ISSN: 1696-8352

Oyster extractivism in the Amazon: characterization and perception of extractivists on the conservation of natural banks

Extrativismo de ostras na Amazônia: caracterização e percepção dos extrativistas sobre a conservação dos bancos naturais

Extracción de ostras en la Amazonía: caracterización y percepción de los extractivistas sobre la conservación de los bancos naturales

DOI: 10.55905/oelv22n10-127

Receipt of originals: 09/06/2024
Acceptance for publication: 09/27/2024

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ISSN: 1696-8352

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ABSTRACT

The objectives of this study were to identify extractivists working in the region of Curuçá, Pará, Brazil, to evaluate the perception of these workers on the conservation and exploitation of natural oyster stocks. Applying snowball sampling, semistructured questionnaires were applied in the period from September 2019 to January 2020, resulting in 38 interviewed extractivists. Of the 38 respondents, 50% were older than 40 years, 78.9% were men, and oyster extractivism was the main source of income for 65.8%. In

ISSN: 1696-8352

addition, 94.7% lived in the city of Curuçá, and 36.8% worked as extractivists for 7 to 11 years. The majority reported never having received any training on oyster collection or oyster bank conservation. The extractivists reported that their greatest challenge was collection sites. Lack of training was a risk factor for collecting during the rainy season (OR=1.52), while having received training was a protective factor for collecting seeds (OR=0.64). Additionally, 94.7% of the respondents reported an increase in oyster mortality in the rainy season. Encouraging extractivists to organize into associations or cooperatives with the support of public development policies and providing training focused on sustainable extraction can contribute to the conservation of natural oyster banks by preventing damage to the natural ecosystem.

Keywords: Extraction, Mollusks, Exploitation, Sustainable.

RESUMO

Os objetivos desse estudo foi identificar os extrativistas que atuam na região de Curuçá-PA a fim de avaliar a percepção desses trabalhadores em relação à conservação e exploração dos estoques naturais de ostras. No período de setembro de 2019 a janeiro de 2020 foram aplicados questionários semiestruturados, resultado em 38 extrativistas entrevistados. Dos 38 entrevistados, (78,9%) eram homens, sendo a principal fonte de renda para 65,8%. Dos extrativistas 50% eram maiores de 40 anos. E (94,7%) residia na cidade de Curuçá, e trabalhavam de 7 a 11 anos na atividade. A maioria relatou nunca ter recebido qualquer treinamento referente à coleta e conservação dos bancos de ostras. Os extrativistas responderam, que sua maior dificuldade eram os locais de coletas. A falta de treinamento foi um fator de risco para coleta durante a estação chuvosa (OR=1,52), enquanto que ter recebido treinamento foi um fator de proteção para a coleta de sementes (OR=0,64). E (94,7) relataram um aumento na mortalidade das ostras no período chuvoso. Sugerimos que estimular os extrativistas à se organizarem em associações ou cooperativas junto do apoio de políticas públicas de fomento, recebendo capacitações voltada à extração de forma sustentável e contribuindo desta forma com a conservação dos bancos naturais sem causar prejuízos ao ecossistema natural.

Palavras-chave: Extração, Moluscos, Sustentável, Exploração.

RESUMEN

Los objetivos de este estudio fueron identificar a los extractivistas que trabajan en la región de Curuçá-PA con el fin de evaluar la percepción de estos trabajadores en relación con la conservación y explotación de los stocks naturales de ostras. Desde septiembre de 2019 hasta enero de 2020 se aplicaron cuestionarios semiestructurados, resultando en la entrevista a 38 extractivistas. De los 38 entrevistados, (78,9%) eran hombres, siendo la principal fuente de ingresos para el 65,8%. De los extractivistas, el 50% tenía más de 40 años. Y (94,7%) vivía en la ciudad de Curuçá, y trabajaba de 7 a 11 años en la actividad. La mayoría informó nunca haber recibido capacitación sobre la recolección y conservación de criaderos de ostras. Los extractivistas respondieron que su mayor dificultad eran los sitios de recolección. La falta de capacitación fue un factor de riesgo para la recolección durante la época de lluvias (OR=1.52), mientras que haber recibido

