The Role of Social Capital in Fostering Collective Action for Small-Scale Fishery Co-Management in the Baixo Juruá Extractive Reserve, Central-West Brazilian Amazon

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ABSTRACT – Social capital is pointed out as a key factor for community social organization and the collective management of natural resources. In this study, I investigated the role of community social capital in facilitating collective action for arapaima (*Arapaima* sp.) management and the underlying motivations for engagement on collective action, in the six arapaima management systems of the Baixo Juruá Extractive Reserve (Amazonas). Through semi-structured interviews with 62% of the 95 households of communities that participate on management, I compared household participation in arapaima management in relation to demographic and socioeconomic characteristics, social and political engagement, and social capital. In four out of the six management systems, 70% to 86% of households participated on management, compared to only 31% and 33% in the other systems. Participation in collective action for arapaima management varied in a similar fashion with social capital in the community. Both bonding and bridging social capital come into play in fostering collective action. Although human relations are important components in community collective action, people also reveal utilitarian motivations for engagement. Thus, when incentives are provided, they might find it relevant to participate on resource management. This study highlights the role of social capital in natural resource management and may serve both communities and decision makers.

Keywords: Arapaima management; extractive reserves; Brazilian Amazon.

O Papel do Capital Social na Promoção da Ação Coletiva para Co-gestão da Pesca de Pequena Escala na Reserva Extrativista do Baixo Juruá, no Centro-Oeste da Amazônia Brasileira

RESUMO – O capital social é apontado como um fator chave para a organização social e o manejo comunitário de recursos naturais. Neste estudo, investiguei o papel do capital social comunitário na facilitação da ação coletiva para o manejo do pirarucu (*Arapaima* sp.) e as motivações subjacentes para o engajamento na ação coletiva, nos seis sistemas de manejo de pirarucu da Reserva Extrativista do Baixo Juruá (Amazonas). Por meio de entrevistas semiestruturadas com 62% dos 95 domicílios das comunidades que participam do manejo, comparei a participação dos domicílios no manejo do pirarucu em relação às características demográficas, engajamento social e político e capital social. Em quatro dos seis sistemas de manejo, 70% a 86% das famílias participaram do manejo, comparado a apenas 31% e 33% nos outros sistemas. A participação na ação coletiva para o manejo de pirarucu variou conforme o grau de capital social da comunidade. Tanto o capital social da comunidade como entre comunidades é importante para a ação coletiva. Embora as relações humanas sejam componentes importantes da ação coletiva na comunidade, as pessoas também revelam motivações utilitárias para o engajamento. Assim, quando há incentivos, podem achar relevante participar do manejo de recursos. Este estudo destaca o papel do capital social no manejo dos recursos naturais e pode servir tanto às comunidades quanto aos tomadores de decisão.

Palavras-chave: Manejo de pirarucu; reservas extrativistas; Amazônia brasileira.

El Papel del Capital Social en el Fomento de la Acción Colectiva para Cogestión de la Pesca Artesanal en la Reserva Extractiva del Baixo Juruá, Amazonía Centro-occidental Brasileña

RESUMEN – El capital social es señalado como un factor clave para la organización social comunitaria y la gestión colectiva de los recursos naturales. En este estudio, investigué el papel del capital social comunitario para facilitar la acción colectiva para el manejo de arapaima (*Arapaima* sp.) y las motivaciones subyacentes para participar en la acción colectiva, en los seis sistemas de manejo de arapaima de la Reserva Extractiva Baixo Juruá (Amazonas). A través de entrevistas semiestructuradas con el 62% de los 95 hogares de las comunidades que participan en el manejo, comparé la participación de los hogares en el manejo de arapaima en relación con las características demográficas y socioeconómicas, el compromiso social y político y el capital social. En cuatro de los seis sistemas de gestión, entre el 70% y el 86% de los hogares participaban en la gestión, en comparación con solo el 31% y el 33% en los demás sistemas. La participación en la acción colectiva para el manejo de arapaima varió de manera similar con el capital social en la comunidad. Tanto el capital social vinculante como el puente entran en juego para fomentar la acción colectiva. Aunque las relaciones humanas son componentes importantes en la acción colectiva de la comunidad, las personas también revelan motivaciones utilitarias para el compromiso. Por lo tanto, cuando se proporcionan incentivos, pueden encontrar relevante participar en la gestión de recursos. Este estudio destaca el papel del capital social en la gestión de los recursos naturales y puede servir tanto a las comunidades como a los responsables de la toma de decisiones.

Palabras clave: Manejo de Arapaima; reservas extractivas; Amazonia brasileña.

Introduction

Community-based natural resource management is considered a more effective and inclusive strategy to conserve natural resources than state or private control (Acheson, 2006). Natural resource management involves challenges that are better addressed at different scales and jurisdictions (Murphree, 2000). At the local scale, communities bring their knowledge and institutions to natural resource management, which could involve rules that better respond to local conditions and result in greater compliance than broad scale regulations. As they are closer to the resource base, they might be able to devise diverse and flexible solutions to commons problems, such as changing harvest rates to match replenishment of resource stocks (Ostrom, 1990).

In the theory of self-organized collective action elaborated by Ostrom (1990, 2000), cooperation is an essential element. Rational individuals cooperate if perceived benefits are greater than costs over time. Cooperation in common property regimes depends on relations of trust and reciprocity. Individuals collectively design and follow rules if they believe others in the group will do the same; otherwise, it might be more advantageous to free ride (Ostrom, 1990). This is defined as a collective action dilemma. Individuals in a group may perceive (or not) the advantages to design and maintain institutions regulating their interdependent use of common pool resources, in order to obtain "higher joint benefits or reduce their joint harm" (Ostrom, 1990: 39).

Social capital has been pointed out as a key factor for the social organization and for the collective management of natural resources (Ostrom, 2005; Pretty, 2003; Pretty & Smith, 2004). This concept has been incorporated in studies of common property, given its power to characterize and understand the social relations among actors that prompt them to work together for the collective good. In contrast to other forms of capital (*e.g.* financial or human capital), the power of social capital lies not in individual actors, but in the social relations among them, be these people, communities, or organizations (Woolcock & Narayan, 2000).

There are multiple definitions for social capital, emphasizing more the external linkages of social actors (*e.g.* Bordieu, 1985), the internal linkages (*e.g.* Coleman, 1988; Putnam, 1995), or both (*e.g.* Woolcock, 1998; Adler & Kwon, 2002). Here I adopt Putnam's (1995) definition of social capital, emphasizing networks, norms, and trust that facilitate collective action. More specifically, I focus on "those features that give the collectivity

cohesiveness and thereby facilitate the pursuit of collective goals" (Adler & Kwon, 2002: 21).

