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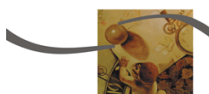
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## The commercial fishing fleet using the middle stretch of the Madeira river, Brazil

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**ABSTRACT.** Fishery resources in the Amazon region are exploited by both industrial and artisanal fishing fleets, that differ in their use of fishing gear and fishing grounds. Data on the physical characteristics of the vessels belonging to the fishing fleets using the Solimões/Amazonas river and estuaries are limited. This article presents an analysis of some physical characteristics of the commercial fishery fleet using the middle stretch of the Madeira river. Data were quantitative collected using interviews of the owners and/or skippers of fishery vessels between January 2003 and May 2004. The boats used for fishing in the region varied in size from 8 to 14 meters and had an average storage capacity ranging from 4.5 to 6.1 tons. Canoes were also used for fishing and ranged in length from 5 to 9 meters, with an average storage capacity of 0.2 tons. The results of this study demonstrate that boats in the Madeira river fleet had similar characteristics to the fishery fleet of the Solimões/Amazonas river with respect to length, use of gear, and fish storage.

**Keywords:** inland fishery, Amazonian, commercial fishery, fishing capacity.

### A frota pesqueira comercial do médio rio Madeira, Brasil

**RESUMO.** Os recursos pesqueiros na região amazônica são explorados por duas frotas denominadas industrial e artesanal, classificadas de acordo com sua área de atuação e com os apetrechos que utilizam, entretanto, as informações disponíveis sobre as características físicas das mesmas estão concentradas na frota que pratica a atividade no rio Solimões/Amazonas e no estuário. Visando preencher esta lacuna, este trabalho apresenta uma análise das características da frota pesqueira artesanal do médio rio Madeira. Entrevistas foram efetuadas com os proprietários e/ou encarregados pelas embarcações de pesca no período de janeiro de 2003 a maio de 2004. Os barcos de pesca da região mediram entre 8 e 18 metros, com capacidade média de estocagem variando entre 4,5 e 6,1 toneladas. As canoas apresentaram amplitude de comprimento entre 5 e 9 metros, com capacidade média de estocagem de 0,2 tonelada. Ficou evidenciado que as embarcações da frota desta região possuem características similares às frotas que atuam no rio Solimões/Amazonas quanto ao comprimento, utilização de apetrechos e tipo de armazenamento de pescado.

**Palavras-chave:** pesca interior, Amazônia, pesca comercial, capacidade de pesca.

### Introduction

Fishing is an important socioeconomic activity for the inhabitants of urban and rural areas within the Amazon Basin, acting as either the main or substantial supplementary source of income for many families. Fishing resources are exploited by two fleet types classified as industrial or small-scale. These two types of fishing fleets act in distinct areas and exploit different fish species. In addition, the fishing gear employed by each type of fleet has been shown to be quite different (BATISTA et al., 2004).

The industrial fishing fleet is composed of boats with steel hulls working particularly in the estuary of the Amazonas river, with fishing focused on the exploitation of catfishes, mainly piramutaba (*Brachyplatystoma vaillantii*) and dourada (*Brachyplatystoma rousseauxii*) (BATISTA et al., 2004). In contrast, the

small-scale fishing fleets are composed of vessels made of wood that are propelled by diesel engines, though they may also include small paddle boats and motorized canoes (BATISTA et al., 2004; FARIA JÚNIOR; BATISTA, 2006; PETRERE JÚNIOR, 1978). The main fishing gear used by the small-scale fishing fleets in this region are purse seine nets and gill nets which catch a great diversity of fish (CARDOSO; FREITAS, 2008; CERDEIRA et al., 2000; ISAAC et al., 2004; VIANA, 2004). The target species of these fleets belong to the Orders Characiforms and Siluriforms. Catches made by the small-scale fleet supply the main urban centers of the region (BITTENCOURT; COX-FERNANDES, 1990).

