PROBABILITY OF EMIGRATION OF AMAZONIAN CATFISH FISHERS: A MANAGEMENT APPROACH *

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ABSTRACT

This study aimed to determine the probability of emigration for Amazonian catfish fishers. The survey was performed from August 2002 to May 2003 and 2,105 fishers were interviewed. The main channel of Solimões-Amazon River was divided in five regions with distinct socioeconomic, institutional and fishing characteristics. A logistic regression model was applied to verify which one of those features would influence the estimated probability of emigration through the entire river channel and to each region. Results indicate low probability of emigration in the channel and to all regions, but mainly in Estuary (P = 0.1) which has the best organizational structure and job opportunities. The likelihood of emigration slightly increases upstream. Consequently Tabatinga had the higher probability of environmental exodus (P= 0.5). The fishers most likely to emigrate were those who have lived in the community for shorter period of time, as well as the recent entrants into the fishing activity and those not affiliated to Colony of Fishers. Since this result was converse to the overall fisheries management agency expectancies, the importance of co-management arrangements including the fisher's perspectives and interest was briefly discussed, in opposition to the early traditional management view, which is focused just on the fish stocks.

Key words: environmental exodus; *Brachyplatystoma* sp, Amazonian catfish fishers; socio-economic characteristics; fishery management; participative management.

PROBABILIDADE DE EMIGRAÇÃO DOS PESCADORES DE BAGRE DA AMAZÔNIA: IMPLICAÇÕES PARA O MANEJO

RESUMO

Este estudo objetivou determinar a probabilidade de emigração entre os pescadores de bagres Amazônicos. Foram entrevistados 2.105 pescadores de Agosto-2002 à Maio-2003. O canal principal do Rio Solimões-Amazonas foi dividido em cinco regiões com características socioeconômicas, institucionais e de pesca distintas. Um modelo de regressão logística foi aplicado para verificar qual destas características influenciaria a probabilidade de emigração estimada para o canal principal do rio e em cada uma das cinco regiões. Os resultados indicam baixa probabilidade de emigração no canal e para todas as regiões, mas principalmente no Estuário (P = 0,1) que tem melhor estrutura organizacional e oportunidades de empregos indiretos. A probabilidade de emigração aumenta discretamente rio acima. Conseqüentemente, Tabatinga teve a maior probabilidade de êxodo ambiental (P= 0,5). Os pescadores mais propensos a emigrar são aqueles que vivem na comunidade há menos tempo, aqueles que pescam há menos tempo e aqueles não filiados à Colônia de Pesca. Uma vez que este resultado é oposto ao esperado pelas agências de manejo da pesca, a importância do co-manejo e da inclusão das perspectivas e interesses dos pescadores no manejo pesqueiro são brevemente discutidas, em oposição à abordagem tradicional que é focada apenas em avaliação de estoques.

Palavras-chave: êxodo ambiental; *Brachyplatystoma* sp, pescador de bagre amazônico; características socioeconômicas; gestão da pesca; gestão compartilhada.

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INTRODUCTION

The Amazon catfish fishery has great biological, ecological and socioeconomic complexities. The piramutaba *Brachyplatystoma vaillantii* and dourada *B. rousseauxii* are exploited by a small scale fishery during their migratory route which spreads over 3,000 Km along the course of the Brazilian Amazon to Bolivia, Colombia and Peru Amazonian rivers (BARTHEM and GOULDING, 1997). These species are also the only freshwater fish industrially exploited in Brazil. Since governmental subsides in 80´s, the industrial fleet in the Amazon River estuary improved and has caused a recruitment overfishing (BARTHEM and GOULDING, 1997; ALONSO and PIRKER, 2005) by taking the juveniles of piramutaba. The landings of piramutaba dropped from 28,000 mt in 1977 to the half in 1988 and 2003. The overexploitation of piramutabas leaded to an increase of the fishing effort on the dourada (*B. rousseauxii*), which catches oscillated from 1.547 mt (1994 -1996) to 17.000 mt in 2003 (BARTHEM *et al*., 1991; BARTHEM and GOULDING, 1997; RUFFINO, 2004; FABRÉ and BARTHEM, 2005).

International catfish management must now give priority to understand fishing activity in order to avoid the economic collapse that will probably follow the decline in the catfish fishery in Amazon River (PETRERE *et al*., 2004). Its management therefore requires socioeconomic, traditional and professional information to comprehend and perhaps foresee the behavior and expectancies of the fishers.