In the context of governance of common-pool resources, it is important to understand the motivations people have to engage in collective action for controlling the use of natural resources. People engage in regulating common-pool resources when they perceive that these are overexploited (Ostrom, 1990; Baland & Platteau, 1996), but a key question is what makes them invest in the collective gain over their own individual benefits and comply with rules, without being sure that others in the group will do the same (Portes, 1998; Ostrom, 2000). According to Putnam (1993), norms of generalized reciprocity guide people's behavior in social groups. These norms create a general understanding that if one actor does something for another, at some point in the future this other will pay the first back. Thus, these norms "transform individuals from self-seeking and egocentric agents with little sense of obligation to others into members of a community with shared interests, a common identity, and a commitment to the common good" (Adler & Kwon, 2002: 25).

Despite disagreements on whether certain aspects of social relations, such as trust, are sources or consequences of social capital (Woolcock, 2001), I employ it in my operationalization of social capital. The purpose is not to identify the factors affecting social capital, but rather to understand its role in eliciting participation in collective action for small-scale fisheries management in the Amazon. My focus of analysis are the social connections within ("bonding") and among ("bridging") communities. Bonding social capital refers to social relations among actors from the same social group (family members, close friends, neighbors), while bridging social capital designates relations among actors of different groups (more distant friends, colleagues, associates; Gittell & Vidal, 1998; Woolcock, 2001).

Collective action in the Amazon rural communities

In the western Amazon, collective action among smallholders emerged with the formation of riverine communities in the 1970s-1980s through efforts of the *Movimento de Educação de Base* (MEB) of the Catholic Church. Former rubber tappers living in isolated households within the forest were aggregated into communities along the main rivers and tributaries to better access public policies such as education. At the same time, the Church stimulated their sense of collectivity, belonging, and solidarity, incentivizing labor-sharing groups (known as *mutirão* or *ajuri*) and the collective defense of lakes.

Amazon rural communities are generally constituted by kinship and friendship relations, which facilitates collective action (Harris, 2000). Closely related kin are connected by strong norms of solidarity, in which no reciprocity is expected in return for help. Solidarity networks are based on work, food exchange (characterized by an interval between receipt and repayment), aid, and visit (Lima, 2006). Solidarity relations have more value than relationships of credit and debt among neighbors (Harris, 2000). Thus, it is especially relevant to understand the role of social capital in determining collective action.

Studies on community collective action in the Amazon focus on the emergence and outcomes of local management institutions for natural resource conservation (Castro, 2000; Futemma *et al.*, 2002; Pinho *et al.*, 2012), and on the rationale for individual engagement (Schons *et al.*, 2020), with little reference to the underlying social relations accounting for engagement in collective action. This gap is particularly evident for small-scale fisheries that provide a useful study case for examining the role of social capital in fostering collective action for resource management.

Small-scale fisheries management

Small-scale fisheries are important for local livelihoods in Amazonian communities, as fishing in the Amazon holds valuable cultural, economic, and biological meanings (Castro, 2000). Most riverine communities live on small-scale agriculture, but some depend economically on fishing for most or part of the year. Fish constitute their main source of protein.

New management schemes have been developed from the 1960s to the 1980s in the Amazon in response to increasing conflicts due to invasions of lakes by commercial boats (Castro, 2000; Ruffino, 2008). Similar to *empates* that characterized the rubber tappers social movement

in Acre, riverine communities developed collective strategies to protect lakes and impede the access of commercial boats to their fishing territories (Castro, 2000). Moreover, they established lake zoning based on their functions (no-take, subsistence, or commercial fishing), rotating these with time. That way, they implemented sustainable use strategies for long-term fishery conservation.

Management of the largest fish with scales in the world, *pirarucu* or arapaima (*Arapaima* spp.), endemic to the Amazon basin, emerged from the combination of scientific and traditional knowledge (Castello, 2004). Together, researchers and fishers developed a method to accurately count arapaima in floodplain lakes in the dry season, allowing sustainable management quotas to be set by the government (Castello, 2004). Management is held through co-management arrangements with the government but depends mostly on community organization and collective action. Communities collectively develop local rules and strategies for governing fish stocks and avoid free riding, with multiple successful cases documented (Castello *et al.* 2009; Campos-Silva & Peres, 2016; Pinheiro *et al.*, 2018; Gurdak *et al.*, 2019). However, there remain questions about the aspects of social capital and its importance for the emergence and effectiveness of collective action to ensure the sustainability of the arapaima fishery. I therefore focus on the role of community social capital in facilitating collective action for the management of arapaima in this study. My main research question was: Do management systems with higher social capital present higher engagement in collective action for arapaima management? I hypothesized that the higher the social capital, the higher the participation in arapaima management. I also investigated whether a set of community characteristics affected community collective action. Finally, I examined the underlying motivations for community engagement in collective action in arapaima management systems.

Study area

This study was conducted in the Baixo Juruá Extractive Reserve, a federal protected area covering nearly 188,000 hectares of forests and aquatic systems in the central-west Brazilian Amazon. The Baixo Juruá Extractive Reserve was created in 2001 by demand from local residents, represented by the Association of Rural Workers of Juruá (ASTRUJ), to guarantee their land use rights and control overfishing in their territories (ICMBio, 2009). At the time of data collection, in the Baixo Juruá Extractive Reserve there were 15 settlements, hereinafter called communities, where there resided 132 families constituted by 748 people, 14% of them considered authorized users by the reserve management plan (ICMBio, 2009). These were former residents that moved to Juruá town in search for education or job opportunities but kept social and/or production ties with the communities. For these reasons, they also had *de jure* rights to use natural resources and participate on fisheries management in the reserve. Residents were former rubber tappers from families that had resided in the area for many generations. Their main livelihood activities were small-scale agriculture, fishing, forest extractivism, small animal husbandry and small-scale cattle ranching.

Management of arapaima began in the Baixo Juruá Extractive Reserve in 2006 due to demand by local communities. Management is formally coordinated by ASTRUJ. It started in three areas, and it was later expanded to another three, involving a total of eight communities in the following six management systems (rivers, lakes, and connecting channels governed by communities): Botafogo, Antonina, Planeta complex, Lago do Baixio, Lago Socó and Andirá (Figure 1). Three of these systems (Botafogo, Antonina, and Lago do Baixio) were managed by single communities (Botafogo, Antonina, and Socó, respectively), while in the others, representatives of two or more communities participated in management (Table 1): a) the Planeta complex of lakes (Planeta) involved some managers from Antonina and Botafogo, including authorized users; b) Lago Socó involved managers from Forte das Graças 1 and Socó; and c) Andirá involved managers from five communities inhabiting or using the Andirá river (Forte das Graças 1, Escondido, Cumarú, Itaúba and Igarapé do Branco). Remaining communities of Baixo Juruá Extractive Reserve did not participate in arapaima management.