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capacitación fue un factor protector para la recolección de semilla (OR=0.64). Y (94.7) informó un aumento en la mortalidad de ostras en la temporada de lluvias. Sugerimos alentar a los extractivistas a organizarse en asociaciones o cooperativas con el apoyo de políticas públicas de desarrollo, recibiendo capacitación orientada a la extracción sostenible y así contribuir a la conservación de los bancos naturales sin causar daños al ecosistema natural.

Palabras clave: Extracción, Mariscos, Sustentable, Exploración.

1 INTRODUCTION

Extractivism consists of the use of natural resources with potential for economic exploitation, either through the fresh consumption of the extracted food or through its processing, refining and industrialization (Machado, 2009; Queiroga et al., 2015; Gomes et al., 2019). In most cases, natural resources are goods of common use by society and are used by people to meet their needs (Begossi et al., 2012; Freitas et al., 2012; Assis et al., 2020).

The extraction of mangrove oysters is still practiced in the northern and northeastern regions of Brazil (Santos et al., 2017). In the state of Pará, this activity occurs throughout the year and is performed by families from communities that live close to mangroves, constituting the main or complementary income source of these families (Nishida, 2004; Nishida, 2006; Campos, 2011).

Among the different types of cultivation, oyster culture is an important source of alternative income for populations living in coastal zones. In the state of Pará, this practice has been grown since 2001, and its main producers are the municipalities of Curuçá, Augusto Corrêa, Maracanã, Salinópolis and São Caetano de Odivelas, located in the northeastern mesoregion of the state (Sampaio et al., 2019). The extraction of oysters in this region is still an activity widely practiced by the artisanal fishing sector, especially the community of Vila de Lauro Sodré in the municipality of Curuçá (Santos et al., 2017; Sampaio et al., 2019). Since 2004, there have been reports that the number of oysters in natural banks exploited in the region has decreased due to overexploitation, as the recovery time of the banks has not been considered.

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The states of São Paulo and Paraná established a closed oyster season to mitigate the overexploitation of oyster banks. According to Ordinance No. 40 of December 16, 1986, the extraction of oysters is prohibited between December 18 to February 18 in estuarine regions along the coast of São Paulo and in the Paranaguá Lagoon region in the state of Paraná because this is the peak reproductive period of these animals (BRASIL, 1986). However, the state of Pará does not have legislation regarding the regularization, monitoring and extraction period of oyster banks Sampaio et al. (2019), generating concern regarding the medium and long term effects due to the disordered extraction of these banks, potentially resulting in an oyster shortage due to lack of awareness of the importance of the sustainable use of this natural resource (Machado et al., 2015; Ostrensky, 2016; Lopes, 2017). Therefore, an evaluation of oyster extractivists regarding their perception of oyster bank conservation is of fundamental importance for sustainable management. The aim of the present study is to identify extractivists working in the Curuçá region and evaluate the perception of these workers regarding the conservation and exploitation of natural oyster stocks.

2 MATERIALS AND METHODS

2.1 STUDY SITE

The municipality of Curuçá (00°43’48” S, 47°51’06” W) is located in the northeast mesoregion of the state of Pará, Brazil, encompasses 36,678.24 hectares, and has a population of 40,066 inhabitants, mostly composed of fishers and small farmers (IBGE, 2019). The Mãe Grande de Curuçá Marine Extractive Reserve (MER) is located in the region and covers an area of 37,062 hectares, encompassing several coastal ecosystems, such as mangroves, salt marshes, estuaries and beaches (Brasil, 2007; Campos, 2011).

