Rivas, 2006; Barra et al., 2012; Albuquerque et al., 2015).

Commercial artisanal fishing in the Middle Rio Negro region is diverse, with fishermen employing different fishing gears during fisheries (Sobreiro et al., 2006; Barra et al., 2012; Inomata and Freitas, 2015a; Ladislau et al., 2020). According to Inomata and Freitas (2015a), commercial fishing carried out in the municipality of Barcelos is characterized as "multi-equipment", as they present variability in their operational and physical characteristics, which are related to the type of target species and environments. The characteristics of commercial fisheries in the Rio Negro are similar to those in other regions of the Amazon (Vasconcelos et al., 2014; Zacardi et al., 2017).

The Demeni River is considered the main commercial fishing area in Barcelos (Inomata and Freitas, 2015b). According to the study by Santos and Freitas (2019), this may be related to the fact that this river has limnological characteristics that are different from other rivers of the Negro River basin. Its waters change from transparent to white throughout the year, and there are several areas on the margins that could serve as nurseries for various species of fish and, consequently, may be more productive than the blackwater rivers (Bayley and Petrere, 1989).

When asked about their knowledge on fishing legislation, lack of information was common, similar results were also pointed out in relation to pilot guides also in the middle Negro River (Ribeiro et al., 2020). The normative instruction N° 35 of September 29th, 2005-MMA, established the protection of pacu (subfamily Myleinae), aracu (family Anostomidae), matrinxã (*Brycon* spp.), aruanã (*Osteoglossum* spp) in the period between 15/11 and 15/03; however, it was observed that the fishers know about the closed season in the region, though this was reported in greater proportions for the fishers of the urban zone.

The Barcelos fishermen's colony began its activities in 2002, with the joining of local ornamental and commercial fishermen's associations, with the desire to achieve more benefits for the category (Sá-Oliveira et al., 2013). As demonstrated in this study, receiving " closed insurance" is the main reason for membership among associates. This fact was also evidenced by Ladislau et al. (2020), in their study with artisanal fishermen of ornamental fish in the Middle Negro River basin, where the authors observed that the receipt of this social benefit often represents the main means of income and livelihood of local riverside families, especially in periods when the fishing of commercial fish species are prohibited.

Based on the reports, it is assumed that most commercial artisanal fishermen understand issues related to fishing sustainability, even intuitively, recognizing the importance of fishing only necessary quantities, releasing smaller fish species, using adequate fishing equipment and respecting the reproductive period of the target fish species. However, we observe that fishermen are interested in participating more in the inspection of local fisheries, either by denouncing the practice of predatory fishing or by adopting measures aimed at preserving natural resources. There is a need for greater involvement of artisanal fishermen, whether in commercial fishing or other types of fishing and users in the actions and construction of public policies aimed at the fishing sector of the Rio Negro, as it is an old requirement of these categories (Ladislau et al., 2020; Ribeiro et al., 2020).

In part, the difficulties reported by the fishermen in this study were related to the seasonality of the rivers in the region. According to Loebens et al. (2016), the river flood period is the time when fish species disperse or, as fishermen say, "disappear", due to the greater availability of shelter and food areas, especially in flooded forests, also known locally as "igapó forest". Seasonal changes in the levels of water bodies in the Middle Negro River basin influence local fisheries production, as in other rivers in the Amazon (Barthem and Fabré, 2004; Freitas and Rivas, 2006; Inomata and Freitas, 2015a; Matos et al., 2018).

The sale of fish has also been a challenge for the fishermen of Barcelos, mainly due to the absence of buyers. As observed in local ornamental fish fishing, where, in addition to the lack of buyers, there was a loss of interest and demand for orders over the years on the part of traders and aquarium companies from Manaus or abroad (Sobreiro, 2016; Ferreira et al., 2020; Ladislau et al., 2020; Yamamoto et al., 2021). In addition, commercial fishermen complain about the low prices paid per kg of fish by traders and middlemen in the region. In Barcelos, there are two groups of fish species that are commercially exploited by commercial fishing for edible fish, known locally as "white fish" (e.g. hake *Plagioscion squamosissimus*, aracu family Anostomidae and pacu family Characidae) and "black fish" (e.g. traíra *Hoplias* spp., Peacock bass *Cichla* spp. and piranhas family Characidae), the latter has a lower market value than the former (Sobreiro, 2007; Barra et al., 2013). The buying and selling prices of fish in the local market is regulated by the law of supply and demand (Sobreiro, 2007).