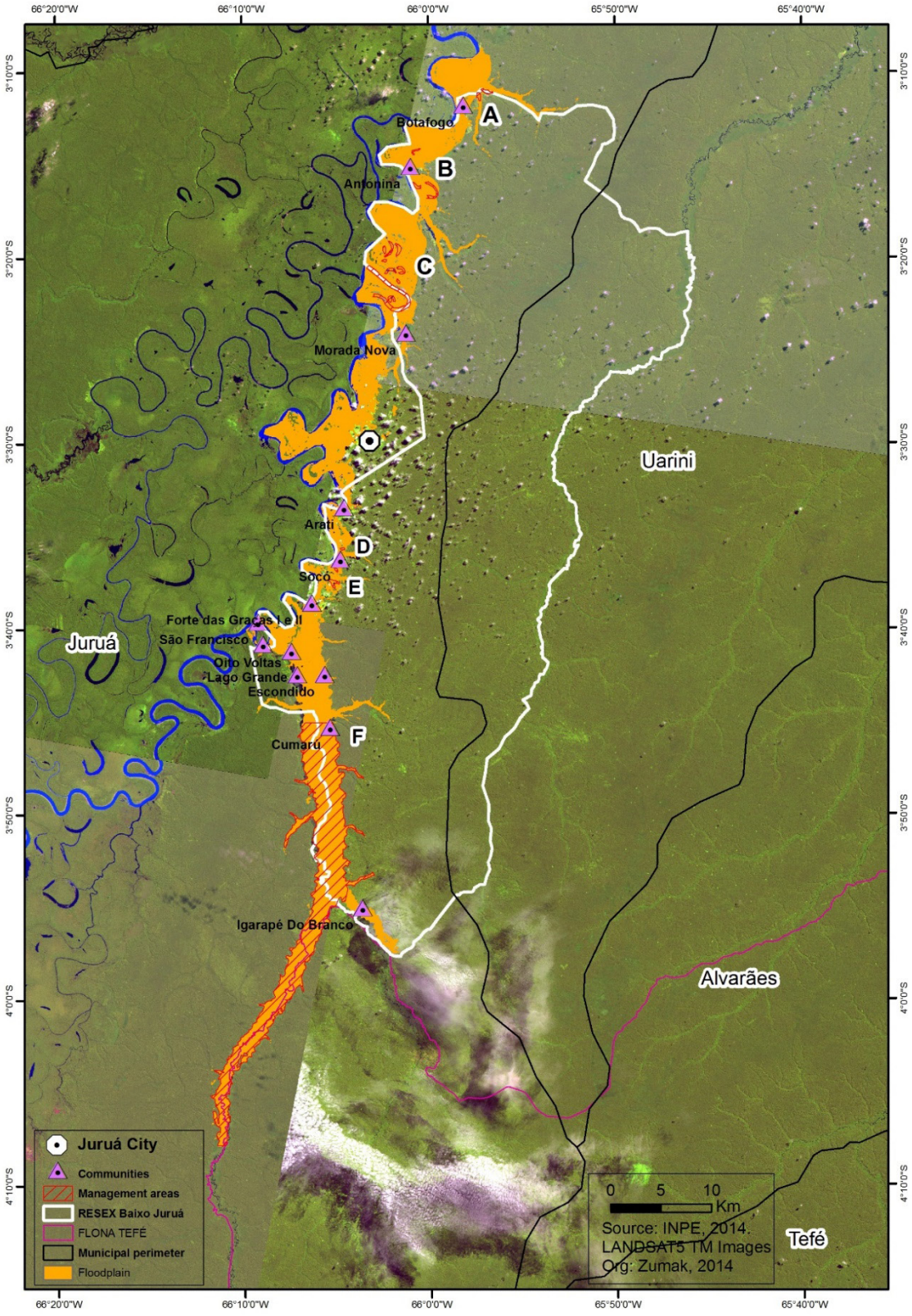

Figure 1 – Communities and arapaima management systems of the Baixo Juruá Extractive Reserve: A - Botafogo, B - Antonina, C - Planeta complex, D - Lago do Baixio, E - Lago Socó and F - Andirá.

Table 1 – Communities (N = total number of households) involved in the six arapaima management systems of the Baixo Juruá Extractive Reserve.

Community (N)	Management system					
	Botafogo	Antonina	Planeta	Lago do Baixio	Lago Socó	Andirá
Botafogo (N=15)	x		x			
Antonina (N=18)		x	x			
Socó (N=7)				x	x	
Forte das Graças 1 (N=38)					x	x
Escondido (N=3)						x
Cumaru (N=12)						x
Itaúba (N=1)						x
Igarapé do Branco (N=4)						x

Methods

I conducted a case study analysis (Yan, 2003) of the six arapaima management systems involving eight communities of the Baixo Juruá Extractive Reserve, from August 2012 to May 2013. I mapped all community households and determined the degree of collective action of management systems by the proportion of households with at least one person engaged in arapaima management. I collected data both through qualitative and quantitative methods. I held participant observation of the arapaima management process at the six areas, examining collective action among members. I conducted semi-structured interviews with a random sample of household heads from the eight communities. I interviewed heads of all households in smaller communities (up to ten houses) and randomly sampled at least 30% of households in larger communities. When both male and female were present at the household, I focused interviews on males because women were rarely involved in the arapaima fishery management in the reserve. In cases that households participated in management in two systems (Table 1) and were sampled twice, questions were responded separately for each system. I used household heads as respondents to compare varying levels of participation in collective action in management and then sought to relate it to multiple potential explanatory variables, including indicators of social capital. I evaluated household participation in arapaima management (dependent variable) among systems in relation to a set of independent variables: a) demographic and socioeconomic characteristics – age; origin; time of residence; years of schooling; religion; occupation; number of household members; agricultural plot size (given by the number of cassava pits or *covas*); and wealth, determined by community house area, whether family owned house in town, total number of assets, and annual income); b) social and political engagement – role played in the community, such as community board, health agent etc.; affiliation to formal organizations; participation in the extractive reserve creation; participation in meetings about the management plan; participation in community/group meetings; and c) social capital (adapted from Krishna, 2004) – participation in labor-sharing groups, known as *mutirões*; trust in lending of materials to others; frequency of mention of norms of reciprocity, solidarity and sense of collectivity in responses to why they joined *mutirão*; participation in food exchange and frequency of food exchange in the community; and proportion of people with whom they could count on in the community. I did not measure participation/frequency of food exchange in systems involving multiple communities as this social network happens only between neighbors. Similarly, I did not measure frequency of participation in *mutirões* in these same areas because it would be biased, as labor-sharing groups met at regular periods of time for patrolling management systems. Then I scored and summed values for each measure of social capital, ranging from 1 to 5, and calculated the social capital index for each management system, estimating the coefficient of reliability through Cronbach's alpha (Bryman, 2012).