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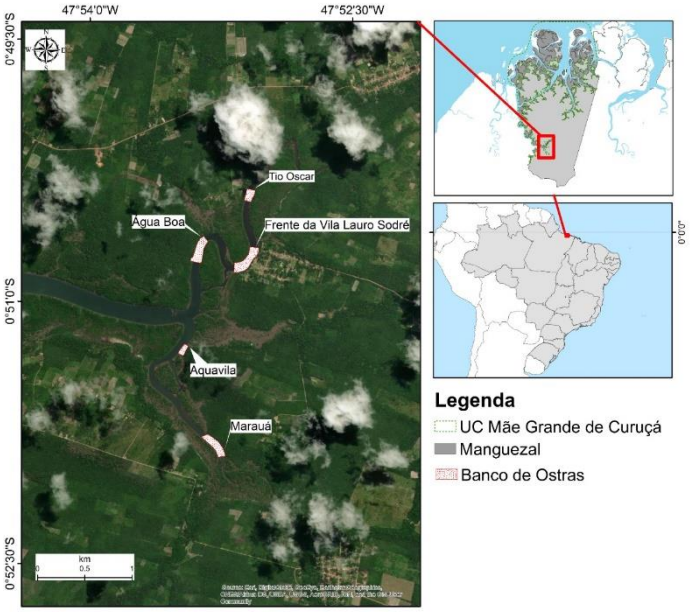
Figure 1- Location of the Mãe Grande de Curuçá Marine Extractive Reserve and identification of the oyster banks in the municipality of Curuçá, Pará, Brazil.



Source: Authors (2024)

Among the various communities in Mãe Grande de Curuçá MER, the Vila de Lauro Sodré community (00°51'04.0" S, 47°53'21.2" W) stands out for its oyster commercialization potential. In addition to oyster farming and extractivism of mangrove oysters, the community carries out other economic activities, such as fishing, agriculture and trade (Sampaio et al., 2019).

2.2 ETHICAL ASPECTS

This study was conducted under the authorization of the National Research Ethics Committee (CONEP) of the Brazilian National Health Council (CNS) under CAAE n. 46523621.0.0000.0018 and of the Chico Mendes Institute for Biodiversity Conservation (ICMBio) under n. 71845-3.

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2.3 SAMPLING AND APPLICATION OF THE QUESTIONNAIRE

To reach the extractivists working in the region, the nonprobabilistic snowball sampling method was applied (Goodman, 1961; Dragan & Isaic-Mani, 2013), considering as seeds the extractivist present in a Mãe Grande de Curuçá MER meeting called by ICMBio on 13th of August, 2019 (n = 6).

From these seeds, other extractivists were sought from September 2019 to January 2020. All study subjects signed an informed consent form.

To obtain information on the profile of the respondents, a previously tested semistructured questionnaire was applied. The questionnaire was organized into five sections that addressed variables related to demographic data, activity characterization, perception of natural oyster banks, management practices and oyster health (Table 1).

Table 1. Description of the questions used in the questionnaire to collect information on extractivists working in the Curuçá region and to evaluate the perception of these workers on the conservation and exploitation of natural oyster stocks.

Topics	Description of the questions
1. Demographic data	Sex, age group, head of household, municipality of residence and length of formal education.
2. Activity characterization	How long have you been working as an oyster extractivist? How many hours per day do you practice oyster extraction? Is oyster extraction your main work activity? Is oyster extraction the main source of income for your family? What is the destination of the extracted oysters? Banks where the extraction is currently performed; Banks where extraction has been performed in the past; Why do you not use these banks anymore? What is the greatest challenge of oyster extraction? Do you have any health problems that may be related to oyster extraction? Have you received any type of training to perform oyster extraction? Would you be interested in receiving training? Do you have an environmental license for oyster extraction? If not, would you be interested in receiving a license?