In general, the boats that are used by the small-scale fleet are primarily for the storage of fish and are not actively employed in the fishing activity

(PETRERE JÚNIOR, 1978). The actual catches are performed by the fishermen working from within in the canoes; the boats themselves are used for the launch or for affixing fishing gear as well as for the transportation of products to the boats (FARIA JÚNIOR; BATISTA, 2006).

Despite the development of fishery science in recent years within the Amazon region (SANTOS; SANTOS, 2005), studies on the physical characteristics of fishing fleets have concentrated on vessels engaged in the activity within the main channel of the Amazonas River and its estuary (ALMEIDA et al., 2003; BATISTA, 2003; CARDOSO et al., 2004; GONÇALVES; BATISTA, 2008; ISAAC et al., 2008). Thus, the physical and operational aspects of the vessels operating in small municipalities located outside of the main channel of the Solimões/Amazonas river are virtually unknown.

A common and serious mistake in fisheries management strategies is to consider the fish as the centerpiece of the system (HILBORN et al., 2003). Because the fishing activity presents different dynamics that are a function of environmental characteristics, social behavior, and target species that are inherent to the exploitation of natural resources, it is necessary to study the dynamics of the fleets that operate in the tributaries of Amazonas river. In this sense, this work presents an analysis of the physical characteristics of small-scale fishing fleets operating in the Middle Madeira river and also aims to contribute to the overall knowledge of regional fishing activities.

## Material and methods

### Study area

The Madeira river is the second largest tributary of the Amazonas river as measured by water volume (GIBBS, 1967). In the portion located in the State of Amazonas, there are five municipalities: Humaitá, Manicoré, Novo Aripuanã, Borba, and Nova Olinda do Norte; the first three municipalities listed are located in the Middle Madeira river region and were the focus of this study (Figure 1). The last two are within in the Lower Madeira river region and are not examined in detail in this study (GOULDING, 1979). In addition to the commercial landings in the towns located at the banks of the Madeira river, the fish caught in the Madeira river Basin are also landed in Manaus, the capital of the Amazonas State, and in Porto Velho, the capital of the Rondonia State.

### Data collection

Data on the fishing fleets were collected using structured questionnaires and through interviews with the owner and/or skipper of fishing boats in Humaitá,

Manicoré and Novo Aripuanã from January 2003 to May 2004. Information was collected on the following: the vessel dimensions, the power of the engine (HP), characteristics of storage, auxiliary canoes, and the type of fishing gear employed. Secondary data on the total number of boats in the fishing fleet by municipality were provided by Fishermen's Associations Z-35, Z-20, and Z-29 of Humaitá, Manicoré and Novo Aripuanã, respectively. The results presented in this study for canoes relate only to the data collected in the municipality of Manicoré.

### Data analysis

Data were analyzed using descriptive statistics to calculate the frequency of occurrence, average and standard deviation ( $\pm$ ). An analysis of correlation was performed using the data on vessels length, engine power, and storage capacity to verify the relationship between these measures. For this analysis, all of the vessels that were sampled were included. All analyzes were performed using the statistical program R (R DEVELOPMENT CORE TEAM, 2008).