I used both quantitative and qualitative methods of data analysis. I calculated the average and standard deviation values for the continuous variables and the relative frequency for the categorical variables using SPSS. Categorical variables were recorded as binary options (yes or no) or as a five-point Likert-scale.

I coded qualitative data from the semi-structured interviews and calculated the frequency of occurrence of themes and subthemes in responses to why they joined *mutirão* and arapaima management. In this analysis, I considered only households that participated in collective action. I examined differences in qualitative and quantitative data among areas using descriptive quantitative analysis.

Results

I interviewed a sample of 59 family heads (62%) from a total of 95 households in the eight communities involved in arapaima management systems in the Baixo Juruá Extractive Reserve, including authorized users (Table 2). Ninety percent of respondents were male. Four out of the six systems showed high levels of household participation in arapaima management: 86% in Lago do Baixio (N=6), 82% in Antonina (N=14), 80% in Planeta (N=28; 13 from Botafogo and 15 from Antonina), and 70% in Botafogo (N=7). Lago Socó (N=15) and Andirá (N=18) exhibited low levels (33% and 31%, respectively) of participation in arapaima management. In some areas, participation involved not only resident families but also authorized users: one user family from Socó community was involved in management at Lago do Baixio and Lago Socó; and six user families from Botafogo and two from Antonina were involved in management at the Planeta complex.

In terms of demographic characteristics (Table 3), household heads of Planeta were the oldest on average (45.4 ± 15.3 years), while those from Lago do Baixio were the youngest (31.6 ± 14.5 years). All family heads from Lago do Baixio originated from other areas, as was the case with most people in Antonina (67%), Lago Socó (62%), and Planeta (56%). Most respondents in Andirá (58%) and Botafogo (56%) had roots in the same community. Time of residence varied from an average of 15.9 ± 14.6 years in Lago do Baixio to 36.8 ± 11.1 years in Botafogo. Catholics represented between 78% and 100% of household heads in all areas, with some agnostics in Lago do Baixio (14%) and Lago Socó (8%), and Protestants in Botafogo (22%) and Lago Socó (8%). Regarding occupation, most respondents (67% to 86%) from Andirá, Lago do Baixio, Botafogo, and Antonina were small farmers. In Lago Socó, small farmers and fisherman were equally represented (38%) among household heads. A relatively high proportion of other occupations (students, retired, wage labor and carpenters) was found in Planeta complex and Antonina (33% to 44%).

Among household socioeconomic characteristics (Table 4), the highest average number of members was found in Andirá (6.1 ± 2.8) and the lowest in Lago do Baixio (4 ± 1.5) and Planeta (4.1 ± 2). Agricultural plot size varied greatly among areas: from 11,555 ± 9,258 *covas* in Planeta to only 4,684 ± 5,427 *covas* in Lago Socó. In terms of wealth, Lago do Baixio differed substantially from the other areas: on average, households presented the highest annual income (US$ 13,339 ± 6,232), the smallest number of assets (7.3 ± 4.5 of the range of items considered) and community house area (39.7 ± 35.6m^2), and the lowest proportion of families (14%) who owned a house in town. The opposite pattern was found for Planeta: it presented the largest community house area (73.6 ± 47.5m^2) and number of assets (17.4 ± 9.4), as well as a high proportion of people (67%) who owned a house in town, and the lowest annual income (US$ 10,732 ± 5,254) among all systems. In general, small-scale agriculture comprised the the most important economic activity among households, except in Lago Socó and Andirá where extractive activities (*e.g. açaí*, fishing) had a more prominent role than in other areas. The productive component (coming from agriculture, extractivism, and animal husbandry) represented between 27% (Lago Socó and Andirá) and 40% (Botafogo) of annual household income. Thus, the non-productive component, consisting of wage labor, services, and governmental social benefits, provided the most important source of annual income in all systems, varying from US$ 6,523 to US$ 9,550. When examining *per capita* income, households in Lago do Baixio were the richest, followed by Planeta, Botafogo and Antonina, Lago Socó, and Andirá, varying in a similar fashion as participation in arapaima management.

Table 2 – Relative frequency of participation in arapaima management systems in the Baixo Juruá Extractive Reserve, and sampling data.

Management area	Lago do Baixio	Antonina	Planeta	Botafogo	Lago Socó	Andirá
Total N of households	N=7	N=17	N=35	N=10	N=45	N=58
Total N of households that participate in arapaima management	N=6 (86%)	N=14 (82%)	N=28 (80%) Botafogo[a] (N=15) Antonina[a] (N=13)	N=7 (70%)	N=15 (33%) Socó (N=6) Forte das Graças 1 (N=9)	N=18 (31%) Forte das Graças 1 (N=4) Cumarú (N=10) Escondido (N=2) Itaúba (N=1) Ig. Branco (N=1)
Sampled households	N=7	N=9	N=12	N=9	N=13	N=12
Gender (male respondents)	86%	89%	100%	89%	92%	83%

[a] These numbers include former residents (authorized users).

Table 3 – Demographic characteristics of household heads of the six management systems in the Baixo Juruá Extractive Reserve.

Indicator/Management area	Lago do Baixio (N=7)	Antonina (N=9)	Planeta (N=12)	Botafogo (N=9)	Lago Socó (N=13)	Andirá (N=12)
Age (average ± standard deviation)	31.6 ± 14.5	38.7 ± 5.2	45.4 ± 15.3	40.9 ± 8.3	39.5 ± 13.7	40 ± 10.4
Origin:						
Same community	0%	33%	44%	56%	38%	58%
Other area	100%	67%	56%	44%	62%	42%
Time of residence	15.9 ± 14.6	28.3 ± 12.5	34.2 ± 13.7	36.8 ± 11.1	27.3 ± 15.3	32.6 ± 12.5
Years of schooling	2.3 ± 1.4	4.3 ± 3.5	5 ± 3.2	5.7 ± 2.9	3.3 ± 3.6	2.7 ± 2.4
Religion:						
None	14%	0%	0%	0%	8%	0%
Catholic	86%	100%	100%	78%	85%	100%
Protestant	0%	0%	0%	22%	8%	0%
Occupation:						
Farmer	86%	67%	44%	78%	38%	67%
Fisherman	0%	0%	11%	0%	38%	8%
Other (wage labor, student, retired, carpenter)	14%	33%	44%	22%	23%	25%

Table 4 – Socioeconomic characteristics of households from the six management systems in the Baixo Juruá Extractive Reserve.