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3. Perception of natural oyster banks	Is there crop or animal farming going on near the natural banks? Is there any report of activities involving chemical products near the banks? If so, which?
4. Management practices	What is the frequency of oyster extraction in these natural banks in the Amazonian summer? What is the frequency of oyster extraction in these natural banks in the Amazonian winter? Number of dozens harvested at a time; How is the collection performed? At what stage is the oyster extracted?
5. Oyster health	Do you think oysters can get sick? Do you think other animals may pose a threat to oysters? If so, which ones? Have you noticed a higher oyster mortality in any season of the year? Were you able to identify the reason? Do you think oysters can be contaminated/infected? How are they infected? Do you think there are diseases that can be caused by oyster consumption? If so, which ones?

Source: Authors (2024)

2.4 DATA ANALYSIS

Based on the data obtained from the questionnaires, a database was constructed, and descriptive statistical analyses were performed using SPSS Statistics 24.0. The chi-squared test was applied to test the association between the variables and the odds ratio was calculated, when it was possible, considering $p<0.05$ as significant.

3 RESULTS

3.1 DEMOGRAPHIC DATA

In total, 38 oyster extractivists were interviewed. The majority were men (78.9%), heads of household (84.2%), older than 40 years (50%) and resided in the municipality of Curuçá (94.7%). Regarding the length of formal education, most extractivists reported having attended school for a period of 6 to 9 years (42.1%), (Table 2).

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Table 2. Demographic data on oyster extractivists from the region of Curuçá, Pará, Brazil.

Demographic data	Responses in descending order of frequency (%)		
	1st	**2nd**	**3rd**
Sex	Male (78.9)	Female (21.1)	
Age group (years)	Over 40 (50.0)	31 to 40 (28.9)	20 to 30 (21.1)
Head of household	Yes (84.2)	No (15.8)	
Municipality of residence	Curuçá (94.7)	Belém (5.3)	
Education (years)	6 to 9 (42.1)	Up to 5 (39.5)	10 to 13 (10.5)

Source: Authors (2024)

3.2 ACTIVITY CHARACTERIZATION

Regarding the characterization of oyster extraction, 36.8% of the respondents worked as oyster extractivists from 7 to 11 years, and 52.6% had a daily workload of 4 hours. Oyster extraction was the main work activity for 65.8% of the participants and the main source of income for 47.4% of the participants. None of the respondents had an environmental license to perform the activity; however, 63.2% were interested in getting a license to perform the activity. Regarding the destination of the oysters, 46.7% of the extractivists reported that they sell them to intermediaries, and 23.3% reported that they themselves sell them on nearby beaches, (Table 3).

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Table 3. Characterization of the activity of oyster extractivists from the region of Curuçá, Pará, Brazil.

Characterization of the activity of oyster extractivists	Responses in descending order of frequency (%)		
	1st	2nd	3rd
How long have you worked as an oyster extractivist (years)	7 to 11 (36.8)	Over 16 (31.6)	12 to 16 (28.9)
Daily working hours	4 (52.6)	6 (39.5)	8 (7.9)
Oyster extraction is the main work activity	Yes (65.8)	No (34.2)	
Oyster extraction is the main source of family income	No (52.6)	Yes (47.4)	
Destination of extracted oysters	Sale to intermediary (46.7)	Direct sale in beaches (23.3)	Self-consumption (15)
Bank where the extraction is currently performed	Marauá (45.7)	Água Boa (31.4)	Tio Oscar (12.9)
Banks where extraction was performed in the last 2 years	Frente da Vila de Lauro Sodré (47.5)	Tio Oscar (19.7)	Aquavila (16.4)
Greatest challenge of oyster extraction	Collection sites (61.9)	No challenge (23.8)	Low sales price (4.8)
Health problems possibly related to oyster extraction	No (61.1)	Cuts on the body (16.7)	Pneumonia (5.8)
Received some type of training to perform oyster extraction	No (62.2)	Yes (36.8)	
Would like to receive training	Yes (84.2)	No (15.8)	
Would be interested getting a license for oyster extraction	Yes (63.2)	No (36.8)	

Source: Authors (2024)

Oyster extraction was the main source of income for 65,8% of the extractivists. Of the respondents, 62.2% reported never having received any training on the collection, conservation or management of oyster banks and/or oyster-related best practices. However, 84.2% showed interest in these types of trainings. Regarding the health of the respondents, 61.1% reported not having serious health problems. However, 16.7% reported having cuts on the body, and 5.8% reported having contracted pneumonia, possibly related to work.