## Results

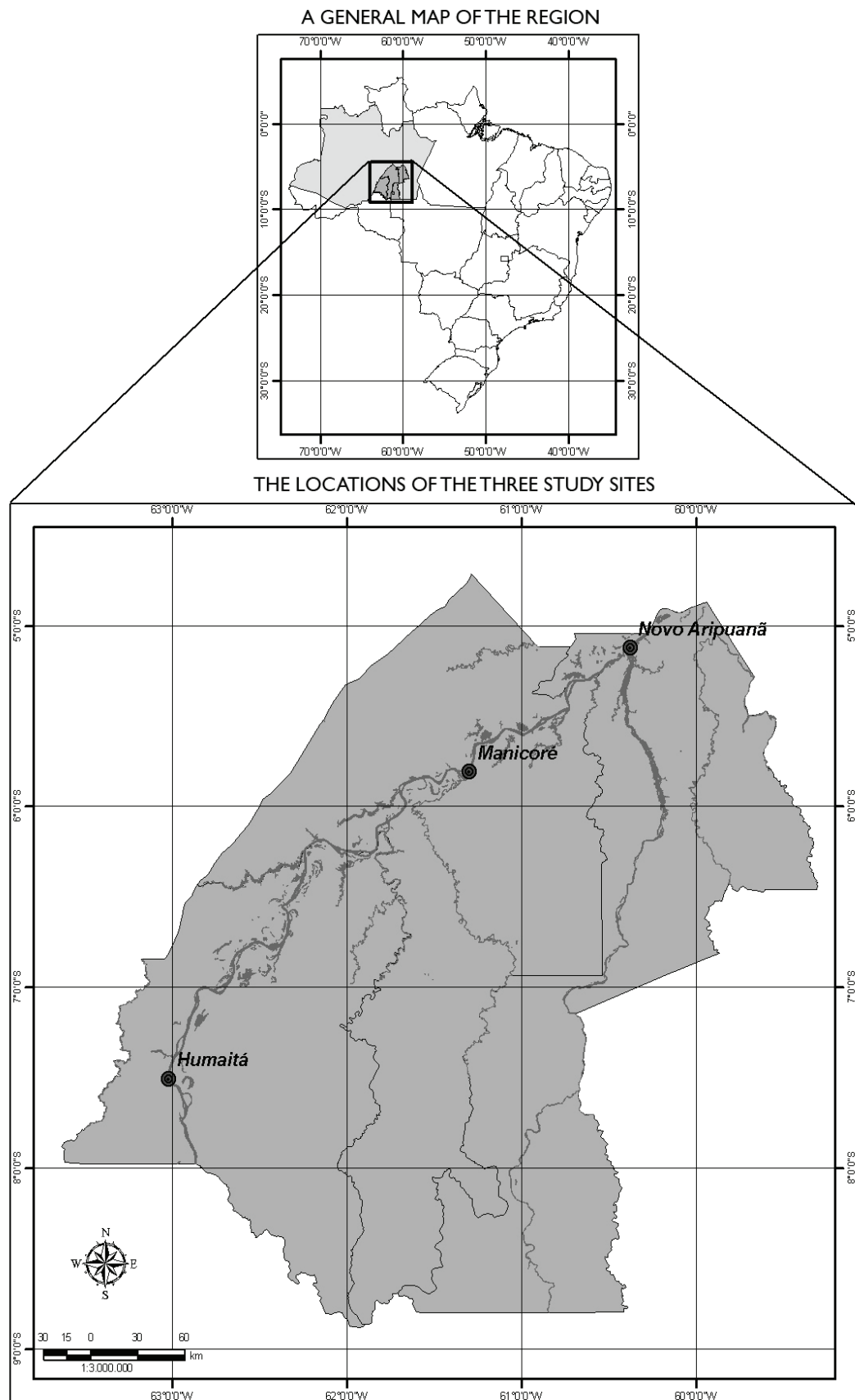
In May 2004 the small-scale fishing fleet in the Middle Madeira river region was composed of 46 boats: 29 were boats from Humaitá, 15 boats were from Manicoré and 2 boats were from Novo Aripuanã. The boats sampled corresponded to 24%, 87%, and 100% of the commercial fishing fleet in these municipalities, respectively.

According to Cardoso and Freitas (2008) in the period from June 2003 to May 2004, approximately 150 canoes landed fish in the municipality of Manicoré. Using this period as a reference, our study sampled 28% of the canoes that are effectively fishing in the Manicoré municipality.

### Physical characteristics of boats and auxiliary canoes

The length of boats in the region ranged from 8.0 to 18.0 meters (m). In Humaitá the length of the boats varied from 8.0 to 14.0 m, with an average length of 12.04 ( $\pm$  1.50) m, and an average width of 2.87 ( $\pm$  0.46) m; in Manicoré, the length varied from 8.0 to 18.0 m, with an average of 12.43 ( $\pm$  2.16) m, and an average width of 3.14 ( $\pm$  0.80) m; in Novo Aripuanã the length of boats was between 14.0 and 16.0 m.