Indicator/ Management area	Lago do Baixio (N=7)	Antonina (N=9)	Planeta (N=12)	Botafogo (N=9)	Lago Socó (N=13)	Andirá (N=12)
Number of household members	4 ± 1.5	5.3 ± 1.7	4.1 ± 2	4.9 ± 2	5.4 ± 2.4	6.1 ± 2.8
Agricultural plot size (number of *covas*)[a]	8,857 ± 3,590	10,889 ± 4,833	11,555 ± 9,258	11,000 ± 9,500	4,684 ± 5,427	8,550 ± 4,520
Wealth:						
House area (m^2)	39.7 ± 35.6	59.8 ± 32.4	73.6 ± 47.5	60.6 ± 21.1	60.4 ± 17.7	62.4 ± 20.8
Own house in town	14%	78%	67%	38%	31%	17%
Total number of assets	7.3 ± 4.5	12.8 ± 3.1	17.4 ± 9.4	15.6 ± 8.4	11.9 ± 4.8	8.2 ± 3.4
Annual income (US$[b]) from:						
Agriculture	2,856 ± 2,411	3,059 ± 3,053	3,691 ± 3,981	3,760 ± 3,912	1,713 ± 3,697	1,797 ± 2,921
Extractivism	932 ± 750	494 ± 737	471 ± 817	598 ± 1,526	1,400 ± 1,632	1,321 ± 1,822
Non-production (wage, services, and governmental social benefits)	9,550 ± 4,575	8,427 ± 4,914	6,523 ± 4,827	7,214 ± 4,641	8,679 ± 7,727	8,337 ± 5,532
Total income (US$)	13,339 ± 6,232	12,076 ± 6,669	10,732 ± 5,254	11,191 ± 7,634	11,809 ± 9,244	11,457 ± 5,312
Per capita annual income (US$)	3,335	2,279	2,618	2,284	2,186	1,878

[a] As a reference, 10,000 *covas* is equivalent to nearly one hectare.

[b] At the time of the study, one U.S. dollar was equivalent to two Brazilian reais.

Regarding social and political engagement (Table 5), the number of respondents with a role in the community (mainly community board and environmental agent) was relatively high in all management systems (78 to 100%), except in Lago Socó (54%). There was no substantial variation in membership in formal organizations, ranging from 78% in Planeta to 100% in Botafogo. Regarding affiliation in their representative association (ASTRUJ), Botafogo had the highest level of membership (100%), Lago do Baixio (43%) and Lago Socó (38%) had the lowest, and the others had intermediate levels (67% to 78%). All or most household heads from Andirá (100%), Planeta (89%), and Botafogo (89%) participated in meetings for the Baixo Juruá Extractive Reserve creation, while only a minority (29%) in Lago do Baixio did. A similar pattern was found for participation in the reserve management plan meetings, which presented high participation in most areas except in Lago Socó (54%) and Lago do Baixio (43%). Botafogo showed the highest level (78%) for participation in community/group meetings, and Lago Socó the smallest (23%). Considering all the above indicators, overall Botafogo exhibited the highest degree of social and political engagement, while Lago do Baixio and Lago Socó presented the lowest ones.

The social capital index presented a high reliability coefficient ($\alpha = 0.823$) and varied from 0.69 (Baixio lake) to 0.47 (Andirá; Table 6). Social capital varied in a similar fashion among the management systems with levels of participation in arapaima management. Participation in *mutirões* varied from high to moderate levels: the highest value of 100% was in Lago do Baixio, followed by 92% in Lago Socó, 89% in Antonina, 83% in Andirá, 78% in Botafogo, and 67% in Planeta. Baixio lake also presented the largest proportion (71%) of households frequently involved in *mutirões*. When asked why they joined *mutirão*, responses regarding a sense of collectivity appeared in all areas, with the highest

Table 5 – Social and political engagement of households from the six management systems of the Baixo Juruá Extractive Reserve.

Indicator/Management area	Lago do Baixio (N=7)	Antonina (N=9)	Planeta (N=12)	Botafogo (N=9)	Lago Socó (N=13)	Andirá (N=12)
Role in the community	86%	78%	89%	89%	54%	100%
Membership in formal organizations	86%	89%	78%	100%	92%	83%
Membership in ASTRUJ	43%	78%	78%	100%	38%	67%
Participation in the Extractive Reserve creation	29%	67%	89%	89%	69%	100%
Participation in meetings related to the management plan	43%	89%	89%	100%	54%	83%
Frequent participation in community/group meetings	43%	56%	67%	78%	23%	58%

values for Planeta (47%) and lowest for Lago do Baixio (17%), Lago Socó and Andirá (13%). Trust in lending of materials to others also varied substantially among areas: Lago do Baixio (100%) and Planeta (89%) presented the highest levels of trust, while Botafogo (33%) and Lago Socó (15%) exhibited the lowest levels.

Norms of reciprocity and solidarity did not appear frequently in motivations for joining *mutirão* (Table 6). Norms of reciprocity were highest in Lago do Baixio (33%) and lowest in Andirá (7%) and were not mentioned in Botafogo. Norms of solidarity varied from 44% in Antonina and 40% in Planeta and Andirá to 13% in Botafogo. All households in Lago do Baixio and Antonina and most in Lago Socó (92%) and Botafogo (78%) participated in food exchange networks based on kinship and/or neighborhood. Frequent food exchange was more common in Botafogo (89%) and less in Lago Socó (62%). Lago do Baixio presented the highest frequency of people who said they could count on most people in the community/group, while Andirá (17%), Lago Socó (15%), and Botafogo (11%) reported the lowest frequencies.

Table 6 – Social capital indicators and index scores (in brackets) of households from the six management systems of the Baixo Juruá Extractive Reserve.