As a paradigm many theoretical management assumptions around the world predict the displacement of fishers as a result of resource depletion. This drifting would be part of fishery culture and socioeconomic features. Consequently fisher are assumed to be likely to a nomad behavior following the resource availability and avoiding its depletion (MARTIN, 1994; BÉNÉ, 2003). Nevertheless, usually managers and fishery scientists have poor information or lack of methodologies to confirm this statement.

In the present work, a logistic regression model was applied to a socioeconomic, institutional and fishing features dataset in order to determine which socioeconomic features currently determine the likelihood of emigration by catfish fishers from their community in the face of the apparent exhaustion on catfish fishing and consequently on the fisher's well-being.

STUDY AREA AND METHODS

The sample area was divided in five regions (Figure 1). In Pará State: (1) 'Estuary' (Amazon River estuary, in Belém); and (2) 'Santarém' (880 km from the estuary, at Lower Amazon). In Amazon State: (3) 'Manaus' (1,300 km far from the estuary in Middle Amazon); (4) 'Tefé' (1,650 km far form the estuary at Upper Amazon River) and (5) 'Tabatinga' (3,000 km from estuary at Upper Solimões River).

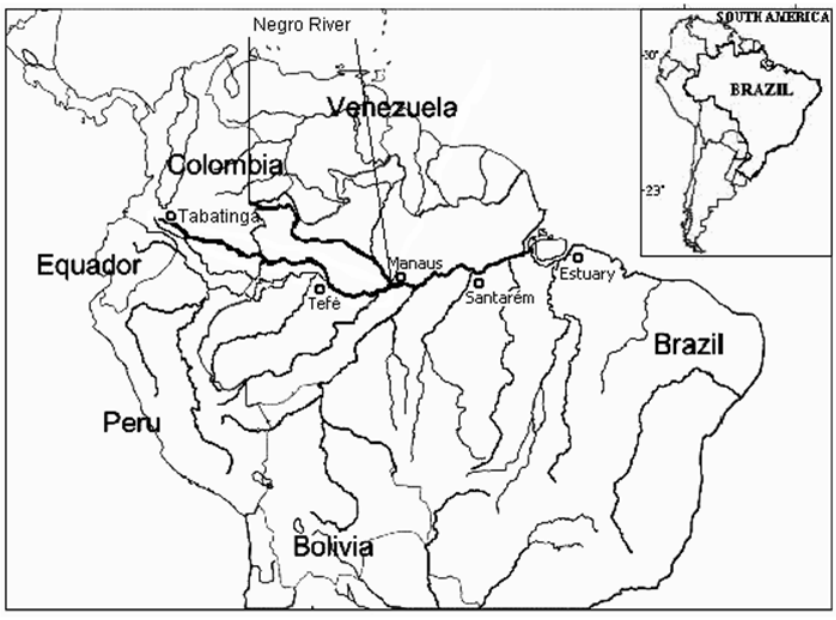

Figure 1 - The sites sampled throughout the Solimões-Amazon River channel (Estuary; Santarém; Manaus; Tefé and Tabatinga).

The socioeconomic, institutional and fishing data were undertaken from August of 2002 (dry season) to May of 2003 (rainy season) and can be found in PARENTE *et al.* (2005) and BARROS and RIBEIRO (2005). From the estimated total of 11,698 catfish fishers living in the study area the total of 2,105 fishers were interviewed and asked regarding to their willingness to move away in case of catfish fishery collapse.

To assess the fisher's probability of emigration [g(EMG)] from their community a logistic analysis – *logit* (HOSMER and LEMESHOW, 1989; LI and MATTSSONN, 1995) to channel as a whole (model 'Channel') and to each region was performed. The binary dependent variable was the ´willingness to emigrate` (EMG=1) or not (EMG=0) revealed by catfish fishers as showed by the equation below. The influence of socioeconomic, institutional and fishing data upon the likelihood of emigrate was estimated using the variables listed in Table 1.

$$Pi = e^{Y_0+\sum YnXn} / 1 + e^{Y_0 0+\sum YnXn}$$

where:

P_i = dependent qualitative variable [g(EMG)]

γ_0 = constant of regression

γ_i = coefficient of independent variable (s)

x_i = vector of independent variable (s) (listed on Table 1)

Table 1 - Independent variables used in the logistic regression model –logit performed to verify the catfish fisher likelihood to emigrate through Solimões-Amazon River channel.