The extractivists identified five oyster banks in the community of Vila de Lauro-Sodré: i) Marauá (47°5'17.23"W, 0°51'49.38" S), ii) Água Boa (47°53'22.50" W, 0°50'42.62" S), iii) Tio Oscar (47°53'5.32" W, 0°50'23.60" S), iv) Frente da Vila Lauro Sodré (47°53'6.42" W, 0°50'46.07"S); and v) Aquavila (47° 53'28.06" W, 0°51'16.68" S).

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Among these banks, Marauá (45.7%) and Frente da Vila de Lauro Sodré (47.5%) were the most exploited. However, 75.8% of the respondents stated that recently, the Frente da Vila de Lauro Sodré bank has not been frequently used for extraction due to the scarcity of oysters at this site.

3.3 PERCEPTION OF NATURAL OYSTER BANKS AND MANAGEMENT PRACTICES

Even if infrequently, as reported by the extractivists, there are crop/animal farming activities (10.5%) or activities involving chemical products, such insecticide use (8.1%), being conducted close to the oyster banks.

Regarding management practices, the most commonly used collection method according to the respondents was diving (52.6%), followed collecting directly from the mangrove roots (26.3%). Among all oyster collected, oysters in the adult stage are the most collected (83.7%). Even the fact of having received training proved to be a protective factor for seed collection (OR=0.64).

Table 4. Oyster extraction-related management practices reported by the extractivists.

Management practices	**Responses in descending order of frequency (%)**		
	1st	**2nd**	**3rd**
What is the frequency of oyster extraction in these natural banks in the Amazonian summer?	More than once a week (73.3)	Weekly (23.7)	Monthly (2.6)
What is the frequency of oyster extraction in these natural banks in the Amazonian winter?	More than once a week (63.2)	Does not extract in this period (23.7)	Weekly (5.3)
How is collection performed?	Diving (52.6)	Collecting from mangrove roots (26.3)	Collecting from rocks (19.3)
At what stage is the oyster extracted?	Adult (83.7)	Seed (16.3)	
How many dozens are extracted at a time?	More than 10 dozen (42.1)	8 to 10 dozen (26.3)	5 dozen (21.1)

Source: Authors (2024)

Regarding the frequency of extraction from natural banks, 73.3% of the respondents reported extracting oysters more than once per week during the Amazonian

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summer (June to December), and 23.7% reported doing so weekly in this season. In turn, during the Amazonian winter (January to May), most extractivists (63.2%) reported extracting oysters more than once a week, but 23.7% reported not extracting oysters during this period. Lack of training was associated with this behavior, constituting a risk factor for oyster collection in winter (OR=1.52). Regarding the amount of extraction, 42.1% of the respondents reported that they collected more than 10 dozen per day.

3.4 KNOWLEDGE OF OYSTER HEALTH

When questioned about oyster health, 94.7% of the respondents reported an increase in oyster mortality during the rainy season (Amazonian winter), attributing this event to decreased salinity (96.7%) (Table 5). In addition to the negative effect of decreased salinity on oyster development and survival, the respondents reported the presence of oyster competitors and predators, such as dog whelk (45.7%) and puffer fish (Tetraodontidae) (28.3%).

The majority of the respondents (68.4%) believe that oysters can acquire diseases, and 42.1% stated that these organisms can be contaminated by bacteria, with local water circulation as the possible main source of contamination (60.9%). In addition, 76.3% of the respondents believed that oyster consumption can cause diseases such as diarrhea (59.5%) and vomiting (29.7%).