Indicator/Management area	Lago do Baixio (N=7)	Antonina (N=9)	Planeta (N=12)	Botafogo (N=9)	Lago Socó (N=13)	Andirá (N=12)
Social capital index[a]	0.69	0.66	0.60	0.51	0.49	0.47
Cooperation:						
Participation in *mutirões* (%)	100% (5)	89% (5)	67% (4)	78% (4)	92% (5)	83% (5)
Frequent participation in *mutirões* (%)	71% (4)	56% (3)	-	56% (3)	31% (2)	-
Trust:						
High trust in lending materials[b]	100% (5)	67% (4)	89% (5)	33% (2)	15% (1)	67% (4)
Reciprocity:						
Norms of reciprocity in participation in *mutirões*	33% (2)	22% (2)	13% (1)	0% (1)	13% (1)	7% (1)
Solidarity:						
Norms of solidarity in participation in *mutirões*	33% (2)	44% (3)	40% (2)	13% (1)	21% (2)	40% (2)
Participation in food exchange	100% (5)	100% (5)	-	78% (4)	92% (5)	-
Frequent food exchange	71% (4)	67% (4)	-	89% (5)	62% (4)	-
Proportion of people who count on the majority of the community/group	43% (3)	22% (2)	22% (2)	11% (1)	15% (1)	17% (1)
Social cohesion:						
Sense of collectivity in participation in *mutirões*	17% (1)	28% (2)	47% (3)	33% (2)	13% (1)	13% (1)

[a] Values were scored from 1 (low) to 5 (high) according to the degree of social capital (1: <20%; 2: 21-40%; 3: 41-60%; 4: 61-80%; 5: >80%). The index varies from 0 to 1 and it is proportional to the number of indicators.

[b] *motor rabeta* (engine for canoes), shotgun, gillnet, *haste de pirarucu* (artisanal fishing spear), *paneiro* (artisanal basket for carrying cassava from crops) and money.

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Household heads listed several reasons for engaging in collective action. From qualitative coding, I identified 11 subthemes related to human relations and five subthemes of utilitarian motivations among 56 household heads participating in *mutirão* (Table 7). The most mentioned subthemes within the former were sense of collectivity (18), norms of solidarity (17), norms of reciprocity (9), invitation (5), interdependence (4), and friendship/integration (4). Within the latter, the most common subthemes were efficiency/easiness (17) and satisfaction with work (5). Among reasons of 48 household heads for joining arapaima management, I identified nine subthemes within human relations and 16 regarding utilitarian motivations (Table 8). The most frequently mentioned subthemes within human relations were sense of collectivity (10), excitement (5), norms of solidarity (3), and integration (3). Among utilitarian motivations, the most common subthemes were income (14), natural resource conservation (10), livelihood (4), and management success (4). Overall motivations for engaging in collective action were markedly different between *mutirões* and arapaima management: people reported to be guided mostly by human relations in the former, while in the latter, utilitarian reasons were predominant (Table 9). This pattern was found in all areas, except for Lago do Baixio, where frequencies of human relations and utilitarian motivations were more balanced in the case of arapaima management.

Table 7 – Reasons for engagement in *mutirão* of household heads in the six management systems of the Baixo Juruá Extractive Reserve.

Indicator/Management area	Lago do Baixio (N=7)	Antonina (N=8)	Planeta (N=9)	Botafogo (N=7)	Lago Socó (N=12)	Andirá (N=13)	Total (N=56)
Human relations:							
Sense of collectivity	2	4	5	4	3	0	18
Norms of solidarity	1	4	3	2	3	4	17
Norms of reciprocity	2	3	1	0	2	1	9
Invitation	1	0	1	1	0	2	5
Interdependence	0	2	2	0	0	0	4
Friendship / integration (*amizade* / *entrosamento*)	1	0	0	0	1	2	4
Excitement (*animação*)	0	0	0	0	0	3	3
Incentive to participate	0	1	1	0	0	0	2
Kinship	1	0	0	0	1	0	2
Habit	0	1	1	0	0	0	2
Concern with others' opinions	0	0	0	0	1	0	1
Utilitarian motivations:							
Efficiency/easiness	1	2	4	3	3	4	17
Satisfaction with work	1	0	0	0	2	2	5
River	0	0	0	0	0	1	1
Natural resource conservation	1	0	0	0	0	0	1
Livelihood	1	0	0	0	0	0	1

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Table 8 – Reasons for engagement in arapaima management of household heads in the six management systems of the Baixo Juruá Extractive Reserve.

Indicator/Management area	Lago do Baixio (N=6)	Antonina (N=7)	Planeta (N=9)	Botafogo (N=7)	Lago Socó (N=12)	Andirá (N=7)	Total (N=48)
Human relations (total):							
Sense of collectivity	2	1	3	2	1	1	10
Excitement (*animação*)	1	0	0	0	1	3	5
Norms of solidarity	0	0	1	0	0	2	3
Integration (*entrosamento*)	1	0	0	0	1	1	3
Pleasure	0	0	0	1	0	1	2
Invitation	1	0	0	0	0	0	1
Leadership	0	0	1	0	0	0	1
Conflict resolution	1	0	0	0	0	0	1
Mistrust	0	0	1	0	0	0	1
Utilitarian motivations:							
Income	1	4	4	3	1	1	14
Natural resource conservation	0	1	4	3	2	0	10
Livelihood	0	1	1	0	0	2	4
Management success	1	0	0	1	1	1	4
Legal fishing	0	2	0	0	1	0	3
Reserve	0	0	0	0	0	3	3
Lack of rule compliance	0	0	0	0	1	2	3
Knowledge acquisition	1	0	1	0	0	0	2
Appreciation for fishing	1	0	0	0	0	1	2
Easiness	0	0	0	0	0	1	1
Fish	0	0	0	1	0	0	1
Lakes	0	1	0	0	0	0	1
Show to Juruá town that reserve is good	0	0	0	0	0	1	1
Involvement with guarding	0	0	0	1	0	0	1
Docked pay due to absence in patrolling	0	0	1	0	0	0	1
Domestic labor	0	0	0	0	0	1	1

Table 9 – Motivations for engaging in collective action in the Baixo Juruá Extractive Reserve.

Indicator/Management area	Lago do Baixio	Antonina	Planeta	Botafogo	Lago Socó	Andirá	Total
Mutirões (N)	7	8	9	7	12	13	56
Human relations	10	17	17	8	13	14	79
Utilitarian reasons	6	2	4	3	6	9	30
Arapaima management (N)	6	7	9	7	12	7	48
Human relations	6	1	6	3	3	9	28
Utilitarian reasons	4	9	12	10	6	13	54

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Discussion

Collective action is an important element of community livelihoods in the Amazon (Futemma, 2006; Lima, 2006). Through *mutirões*, community members get together to clear land for agriculture, plant and harvest crops, produce manioc flour, clean the community area, build infrastructure (community houses, bridges etc.), clear the soccer field, take away fallen wood or grasses that impede access of canoes on waterways (*igarapés* or *furos*), guard lakes, *igarapé* mouths, or turtle nesting beaches against poaching, and organize community *festejos*. Communities also count on social networks based on kinship and/or friendship for food exchange, child care, etc. These social networks based on relations of trust, reciprocity, and solidarity within the social group (bonding social capital) are the basis of a community's social and economic system of production and reproduction (Futemma, 2006). Therefore, bonding social capital enhances connectedness and collective action within the community.