Variables	Description
REGION (regions)	Estuary Santarém Manaus Tefé Upper Solimões
SCHOOL (Educational level)	Illiteracy Semi illiteracy Basic school (complete and/or incomplete) High school (complete and/or incomplete) University degree (complete e/or incomplete)
NCH	Number of children
AGE	Age
YRES	Years of residence in the community
YFISH	Years of fishing practice
YCATF	Years of catfish exploitation
MARIT (Marital state)	Married (mistresses, divorced, disunited or widowed) Single
AFFCO	Affiliation to the Fishers Colony of Fishers
ACTI	Have another economic activity beyond catfish fishery

RESULTS

The main null hypothesis under assumption (H_0 = fisher is most likely to leave their fishing spot and community, if the resource become scarce) was refuted, since the majority of fishers interviewed (84.5%) were not willing to emigrate. Institutional organization, marital status and the number of years living in their community seem to have influence on models fitted (Table 2).

Emigration of catfish fisher in the Solimões-Amazon River channel as a whole seems to be an unlikely event (Table 3).. All probabilities were low and mostly ranged from 0.1 to 0.3. In 'Channel' model e.g. the higher probability of emigration was P=0.3 relying on single fishers, on those who live shorter periods of time in the community and on those who do not live in Amazon River estuary, hereafter the estuary, which has the better institutional framework. Nowadays in all localities more than 70% of fishers are married. Hence, these fishers must reallocate all family members (mean of 6 individuals including 2.3 children per family) to emigrate. In essence therefore in the whole basin marital status could prompt as many as 30% of catfish fisherman to emigrate.

Despite the significance of years of fishing experience in 'Estuary' model, this region had the lowest probabilities in the study (P=0.1).

In 'Santarém' model only marital status have an influence on catfish fishers emigration patterns. However the probability is low even among single

fishers, who are more likely to emigrate (P=0.3).

In 'Manaus' model only the period of residence (in years) could determine the permanency of catfish fishers in the region, since those living outskirts of Manaus for shorter periods of time were more likely to emigrate (P=0.3).

In 'Tefé' model, despite the number of years of fishing or the number of catfish fishing experience had arose as a significant factors, the probability was too low (P= 0.1).

In 'Tabatinga' model the most likely to emigrate were those fishers who live shorter periods of time in the community (less than one year) and fishers not affiliated to the Colony of Fishers. Both factors have the highest probability of this study (P=0.5).

Table 2 - The willingness to emigrate [g (EMG)], significant variables and p-values estimated by logit model to Solimões-Amazon River channel and to each region (χ^2 – chi- square; Rho^2=coefficient of logistic regression whose better fitness is between 0.2 and 0.4; p-value for each variable is presented in parenthesis in the second line; ESTUARY = region of living; MARIT = marital state; YRES = years of residence in the community; YFISH= years of fishing practice ; YCATF = years of catfish exploitation; AFFCO = affiliation to the Colony of Fishers).

Model/ Region	Equations estimated (*p*-values)	Rho^2	χ^2
CHANNEL (n = 1000)	g (EMG) = – 0.975 – 0.675*ESTUARY – 0.580***MARIT** – 0.02 ***YRES** (p=0.003) (p=0.000) (p=0.003) (p=0.002)	0.0550	0.000
ESTUARY (n = 256)	g (EMG) = – 2.156 – 0.04 * **YRES** (p=0.000) (p=0.009)	0.078	0.003
SANTARÉM (n = 212)	g (EMG) = – 0.693 – 1.539 * **MARIT** (0.020) (0.000)	0.075	0.000
MANAUS (n = 206)	g (EMG) = – 0.798 – 0.026***YRES** (p=0.008) (p=0.023)	0.026	0.018
TEFÉ (n = 190)	g (EMG) = – 2.227 – 0.101*YFISH + 0.073*YCATF (p=0.002) (p=0.001) (p=0.028)	0.11	0.000
TABATINGA (n = 136)	g (EMG) = – 0.149 – 0.033***YRES** – 0.9*AFFCO (p=0.725) (p=0.046) (p=0.054)	0.07	0.007

Table 3 - Catfish fisher's willingness to emigrate by region and the probability associated to each significant variable in the logit model per region (0 – null probability; 1- higher probability or 100%).