Table 5. Extractivists' perception of oyster health.

Knowledge of oyster health	**Responses in descending order of frequency (%)**		
	1st	2nd	3rd
Do you believe that oysters can get sick?	Yes (68.4)	No (31.6)	
Do you believe that other animals pose a threat to oysters?	Yes (78.9)	No (21.1)	
If so, which ones?	Dog whelk (45.7)	Puffer fish (28.3)	Fish (10.9)
In which season of the year do you perceive greater oyster mortality?	Rainy season (94.7)	Non-rainy season (5.3)	
Do you think you know the reason?	Yes (78.9)	No (21.1)	

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If so, what is the reason?	Lower salinity (96.7)	Low pH (3.3)	
How are oysters infected?	From the water where it was collected (60.9)	Does not know (21.7)	From handling at the time of collection (13)
Do you believe that oyster consumption can cause diseases?	Yes (76.3)	No (23.7)	
If so, which diseases?	Diarrhea (59.5)	Vomiting (29.7)	Allergy (5.4)

Source: Authors (2024)

4 DISCUSSION

The predominance of men in fishing and oyster farming and extractivism observed in Curuçá corroborates the findings by (Machado et al., 2010; Castilho-Westphal et al., 2014; Ribeiro et al., 2016 and Henriques et al., 2018). This characteristic may be related to the physical effort required for oyster extraction, such as sun exposure and diving practices (Reis et al., 2020). Notably, extractivists often have help from family, including wives and children (Santos et al., 2017).

Monteles et al. (2009), in the municipality of Raposa in the state of Maranhão, and Santos et al. (2017) in the municipalities of Valença and Taperoá in the state of Bahia, observed a higher prevalence of women working in shrimp, mussel, crab and oyster extraction and in the processing of these animals. Women who perform this type of activity usually do so near their homes and for a few hours during the day, reconciling it with daily household chores.

The extractivists in the study region had a low educational level, corroborating the results from studies by (Quintero et al., 2002; Araya et al., 2009; Immanuel e Rao 2009; and Bose et al., 2013. The majority of interviewed oyster extractivists were older than 40 year of age, as also observed in other locations in the state of Pará (Reis et al., 2020) and in other Brazilian locations (Monteles et al., 2009; Machado et al., 2010; Castilho-Westphal et al., 2014; Santos et al., 2017; Mourão et al., 2020).

Monteles (2009) studied shellfishers in the municipality of Raposa, Maranhão, and found that these workers had worked in oyster extraction for more than 10 years. This

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long period of involvement reinforces that knowledge of extractive practices is transmitted among the most experienced relatives within these communities, usually starting at a young age (Johnsen e Vik., 2013; Braga et al., 2018).

The main source of income for the residents of the Vila de Lauro Sodré community is oyster extraction and sale. Santos et al. (2017) reported that in the municipalities of Valença and Taperoá in Bahia, oyster extraction is also the main source of income, thus demonstrating similar characteristics among communities located along the Brazilian coast. However, some factors contribute to the search for other occupations to supplement income, such as informal services, which are associated with decreased oyster production, as mentioned by many of the respondents.

Part of this decrease in the natural production of oysters may be related to the anthropogenic pressure on the oyster banks due to the lack of knowledge on the part of extractivists regarding the production cycle of these mollusks, hampering the correct way of extracting the banks (Castilho-Westphal et al., 2014; Sampaio et al., 2019). In 2009, many oyster farmers in Curuçá reported a scarcity of oysters for extraction; therefore, they sought farming as an alternative to preserve natural banks (Hoshino et al., 2009; Sampaio, et al., 2019). In addition to excess extraction from natural oyster banks, Hoshino et al. (2009) noted that industrial activities, domestic waste and mangrove deforestation can compromise oyster health and production, depleting natural stocks and consequently the source of income of these extractivists.