Collective action in arapaima management involves collective decision making, monitoring each other's behavior, guarding of lakes and other aquatic bodies against free riders, as well as fishery management and benefit sharing. As fisheries are common-pool resources, it is difficult to prevent others from using them, and the use by one reduces the availability of the resource pool to others (Berkes & Farvar, 1989). Unless there is a high level of trust and effective norms of reciprocity, the possibility of free riding is likely to be high. In systems with dense social networks in which members are highly connected to each other, and they have frequent face-to-face interaction and long-term experience living together, they therefore have more information about each other and their behavior, and free riding becomes much more costly and thus less likely (Adler & Kwon, 2002). Thus, bonding social capital within communities is important for the collective good and enhances engagement in collective action.

Among multi-community management systems such as Planeta, both bonding and bridging social capital come into play. Arapaima management there involves social arrangements within and between communities. In Planeta, young members from Botafogo and Antonina studying and living in town (authorized users) participated in management of arapaima by forming guarding groups that rotated on weekends, replacing adults that stayed on weekdays in the floating house. Although they worked fewer days a year, they received the same amount from management as adults at the end of the year. Managers decided on equal payment because they understood the importance of participation by young managers. Youths comprised almost one-third of managers from Planeta, providing valuable human and social capital for arapaima management. First, it reduced the time that household heads spent in guarding the floating house, thus allowing them more time for other livelihood activities in their communities. Second, the youths were healthier than the adults, most of whom were in their forties and could no longer carry heavy weights due to serious back problems. Third, because they were sons, grandsons, nephews, cousins and/or brothers of adult managers (who were household heads), youths occupied a subordinate social status in decision making. Respect for elders is a strong norm in the social structure of rural Amazonian communities. Kinship and hierarchy, which Coleman (1988) calls "intergenerational social capital", contributed to the density of the social network, increasing trust and connectedness among members. And fourth, participation in arapaima management strengthened the young generation's connection to the extractive reserve, to traditional livelihoods and to the collective defense of community territories. As the young of rural communities moved to town to study, they tended to be increasingly influenced by the urban culture and drifted apart from the traditional rural lifestyle, which was a concern to their families and local leaders. Through the involvement of youth in guarding the floating houses, older managers saw future possibilities of young people gaining benefits from the fishery and continuing their collective struggle.

Management systems varied substantially in terms of the demographic and socioeconomic indicators examined, independent of people's participation in arapaima management. Lago do Baixio was composed of younger household heads, all of them born elsewhere, moving to the community some years before the reserve was created; most did not participate in the process of creation of Baixo Juruá Extractive Reserve or in the management plan meetings. They were mostly small farmers, Catholic, with low levels of education and relatively low social and political engagement. Lago do Baixio households were the richest in

terms of average income, but they invested little in their material wellbeing, as evidenced by their low number of assets and lack of house in town. Antonina had a high proportion of household heads born in other areas, who were on average older and had lived in the community for a longer period than in Baixio. Most were small farmers, Catholic, with moderate levels of education, high incomes, big houses in the community, a moderate number of durable goods as assets, and a house in town. They presented moderate to high social and political engagement. Planeta had the oldest respondents, all of them Catholic, with equal proportions of small farmers as compared to other occupations such as students, retirees, and wage laborers. They presented high levels of education, one of the biggest average areas in agricultural plots, and one of the highest incomes from agriculture. In general, managers of Planeta could be considered the wealthiest among all areas, as they had one of the highest *per capita* annual incomes from productive activities, the biggest community houses, the highest number of durable goods items as assets, and a moderate proportion of people who owned a house in town. Botafogo differed from the other areas for its highest level of education, significant proportion of Protestants (although most of the group was Catholic), income from agriculture, and social and political engagement. Lago Socó showed the greatest religious diversity and highest frequency of fisherman along with small farmers. They had small agricultural areas, enough for subsistence, and showed one of the lowest incomes from agriculture and the highest from extractivism (mostly due to fishing). Household heads there reported the lowest degree of social and political engagement, despite their high membership in formal organizations. This system was the only one in the Baixo Juruá Extractive Reserve whose community (Forte das Graças 1) had a formal association. Finally, Andirá was the most complex management system, involving five communities. The dominant community (Cumarú) was indigenous. All household heads were Catholic, with low levels of education, and few people owned a house in town. They were the poorest group, exhibiting the lowest *per capita* income and a small number of assets. As in Lago Socó, they presented low levels of income from agriculture and high levels from extractivism. Andirá showed a moderate to high degree of social and political engagement.

Two indicators varied with participation in arapaima management: *per capita* annual income and social capital. Areas with higher income *per capita* tended to have higher participation in management. It could be that annual income reflected higher income from arapaima management, and thus high earning potential would attract more people to the activity than low earning potential. However, this is different than expected: the area with highest participation (Lago do Baixio) had the lowest number of people and presented one of the lowest incomes from management (US$ 190), while the one with lowest participation (Andirá) exhibited moderate income from the fishery (US$ 440). Another possibility is that *per capita* income was positively associated with social capital. Thus, areas with high social capital would be the ones able to mobilize more resources and have higher economic gain. Grootaert & Narayan (2004) found a positive relationship between social capital and household welfare in Bolivia.

This discussion raises the key issue of whether higher social capital motivated higher participation in fishery management. In the present study, social capital overall was higher in areas with higher participation in management (Lago do Baixio, Antonina, and Planeta), and lower in areas with lower participation (Botafogo, Lago Socó, and Andirá). This key finding thus confirms the hypothesis set forth earlier for this question. Group members more connected to each other by relations of trust, reciprocity, and solidarity, were more prone to act collectively. Lago do Baixio presented the highest social capital: this small group comprised kin related households connected by frequent, reciprocal relations of cooperation, based on high levels of trust and solidarity. Antonina was an intermediate size community, but mostly kin related, presenting high levels of social capital, and exhibiting high cooperation and solidarity. Planeta exhibited moderately high social capital, given by high levels of trust, norms of solidarity and a stronger sense of collectivity than in other areas. Despite having members who were not bound by kin ties, as well as having less experience of working together and less information about each other's behavior, they did have long-term friendships and a shared set of internal norms of solidarity and sense of collectivity. They trusted each other more as a group of collaborating managers than their peers from their own communities, probably

because of known free riders from Antonina and Botafogo who were not involved in management of the Planeta complex of lakes. The other areas exhibited lower levels of social capital, varying slightly. Among those three, Botafogo showed a higher sense of collectivity; Lago Socó showed higher cooperation; and Andirá presented higher trust and norms of solidarity.