Logit Model	Variables	Description	Probability
CHANNEL	Marital state	Single	0.3
		Married	0.2
	Years of residence	0 to 6 years	0.3
		7 to 37 years	0.2
		39 to 77 years	0.1
ESTUÁRY	Years of residence	0 to 19 years	0.1
		20 to 65 years	0
SANTARÉM	Marital state	Single	0.3
		Married	0.1
MANAUS	Years of residence	0 to 10 years	0.3
		12 to 36 years	0.2
		37 to 66 years	0.1
TEFÉ	Years of fishing practice	0 to 6 years	0.1
		8 to 60 years	0
	Years of catfish exploitation	0 to 7 years	0.1
		8 to 60 years	0
TABATINGA	Years of residence	0 to 1 year	0.5
		2 to 14 years	0.4
		15 to 28 years	0.3
		29 to 48 years	0.2
		49 to 66 years	0.1
	Affiliation to Colony of Fishers	Yes	0.5
		No	0.5

DISCUSSION

Regulatory agencies often assume that fishers will relocate form fishing spots or look for new job opportunities if fisheries become depleted. Therefore a smooth employment transition will be expected. The research in this paper suggests otherwise regarding to relocation, and could offer a different option and contribution to the conventional wisdom of fishery managers.

We observe that in spite of low values, the probabilities of emigration increased upstream. Therefore, catfish fishers living near the estuary are even most unlikely to emigrate possibly due to the heterogeneity of direct and indirect job opportunities and the catfish exploitation throughout the year. In fact, in the estuary all fishers exploit piramutaba and dourada due to a complex industrial network of frigorific and road systems which allow the transport of whole production from this site to other Brazilian regions and to other countries (FABRÉ and BARTHEM, 2005). Many of them practice trading activities and indirect fishery services (60%) because of the existence of the fish trade market of Belém (´Ver-o-peso´) and due to trading of handcrafts as well as crop production (PARENTE *et al*., 2005). This context makes the likelihood of emigration even lower in the estuary.

Furthermore, the estuary has better logistic and qualification opportunities. This occurs because of the involvement of social organizations in Pará (NGOs, community association, fishers cooperatives, *inter alia*). In rural/fishing communities e.g. where this institutional support is absent, schools offer just the first four years of education (BARROS and RIBEIRO, 2005). Higher schooling instruction promotes better educational qualification and a chance to practice alternative economic activities. Conversely, low literacy (or illiteracy) represents a barrier in changing of occupations as well as obtaining the papers needed for the fisher's registration as professionals. On the contrary, Tabatinga which is the most upstream region at the border with Colombia has less job opportunities, governmental assistance and input of social organizations, resulting in higher probability of emigration.

In Amazon basin, the depletion of the catfish stock could imply in change of target species, increasing the harvesting on other fish species. This was briefly suggested by BARTHEM (1990) who considers that the small scale fishery would exploit other species instead change of gear, if faced to an overfishing. Actually this already happened upon the dourada when the piramutaba stock became depleted (BARTHEM and GOULDING, 1997).

The tendency to remain in the same site was quoted by the fisherwoman MARTIN (1994), regarding to the salmon fishery in Columbia River. On that site, all sorts of impacts (dams, irrigation, dredging) associated to industrial demand resulted in depletion of salmon's runs. However the fishers remained in their fishing spots and communities, changing gears and strategies. As in Columbia River, the Amazonian catfish fishers developed strategies to remove snags by cleaning their fishing spots ground, named ´pesqueiros´. Fishing skills and knowledge like those results in resource-use dependence between fisher and the environment exploited and can also influence fisher's intention in remains on the fishing site, preserving his livelihood and social community (KURIEN, 1998; SARDA and MAYNOU, 1998).

This characterizes a ´cultural inertia` (BEGOSSI, 1995) and is usually more prevalent amongst the elderly and those who live longer in the community. STEWART *et al*. (2006) consider that this behavior is accentuated by the low degree of employment mobility of fishers. Despite this ´last resort activity´ belief (BÉNÉ, 2003), in some cases small scale fishing is a way of life traditionally chosen and a desired livelihood. This leads fishermen to avoid the nomad behavior and remain in their own site and community. Some communities reveal otherwise good capacity to adjust behavior and methods in face of changes. This resilience ability (Berkes *et al*., 2003) has been observed even in Amazon fishing communities, specially regarding to co-management of fishery resources (IPAM/WWF, 2006; CARVALHO and FABRÉ, in press). Artisanal fishers in the Upper Paraná River floodplain, for instance, use their fishing skill as a job opportunity and work as tourist guides to visitors during the weekends, since the dams imposed alterations on fishery. They demonstrated this resilience capability despite their low literacy and other deprived social features (CARVALHO, 2004). However, concerning to the Amazonian catfish fishers, is seems most likely that they change effort, species exploited or whatever thing otherwise than emigration to a new site.