Among the interviewed extractivists, 61.1% reported never having had oyster extraction-related health problems, followed by 16.7% who had cuts on the body and 5.8% who had acquired pneumonia. Our results regarding extraction-related health problems differ from those of Santos et al., (2017), who reported colds and back pain as the conditions most cited by these workers resulting from routine practices required for extraction. Similarly, Machado et al. (2015) reported back pain as the most cited response by extractivists. This problem may be associated with the tidal flow during oyster extraction and indicates that this work requires considerable physical effort and causes postural problems (Santos, 2008; Hoshino et al., 2009).

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In several Brazilian regions, shellfish extraction plays a key role in the life of estuarine populations, especially among traditional families living in the areas of extractive reserves (Sampaio et al., 2019; Reis et al., 2020). Mollusks are collected from natural banks by free diving and using simple extraction tools such as sickles, baskets and nets. This type of extraction requires great physical effort due to the time underwater and depth of these banks (Diaz, 2013; Castilho-Westphal et al., 2014; Santos et al., 2016; Purcell et al, 2016).

The extractivists were able to point out the reasons for the decrease in natural oyster banks over the years. Attention should also be paid to the social determinants of the problem because the banks are exploited throughout the year as they are the main source of income for most of these extractivists. Therefore, there is a need for environmental education to encourage these extractivists to organize into associations or cooperatives so that they can receive training in correct and sustainable extraction (Alencar, 2011; Freitas et al., 2012; Gomes et al., 2019). Training should mainly focus on the practice of collecting oysters, which should be performed only at the adult stage to preserve seeds and thus avoid oyster shortages (Freitas et al., 2012).

Regarding climate, Lameira Silva et al., (2020) analyzed the effects of environmental factors on the microbiological quality in oyster farming areas in the state of Pará and found that the state has predominant climate classes based on rainfall data, thus establishing four seasonal periods: rainy-to-dry season transition, from May to June; dry season, from July to November; dry-to-rainy season transition, from December to January; and rainy season, in February (Paixão et al., 2013).

Santos et al., (2016) reported that salinity and rainfall play important roles in the oyster cycle. Oliveira et al. (2018) observed that with the increase in rainfall in the Amazon region, there is a decrease in salinity in estuarine systems, leading to higher oyster mortality in the region, as observed by the extractivists of the Vila de Lauro Sodré community. Studies indicate that in addition to salinity, other parameters such as temperature and the presence of suspended organic particles and rainfall also influence the development of oyster banks (Paixão et al., 2013; de Ramos et al., 2014; Ibarra et al., 2017; Lee et al., 2017; Legat et al., 2017; Pantoja et al., 2020).

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Therefore, it is essential to understand the characteristics of the natural oyster banks used by extractivists in order to understand the dynamics of these parameters so that collection can be managed more effectively to obtain higher productivity while also conserving these banks.

There have been reports of the overexploitation of oyster banks in the Curuçá region since 2004, where natural banks are decreasing due to intense extraction, with no time for recovery (Nishida et al., 2004; Sampaio et al., 2019). In Vila de Lauro Sodré, Curuçá, the interviewed extractivists stated that in the last two years, no oyster extraction was performed at the Frente da Vila de Lauro Sodré, Tio Oscar or Aquavila banks as a consequence of overexploitation. In other estuarine regions of Brazil, such as São Paulo and Santa Catarina, there is a closed season for these organisms. During this period, oyster extraction is prohibited because it is the peak reproductive period of these mollusks. The closed season for oysters was determined based on scientific studies, and legal regulations were put in place by environmental agencies (BRASIL, 1986).

The environmental conditions in Pará allow for a continuous oyster reproduction cycle in the coastal areas of the state, even though there is reasonable reproduction during the rainy season due to the low salinity; in contrast, there is reproductive seasonality found in the state of Santa Catarina (Lima et al., 2015; Lameira Silva et al., 2020). Due to the overexploitation of oyster banks, it is important to adopt management measures to restrict oyster catch sizes and certain types of fishing gear and establish a closed season. These measures would minimize long-term damage to the fauna and the economy, benefiting the local communities that depend on this fishery resource (Vanderkooy, 2012; Gomes et al., 2019; Musiello-Fernandes et al., 2021).