In one way or the other, all management systems had a certain level of social capital that permitted them to collectively engage in a corresponding level of collective management of arapaima. All areas presented a high level of participation in *mutirões* regardless of their degree of participation in arapaima management. Interestingly, the level of participation in *mutirão* was generally higher than in arapaima management (except in Planeta), probably because people trusted more each other and were more used to the former kind of social relation. *Mutirão* for agriculture, which was the most common type of labor-sharing group, is an older and more established form of collective action within communities as part of their subsistence strategy. It can involve more people, depending on the level of group organization. In small to moderate size communities (*e.g.* Botafogo and Antonina), families invited others to join them in *mutirão*, and people were accustomed to collaboration, with or without expectations of future reciprocal behavior. In bigger communities such as Forte das Graças 1 (from Lago Socó), *mutirões* were organized in monthly meetings of the community association, in which associates assumed the commitment to participate, hence increasing trustworthiness in working for labor-sharing groups.

Arapaima management, a market-oriented activity, usually involved more people than *mutirões*. It depends on labor availability more than on strict relations of cooperation among members, although that also plays a role. Labor force availability was key for patrolling areas against free riding and for the arapaima fishery, as a single fish could weigh more than 100kg. Therefore, task contingencies explained differences in the value of social capital between these social networks (Adler & Kwon, 2002). *Mutirão* was more dependent on trust and cooperation; thus, it was better to have embedded ties with repeated exchanges between a small number of actors (denser networks). Arapaima management also depended on trust and cooperation but required more actors and involved a stronger element of economic rationality. Thus, the former required fewer but stronger ties, while in the latter it was better to have more ties even if they had weaker connections.

Both humanistic and utilitarian motivations guided people's motivations for engaging in collective action. However, motivations for joining *mutirão* were more consensual than for arapaima management. In the former, there were 16 reasons, while in the latter, 25. For *mutirão*, a sense of collectivity, norms of solidarity and reciprocity were mentioned by 44 out of 56 household heads; efficiency or easiness came out in 17 out of 22 responses. For arapaima management, a sense of collectivity and excitement appeared in 15 out of 27 responses, while income and natural resource conservation were reported by 24 out of 52 people. Another important difference between *mutirão* and arapaima management is that the former was motivated mostly by human relations, while the latter involved more pragmatic thinking related to income, subsistence, and fishery conservation. Interestingly, this rational thinking was not always self-centered. Individual gains (income) were not the main motivation for engagement in arapaima management in the Baixo Juruá Extractive Reserve. For example, managers of Lago do Baixio invested most income from management on water pumps for the collective benefit of the community, as households did not have piped water, and instead they had to get water from the river. In Botafogo, every year managers invested their income from management either on fuel or new parts for the community's power generator, as they had no electricity. In Lago Socó, they decided for two years not to sell fish, but to split it among all families in Socó and Forte das Graças 1 for consumption, even if most of them did not participate in management.

Alongside motivation, Adler & Kwon (2002) pointed out two other key features individuals or groups must attend to activate social capital: ability and opportunity. There certainly exist differences in capacity to manage fishery resources across areas, which I did not measure; however, groups tend to learn and improve their management capacity over time. Regarding opportunity, it is interesting to note that arapaima management is a male activity, and that there are barriers for women's participation, although they may vary across areas. In general, within Baixo Juruá Extractive Reserve communities

there is a gender division of labor common among rural areas, in which women are more dedicated to agriculture, domestic labor and child care, while men are in charge of fishing, hunting, and construction, besides agriculture. In all areas, female participation in management consisted in voluntarily cooking during the arapaima fishery in solidarity with men. Only in Andirá were women involved in guarding the floating house, as they would take small children with them and accompany the men. In other management systems, women were not able to participate, as they could not leave their small children alone. This has important implications, not only for the social capital of groups, but for interpretation of the results of this study: communities with divorced or widowed women with small children as household heads (*e.g.* Botafogo) exhibit less participation in management.

Conclusion

This study examined the role of community characteristics and social capital in facilitating collective action in six arapaima management systems involving eight communities of the Baixo Juruá Extractive Reserve. Collective action within and among communities took place in heterogeneous settings with groups varying in age, origin, length of residence, educational level, religion, occupation, household size, wealth, and livelihood. However, participation in management varied in a similar fashion with social capital. Group members more connected to each other by relations of trust, reciprocity, and solidarity, were more prone to act collectively. Both bonding and bridging social capital come into play in fostering collective action.

Social capital is key for collective livelihood and conservation strategies in the Amazon. Social relations of cooperation based on trust, norms of solidarity and reciprocity are invisible forces that unite groups within and among communities. Social networks involving exchange of food or services are important for the moral life of community members as it helps to keep good relationships with as many people as possible, being these close kin or not (Harris, 2000). Hence, social capital facilitates cooperation reducing the costs of working together, developing and enforcing rules, and monitoring each other's behavior, which are key for resource governance (Ostrom, 1990) and sustainability (Pretty & Smith, 2004). Social capital has been pointed out as a major element accounting for the success of fisheries co-management worldwide (Gutierrez *et al.*, 2011).

Moreover, this study investigated household motivations to enroll in collective action. Reasons consisted of human relations, in terms of a sense of collectivity, solidarity, and reciprocity, as well as utilitarian motivations, given by income and fishery conservation. Positive economic and environmental outcomes of the arapaima fishery are easily perceived by communities, incentivizing members to invest in institutional arrangements for collectively governing management systems (Pinheiro, 2018). At the household level, engaging in fisheries co-management efforts could bring a net time savings in fishing that could be used for other livelihood activities (Schons *et al.*, 2020). However, it is worth noting that households do not seek only individual gains; in some instances, households decide to invest in collective benefits for the community, as shown for the Baixo Juruá Extractive Reserve.

The present study helps to fill the gap in research of an emblematic case of successful fishery co-management in the Amazon (Campos-Silva & Peres, 2016). While most studies on arapaima focus on fish biology and ecology (Queiroz, 2000; Castello, 2008a, 2008b; Arantes, 2009; Farias *et al.*, 2019), conservation (Castello *et al.*, 2011), and management sustainability (Castello *et al.*, 2009; Pinheiro, 2018; Gurdak *et* al., 2019; Arantes *et al.*, 2022), this study provides a deeper understanding of community social capital underlying collective action for arapaima management. Although the case study method limits the extrapolation of the findings (Yan, 2003), it provides unique information on human organization and the social relations underlying community resource management, contributing to theory on social capital and collective action, and to natural resource management on the ground. Social capital is a driving force to elicit community participation and efforts should be held to identify it and mobilize it for conservation purposes.

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