The number of auxiliary canoes used in the fishing trips varied between two and four per boat. In Novo Aripuanã, the fleet used four canoes, whereas the fleet of Manicoré used between two (46.2) and three (38.5%) canoes and the Humaitá fishing fleet employed three canoes (57.1%). Only one boat in Manicoré fishing fleet used aluminum canoes for the fishing trips.



**Figure 1.** Madeira river Basin, between the towns of Humaitá and Novo Aripuanã.

### Propulsion engines

The boats that were sampled had engines with a capacity ranging between 4 and 75 HP, the most frequently occurring engines had 25 (23.8) and 45 (28.6%) HP. The analysis for the fleet in this region presented a positive correlation between the length of boats and HP ( $r = 0.75$ ).

All of the boats of the Humaitá and Novo Aripuanã fleets presented out board engines as part of the equipment used during the fishing trips. In Manicoré only 46% of the fishermen used out board motors for the propulsion of canoes.

### Storage capacity

The boats sampled generally had two structures for the storage of fish: fixed freeze-box and styrofoam-boxes (expanded polystyrene). The boats in the Humaitá and Novo Aripuanã fleets use freeze-boxes with an average storage capacity of 4.5 ton. (amplitude of 1.5 and 6.3 ton.) and 5.5 ton., respectively (amplitude of 5.0 and 6.0 ton.). In Manicoré, 76.9% of the boats sampled had fixed freeze-boxes, with an average storage capacity of 6.1 ton. (range 2 to 15 ton.), and 23.1% of the boats had only a mobile freeze-box for storage.

The boats in Novo Aripuanã did not have styrofoam-boxes for the fish storage, whereas the boats of Humaitá (100%) and Manicoré (30.8%) did. Boats used in Manicoré had an average of 8 ( $\pm 2.8$ ) boxes, with an additional storage capacity between 0.5 and 1.3 ton. Correlation analysis performed between the length of the boats and storage capacity was positive for the vessels of the fleet ( $r = 0.78$ ).

### Fishing gear

Nine different fishing gear types were identified (Table 1). In Humaitá, the number of gear types per boat varied between 2 and 7: purse seine (85.7%), gill net (85.7%), cast net (85.7%) and demersal longline (66.7%) were present in the majority of the boats.

In Manicoré, the number of fishing gear types varied from 1 to 5 per fishing boat. Purse seine (76.9%) and gill nets (69.2%) were present in the majority of boats. Another important fishing gear, the drift net, used to catch catfishes, was present in 23.1% of the boats. The “escolhedeira”, a gill net utilized to select fish after the catch, was identified in 23.1% of the boats. Within boats that use a gill net as the main gear (Table 1), the number varied from 10 to 35 units.

In Novo Aripuanã, three gear types were identified: purse seine, gill net and “escolhedeira”. Purse seine was the only common gear using by all the sampled boats. One boat possessed two purse seines and another two “escolhedeiras”.

**Table 1.** Composition of fishing gear used by fishing boats in the middle Madeira river region.

Municipality	Boats	Gear								
		PS	GN	DN	MG	ES	PL	HA	CN	DL
	1	X	X	-	-	-	X	X	-	X
	2	X	X	X	-	X	X	X	X	-
	3	X	X	-	-	-	-	X	X	X
Humaitá	4	-	X	-	-	-	-	-	X	-
	5	X	X	-	-	-	-	-	X	X
	6	X	X	-	-	-	-	-	X	X
	7	X	-	X	-	X	-	-	X	-
	1	X	X	-	-	X	-	-	-	-
	2	X	-	-	-	-	X	-	-	-
Manicoré	3	X	X	-	-	X	-	-	-	-
	4	X	-	X	-	-	-	-	X	-
	5	X	-	-	-	-	-	-	-	-
	6	X	X	-	-	-	-	-	-	-
	7	X	X	-	-	-	-	-	-	-
	8	X	-	X	-	-	-	-	-	-
Novo Aripuanã	9	-	X	X	-	-	-	-	-	X
	10	X	X	-	-	-	-	-	-	-
	11	-	X	-	-	-	-	-	-	-
	12	X	X	-	X	X	-	-	X	-
	13	-	X	-	-	-	X	-	-	-
	1	X	-	-	-	X	-	-	-	-
	2	X	X	-	-	-	-	-	-	-

PS = Purse seine; GN = Gill net; DN = Drift net; MG = Monofilament gill net; ES. = “Escolhedeira”; PL = Pelagic longline; HA = Harpoon; CN = Casting net; DL = Demersal longline.

