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# PROCEEDINGS OF THE SECOND INTERNATIONAL SYMPOSIUM ON THE MANAGEMENT OF LARGE RIVERS FOR FISHERIES

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# THE COMMERCIAL FISHING SECTOR IN THE REGIONAL ECONOMY OF THE BRAZILIAN AMAZON

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## ABSTRACT

The purpose of this study was to determine the magnitude of the fisheries sector along the Amazon River in Brazil. Total income and employment were estimated for the principal activities comprising the fisheries sector: fish processing plants, stores selling fishing material, gas stations, restaurants, ice factories and boatyards. Businesses were interviewed in 15 cities along the Amazon River. The number of fishing boats and total catch were estimated using data from the Brazilian Coast Guard (Capitania dos Portos) and fish landings data collected in 7 cities. Results show that the fisheries sector generates R\$389 million yr<sup>-1</sup> and 168 315 jobs. The major share of employment was generated by subsistence and commercial fishing activity, while most income was generated by the processing industry. It was also estimated that 7 531 fishing boats landed 83 847 tonnes in towns along the Amazon River.

## INTRODUCTION

Fisheries have long played an important role in the Amazonian regional economy both for subsistence and trade. In recent decades, a modern commercial fishery has developed, as a result of technological changes and the growth of urban markets and exports. This is transforming Amazon fisheries. In the process total catch and direct and indirect employment and income have grown enormously. Today the fishery is one of the most important renewable resources of the basin and of fundamental importance to the population and economy along the Amazon-Solimões River.

Unlike other sectors of the economy, such as forestry or mining, the fisheries sector receives little or no attention from government policy makers or regional development programs. While generally excellent data on the biological aspects of Amazonian fisheries are now available, there are virtually no data of comparable scope and quality on the economic aspects of regional fisheries. What data are available are usually from questionable sources and grossly underestimate the magnitude and importance of the sector. As a result, Amazon commercial and subsistence fisheries have been the invisible sector, its size and importance to the regional economy largely unknown and grossly undervalued.

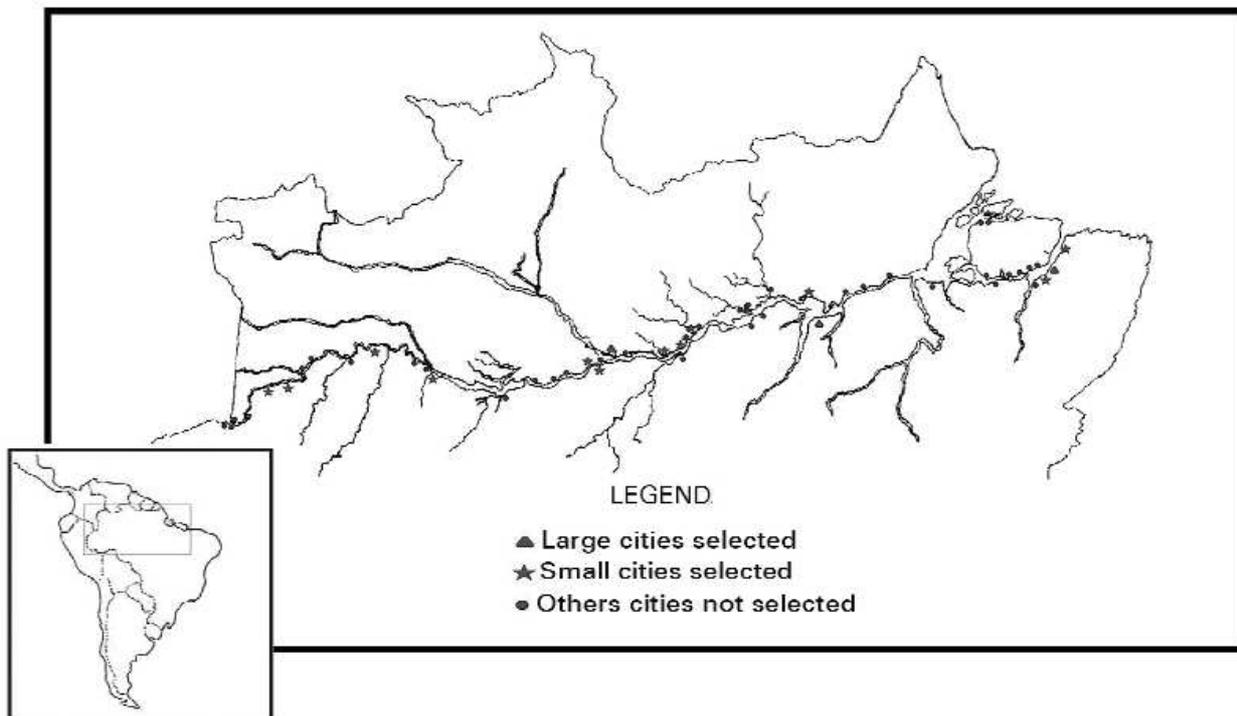
The purpose of this study is to determine the magnitude of the fisheries sector along the Amazon-Solimões River. Total income and employment are estimated for the main activities of the sector, including fish processing plants, stores selling fishing gear, gas stations, restaurants, ice factories and boatyards. The total number of fishers, boats and the total catch along the Amazon River are also estimated. Finally, the long-term benefits generated by the fisheries sector are compared to those generated by the forestry sector.