The presence of fishing boats with greater fishing autonomy known locally as "geladores" was seen as a problem among commercial fishermen, especially among rural residents. As reported by these fishermen, these boats are responsible for catching large amounts of fish: "*they enter the community and take everything*" and "*fish by the ton*". According to Silva (2011), fishing conflicts in the Middle Rio Negro arise due to the decrease in fish that is associated with the intensification of fishing efforts from the 1990s onwards, with the use of gillnets, due to the presence of freezer boats in the region, in addition to population growth and the emergence of new types of fishing in the region, such as sport fishing.

It was noted that the problems faced by commercial artisanal fisheries in the Middle Negro River region are also related to seasonal fluctuations in river levels, as in other regions of the Amazon (Barthem and Fabré, 2004; Freitas and Rivas, 2006; Matos et al., 2018; Inomata et al., 2018). In addition, the lack of jobs and opportunities in the municipality, as well as the decline in artisanal fishing of ornamental fish over the years, have contributed to the entry of people into commercial artisanal fishing (Inomata and Freitas, 2015a; Sobreiro, 2016; Ladislau et al., 2020; Ribeiro et al., 2020). In the fishermen's view, the solution to these problems would be the opening of the commercialization of fishermen to other regions of the Amazon, a practice prohibited since 2001 by Decree n°22.304/2001.

In the Amazonian fisheries scenario in recent decades, fishing efforts have overexploited some stocks (Ruffino, 2005; Batista et al., 2004, 2012; Viana, 2013; Barthem et al., 2019), especially those most targeted by commercial fisheries, such as the tambaqui *Colossoma macropomum* (Isaac and Ruffino, 1996; Costa et al., 2001), piramutaba *Brachyplatystoma vaillantii* (Barthem, 1990; Barthem and Petrere, 1996; Chaves et al., 2003; Barthem et al., 2019) and jaraquis *Semaprochilodus* spp. (Batista, 2000). In the Middle Negro River basin, the decrease in fish supply is associated with the intensification of fishing efforts, through the use of synthetic gillnets from the 1990s onwards in the region, with the increase in the presence of fishing boats with larger autonomy, associated with population growth (Silva, 2011). In addition, local stocks have suffered from the high rates of deforestation that have taken place in recent years in the Amazon, especially in the riparian forests of rivers, where fish normally seek shelter and food in different life stages (Santos et al., 2006).

In the perception of fishermen, there is a decrease in the amount of fish in the rivers and lakes of the region, due to the increase in fishing intensity by larger "geladores" boats and in the number of artisanal fishermen practicing commercial fishing. Claim Similar to what was described in the study by Silva (2011), where riverine fishermen in the Middle Rio Negro region already reported signs of decreasing stocks of target fish species due to the intensification of the use of the area by long-distance fishing boats reach. In the study by Inomata et al. (2018), commercial fishermen from Barcelos already claimed the need to fish in larger and distant areas to catch the same amount of fish they used to fish in the past.

5. Conclusion

We conclude that commercial artisanal fishing for edible fish is an activity of great importance in the socioeconomic and cultural scenario of many riverside families of the Middle Negro River, often consisting of the main source of income and livelihood for these families, which are composed of people with a high level of income. education and low income. For this reason, there is a need for greater attention on the part of the public authorities, especially to solve the various problems surrounding the activity, such as conflicts over the capture of target fish species and access to fishing sites, in addition to the appreciation of the price of fish marketing.

We hope that the information contained in this study can help in the decision-making process of measures aimed at commercial fishing in the Middle Rio Negro region, as well as the management of local fishing resources, thus contributing to the improvement of the quality of life of fishing families. artisanal fisheries and the sustainability of local commercial fisheries.

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