### The motorized canoes in Manicoré

The average length of motorized canoes was 6.8 ( $\pm 0.7$ ) m (range from 5.0 to 9.0 m). The motorized canoes were made of board (91.4%) or a combination of trunk wood (hull) and board.

The power of the engines used ranged from 1.5 to 8.0 HP, the most frequent of the engines having 5.5 (50.0%), 5.0 (12.5%) and 4.0 HP (12.5%). These engines used gasoline (96.8%) and diesel (3.2%) as fuel.

The fishermen using motorized canoes also only used styrofoam boxes for the storage of fish, and the number of boxes ranged from 1 to 9 boxes, with an average of 2.5 ( $\pm 1.3$ ) boxes per canoe, with an ice storage capacity between 50 and 280 liters. The styrofoam box size most frequently used was 170 liters (55.6%), with a storage capacity of 70-80 kg of fish. The fishermen using canoes used ten different types of gear to catch fish (Table 2): the most frequently used were gill nets and cast nets.

**Table 2.** Composition of fishing gear used in the motorized canoes in Manicoré (middle Madeira river).

Gear	Aggregate frequency (%)	Minimum	Maximum	Average	Standard deviation ( $\pm$ )
Bow and arrow	42.9	1	7	2.9	1.6
Harpoon	35.7	1	2	1.1	0.3
Drift net	28.6	1	2	1.3	0.5
Fishing rod	33.3	1	6	2.7	1.4
Peacock bass bait	7.1	1	2	1.7	0.6
Demersal long line	16.7	2	6	3.3	1.7
Gill net	95.2	1	20	7.1	4.2
Purse seine	2.4	1	1	-	-
Casting net	50.0	1	3	1.1	0.5
Trident	42.9	1	8	3.2	2.3

## Discussion

The sustainable management of fisheries resources requires the efficient use of the inputs employed and the maintenance of fishing capacity at an optimum level. These factors would maximize the social and economic benefits inherent to fishing activities. The information about physical and operational characteristics of fishing fleets, as well as the knowledge of the fishermen's strategies is fundamental as a baseline to the fisheries management (SALAS; GAERTNER, 2004).

However, knowledge on the components of the fishing capacity of the fleets is still incipient in the Amazon basin. In actuality, much remains unknown regarding the total number of boats fishing in the region. According to Almeida et al. (2001) the number of boats operating in the region of the Solimões/Amazonas river was approximately 7,351 units. More recently, the IBAMA (Brazilian Environmental Agency) estimated that the number of vessels acting in the State of Amazonas was 2,616 units, of which only 635 were fishing boats. Hence, the boats in the Middle Madeira river would represent approximately 7.24% of all of the boats of the Amazonas.

The question of management related to the components of fishing capacity is not common in Amazonas. Nevertheless, it would not be difficult to implement because the results presented in this study show the existence of similarity between the main physical characteristics (such as length and storage capacity) of the boats using the Middle Madeira river region, and the characteristics presented for boating fishing in the main channel of the Solimões/Amazonas river (ALMEIDA et al., 2003; BATISTA, 2003; GONÇALVES; BATISTA, 2008; ISAAC et al., 2008; VIANA, 2004).

The comparison of the results demonstrated that there is similarity between the length of canoes used in Manicoré and those that landed fish in Tefé, Manacapuru and Itacoatiara (ALMEIDA et al., 2003), and that these canoes are longer than the ones that landed in Parintins (BATISTA, 2003). However, the motorized canoes presented length and storage capacity that was lower than the canoes that are landed in Santarém in the Lower Amazonas river region (ISAAC et al., 2008).