## METHODOLOGY

### DATA COLLECTION

The major activities comprising the sector were organized into four groups on the basis of their functional role within the sector, inputs (ice, boat building, fuel and fishing gear), fishing, processing and marketing (markets and fairs) and services (restaurants). To assess the importance of the fisheries sector, businesses, Coast Guard officers and Fisher Union officials were interviewed in 15 of a total of 52 cities along the Amazon-Solimões River corridor. Cities were chosen from a stratified sample. All three cities larger than 250 000 inhabitants were selected and a random sample of 12 cities was chosen from the remaining 49 (Figure 1). In each city we interviewed representatives of all fish processing plants, stores selling fishing material, gas stations, fish restaurants, ice factories and boatyards that were available and agreed to be interviewed, approximately 89 percent of the total number of businesses in the sampled cities (Table 1). Due to the large number of fish markets and individual vendors a sampling strategy was employed for this sector. In the two largest cities, Belém and Manaus, a random sample of markets was chosen and a sample of vendors was interviewed in each market. In the remaining sample cities all public fish markets were visited and a sample of individual vendors was interviewed. Overall, 17 percent ( $n=238$ ) of the total number of vendors was interviewed in large and small cities. Businesses were identified based on interviews with key informants such as presidents of fisher's unions, government officials, researchers and businessmen. For activities such as boatyards and gas stations, owners were asked to estimate the proportion of their business that involved the fisheries sector.

A field team consisting of a researcher and assistant undertook interviews. The questionnaire was tested and adjusted in Santarém with one assistant and an extra field assistant was trained in a nearby sample city. Interviews in the remaining 13 cities were conducted from April to June 2001. Interviews were short and included questions on the number of employees, production or volume of product sold, selling prices of



■ Figure 1. Map of the Amazon-Solimoes Basin showing location of the sampled cities

products and seasonal variation in economic activity. The number of fishing boats in each city was obtained from the local Coast Guard office. A total of 436 inter-

views were conducted of which about half were with market vendors (Table 1).

**Table 1: Total interviews per type of business, average income and total estimation of annual income (in R\$1) in the Amazon/Solimões River, 2001. R\$3 equivalent to US\$1.**

	Number of business (1)		Average annual income per city		Number business		Total Annual income All cities
	Interviewed	Existing	Large	Small	Large cities (3)	Small cities (49)	
Fish Markets	238	1 366	24 241	13 803	367.67	21.92	41 563 167
Business	48	51	80 786	19 761	10.33	1.67	4 118 183
Ship Yard	7	10	150 000	119 300	1.00	0.58	3 840 506
Ice factory	24	26	463 987	128 570	4.00	1.17	12 938 761
Fish processing plant (2)	12	14	10 896 806	8 462 500			193 593 060
Gas station	32	36	310 905	217 441	6.00	1.50	21 578 166
Restaurant	18	22	232 574	23 628	5.33	0.56	4 367 205
Total	379	1 525					281 999 048