Studies focused on fishers and socioeconomic features must be encouraged since the early

traditional approach in fishery science is the description of fishing and environment, with few or none references to fishers, which are considered by WELCOMME (2001) as the third component of the fishing.

The lack of focus on fishers and its responses (as in behavior as in proposals) to fishery disturbance has been the more strong paradigm on Fisheries Sciences and had led researches and managers to look only to the fishery stock assessment in order to maintain sustainable catches as well as to establish the strategies to recover the fish population. BRETON (1991) also observed this misunderstanding in fisheries management in Costa Rica.

As a consequence, some management actions to protect the natural fish resources had neglected the fisher's judgment, needs and participation, leading to conflict between governmental agencies and fishing communities, as observed around the world such as in USA, Canada, Brazil, South Africa, Indonesia, etc. (MARTIN, 1994; HOLLUP, 2000; NOVACZEKA *et al.*, 2001; POMEROY *et al.*, 2001; CARVALHO, 2002; WIBERA *et al.*, 2004; SOWMAN, 2006, Carvalho *et. al.*, in press).

At the same time, freshwater fishers are also poorly studied in the literature despite the importance of their activity for healthy security, food supply, and income generation, especially in countries affected by huge watersheds. In Brazil, for instance, most approaches on freshwater fishers have been addressing structural and economic topics (e.g. CASTRO and BEGOSSI, 1995; BATISTA *et al.*, 1998; CETRA and PETRERE, 2001; FRANCO de CAMARGO and PETRERE, 2001; CEREGATO and PETRERE, 2003; CARVALHO, 2004; PARENTE *et al.*, 2005 and others).

The current approach on scientific fishery is the co-management. This implies in substitute the top-down agency driven approach to a more collaborative approach that encourages participation, partnership among local users and decision-sharing (JOHN, 1994; CHESS, 2000; BERKES *et al.*, 2001).

Through whole Brazilian Amazon River several initiatives supported by the government in partnership with NGO's and local communities have resulted in rules which include traditional knowledge or traditionally devised rules, as reported by CARVALHO and FABRÉ (in press).

As a result fishery managers following this up to dated approach have promoted the horizontal interchange of experience, i.e. change of lessons learned in those communitarian co-management systems on course. In Upper Amazon River, the communitarian management system for the Pirarucu (*Arapaima gigas*) in the Sustainable Development Reserve of Mamirauá, enabled fishing communities to estimate how many fish they can exploit per year without threaten the sustainability of the system (Castello, 2004). As a result, community-based fishing management has proven as economical as ecological efficient and is now considered as competitive as cattle ranching (IPAM/WWF, 2006),

The fishers' well-being depends on economic and biological issues (the income generated and stock overexploitation). However, other factors, such as communitarian involvement, flow of information regarding to the fishery, individual socioeconomic features, the traditional character of the fishery and political-institutional factors (SINCLAIR, 1990; PALMER, 1991) influence their fishing decisions (effort, catches and gears used). As a consequence, these factors play an important role to avoid an environmental exodus in order to find better fishing sites and restore both fish stocks and fisher's livelihood.

As emphasized by WALTERS and MARTELL (2004) the questions regarding to fisheries management relies not just on the count of fish, but instead to understand the behavior of fishers. More recently involving the users in the understanding of fishery dynamics and management decisions have become an important strategy to the sustainable use of fish resources (co-management). In this context to comprehend the expectancies and perception of fishers about fishery and fish is as important as "count the beans".

CONCLUDING REMARKS

The present study indicates the low probability that catfish fisherman emigrate from their community. Hence, if actual tendencies of exploitation upon these species and especially upon their reproduction and growing habitats were to be maintained, it is fairly to suppose:

a. first, catfish fisher communities will remains as long as possible in their own communities, especially those who live in Estuary;

b. second, the catfish fishers from Tabatinga would be more likely to displacement;

c. Finally, which social group would be gradually pushed on towards an environmental

exodus, i.e. pressed to emigrate due to natural resources exhaustion (recent entrants in the fishing activity; those who live shorter in the community; the singles; and those not affiliated to the Colony of Fishers).

From these results it is reasonable to assume that the traditional character of the fishing practice is a key factor in maintaining the catfish fishers in their own communities. However, the involvement of NGO's in empowerment and institutional organization of fishing communities through the Amazon River seems to have an important indirect effect in maintain fishers in their own sites.

Quantitative approaches as the presented here represents an important way to understand fisher's expectancies and to highlight managers knowledge concerning to the fishers. The next step is the partnership and change of information to meet common objectives for both managers and fisher: keep the fish and fishery sustainability.

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