The similarity between our results and those obtained for others studies remains strong for fishing boats (Table 3). The results showed a great variability in the engines used to power the fishing boats. However, the values presented in this study were similar to other fleets in the Amazon region. The fact that the power of vessels did not influence the catch of

fish does not mean that this factor is unimportant to fishing management: the power of vessels is a characteristic that allows fishermen to move to fishing grounds that are further from the ports of origin.

**Table 3.** Physical characteristics of the Amazonian fishing boats.

Towns	Length (m)	Range (m)	Storage (tons)	Engine (HP)
Belém	10.1 <sup>1</sup>	-	4.8 <sup>1</sup>	30.1 <sup>1</sup>
Santarém	11.0 <sup>2</sup>	4.0 – 23.0 <sup>2</sup>	2.7	26.0
Parintins	-	4.0 – 20.0 <sup>3</sup>	-	-
Itacoatiara	-	9.0 – 23.0 <sup>3</sup>	-	-
Manaus	14.1 <sup>1</sup>	-	11.1 <sup>1</sup>	36.0 <sup>1</sup>
Manacapuru	-	8.0 – 24.0 <sup>4</sup>	-	-
Tefé	11.8 <sup>1</sup>	-	3.6 <sup>1</sup>	23.0 <sup>1</sup>

<sup>1</sup>Almeida et al. (2003); <sup>2</sup>Isaac et al. (2008); <sup>3</sup>Batista (2003); <sup>4</sup>Gonçalves and Batista (2008).

According to Almeida et al. (2003) and Isaac et al. (2008) characteristics such as the length of vessel, fishing gear used, number of fishermen in the crew, the quantity of fuel and ice are the main factors that influence the volume of fish caught in the Amazon region. However, these authors did not study the relationship between the storage capacity of boats and the quantity of fish landed, although Batista (2004) found that there is a strong relationship between the length of boats and the storage capacity. This last factor also affects the volume of fish landed by fishermen using motorized canoes because in the Middle Madeira river region the storage capacity of these fishermen is small (CARDOSO; FREITAS, 2008).

Although the fishermen using boats have seven fishing gear options, purse seine is clearly the main gear used, as had been reported by Goulding (1979) and Cardoso and Freitas (2008) for the main channel of the Madeira river. Another similarity between the local fishing fleet and others existing in the Amazon region is the great occurrence of boats that use only gill nets.

The use of purse seine requires two canoes: a large one that is used to transport gear and the catch; and another smaller, denominated hull used by the "cambiteiro", who is the fishermen responsible of closing the purse seine during the catch. The boats in the fleets of the study region also follow this pattern, and in some cases, there were fleets with four canoes that were likely used for the distribution of fishermen to more effectively fish using gill nets or to transport small quantities of fish for sale in the port of landing (CARDOSO; FREITAS, 2006).

Although the fishing fleets of the region apparently did not reach a level of fishing capacity that could jeopardize the sustainability of stocks, studies should be performed to estimate the actual level of fishing capacity. Such data would provide the resource managers with a more holistic view of the

technological level employed by local commercial fishermen and their capacity to catch fish.

It is important that management measures are appropriate to the peculiar microrregions common in the Amazon region because they are more likely to be accepted by the local fishermen. It is important to emphasize that the lack of control over the number and size of the boats, which are the main components of the fishing capacity of a fleet (SMITH; HANNA, 1990), may lead to problems in relation to the exploitation of stocks and fishing grounds in a short period of time. It is vital for managers to take measures in order ensure that this can be controlled.

## Conclusion

The commercial fishing fleets based in the Middle Madeira river exhibited artisanal characteristics that were similar to other fleets within in the States of Amazonas and Pará. The similarity between the physical characteristics of the fishing boats and the gear used with others fishing fleets within the Amazon region is interesting because it will allow managers to engage in a set of more appropriate management rules.

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