Regarding hygienic-sanitary aspects, in a study conducted by Santos et al., (2017), oyster farmers reported that the lack of hygiene measures in oysters processing for fresh consumption caused diseases such as diarrhea and worms. These results corroborate the present study, in which 76.3% of the extractivists believe that some disease can be caused by oyster consumption and 59.5% believe that contaminated oysters consumed fresh can cause diarrhea. It is possible to associate oyster consumption with this symptom because these mollusks can harbor a number of pathogens that infect the intestinal tract.

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According to Ballesteros et al. (2016) and Alfama et al. (2019), foodborne diseases cause symptoms such as diarrhea, nausea and stomach pain, and the consumption of oysters specifically is among the main causes of hospitalization for acute gastrointestinal disease.

Regarding the ways that oysters become contaminated, extractivists understand that contamination can occur from the water where the oysters are collected. A similar result was found by Santos et al. (2017), as the interviewed shellfishers recognized that shellfishing can be affected by environmental pollution, sewage discharge and the presence of garbage along the estuary. These findings raise concern regarding the consumption of oysters that are contaminated through sewage discharge and garbage dumped around estuaries.

Studies have been conducted in the Pará region regarding cultivation areas and the presence of bacterial agents in oysters. Oliveira et al. (2020) studied the occurrence, antibiotic resistance and virulence of *Escherichia coli* strains isolated from *Crassostrea gasar* cultivated in four estuaries in the Amazon and found that samples from Santo Antônio de Urindeua, in Salinópolis, had a greater number of *E. coli*. Lameira Silva et al. (2020) detected the presence of *Salmonella* sp. In 33.33% of oyster samples grown in Vila de Lauro Sodré, Curuçá, noting the risk of fresh oyster consumption to public health as well as the need to subsidize microbiological analyses of oysters from natural banks in the region.

Studies such as that by Sampaio et al. (2019) show that the structure of oyster farming in Pará needs to improve; however, because the oyster market is growing, oyster extractivism also needs to be considered so that production by both activities, as well as environmental variables, are monitored and the commercial presentation of the product improves. Similarly, public policies are necessary for regulating oyster producers and protecting natural oyster banks.

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5 CONCLUSION

Oyster extractivism is an activity performed mostly by men in the mesoregion of Curuçá, Pará, Brazil. Despite advancements in oyster farming, oyster extractivism represents a viable income alternative for artisanal fishers and family farmers in the region due to its characteristics in the area studied.

Most extractivists continue to extract oysters in the Amazonian winter, a period of low salinity. Not having received training was found to be a risk factor for oyster extraction during winter, and having received training was a protective factor against oyster extraction at the seed stage.

Additionally, it was found that the oyster banks are exploited year-round because they are the main source of income for most extractivists. Therefore, there is a need to encourage the extractivists to organize into associations or cooperatives through the support of public development policies so that these individuals can receive training on oyster extraction to prevent the overexploitation of the natural banks and facilitate sustainable extraction without harming either oyster extraction or the natural ecosystem. Additionally, conservation and financial education training can promote environmentally friendly oyster extraction while maximizing financial gains, thus contributing to the economic development of the traditional populations along the coast of Pará.

ACKNOWLEDGMENTS

We thank PAPQ/PROPESP-UFPA for financial support and the Brazilian Agency for the Improvement of Higher Education (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES) for the doctoral scholarship. Additionally, we thank the Mãe Grande de Curuçá Marine Extractive Reserve for all the support for this study and the Chico Mendes Institute for Biodiversity Conservation (Instituto Chico Mendes de Conservação da Biodiversidade – ICMBio) for authorizing the scientific research.

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