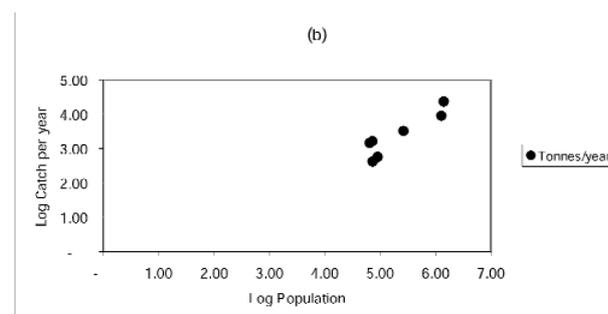
(1) Does not include interviews with unions, Coast Guard and fish markets managers.

(2) In the cities visited there were 14 fish industries from which 12 were interviewed. As we have the total number of fish processing plants for the two states (20) there is no need to estimate using the cities sampled.

## ANALYSIS

Economic performance of the fishing sector was estimated in terms of employment and income. Gross income and employment were calculated in three steps: first, the average income and employment was calculated for each type of business for small and large cities separately. Then based on the total number of businesses in each city the total income and employment was calculated for a city. Finally this value was scaled up for the 49 small and 3 large cities along the Amazon-Solimões. For example, in the case of fish markets in small cities given an average of 22 vendors with a gross annual income of R\$13 803 per vendor the total annual income for the fish market was of R\$302 562. For all 49 small cities the total income was estimated at R\$14 825 394 (Table 1). The same methodology was used to estimate number of boats. To avoid double counting fish in the marketing chain, the value of the fish sold by the commercial fleet to fish markets and processing plants was deducted from the total income of these two segments. Subsistence fishing is also valued using the price of fish sold in the community to highlight the economic importance of this segment in relation to others (Cowx 2003; Hanley, Shogren and While 1997).

The relationship between landings and urban population was used to estimate total landings. Data on fish landings in 7 cities were obtained from the literature and the relationship between urban population and landings was found to be linear. This relationship was used to estimate the catch of the cities that do not have landing data. A linear relation was used because of the tendency to overestimate results based on averages (Figure 2).



■ **Figure 2.** Number of tonnes landed in several cities in relation to county population (Source: Manaus, Itacoatiara, Manacapuru, Parintins based on Batista (1998); Santarém, Almeida *et al.* (2001); Tefé, Barthem (1999); Belém, Barthem (sd) Population data: IBGE several years). Does not include fish processing plant landings.

## RESULTS

### NUMBER OF BOATS AND FISHERS

Based on the number of fishing boats registered with the Coast Guard per city (Figure 2), we estimate that 7 531 fishing boats operate on the Amazon-Solimões river. Assuming there are 6.4 fishers per boat (Almeida, Lorenzen and McGrath 2003), we estimate that there are 48 198 fishers in the commercial fleet.

Data from the Santarém and Tefé regions were used to estimate the total number of rural families along the Amazon/Solimões River. In Santarém there are 198 communities with a total of 9 876 families (De Castro 1999) on 2 683 km<sup>2</sup> of floodplain resulting in a population density of 3.68 families km<sup>-2</sup>. The floodplain area along the Amazon River in the State of Pará is estimated to be 21 720 km<sup>2</sup> (based on Bayley and Petrere 1989) for a total population of 79 930 families. Queiroz (1999) estimates the population of the Mamirauá Ecological Station on the Solimões River to be 672 families in an area of 2 420 km<sup>2</sup> for a population density of 0.28 families km<sup>-2</sup> (Queiroz 1999). Multiplying by the area of várzea along the Amazon-Solimões River, we estimate that there are 18 166 rural families on the floodplain in the state of Amazonas. The total for the states of Pará and Amazonas is 98 096 families. Assuming 1.14 fishers per household (Ruffino, Mitlewski, Isaac *et al.* 1999), the number of fishers on the Amazon-Solimões floodplain is estimated to be 111 829.

Using a somewhat different methodology, Bayley and Petrere (1989) arrive at a figure of 228 600 subsistence and commercial fishers in 1980 for the entire Amazon basin, equivalent to 102 870 (45 percent of the total), if only the Amazon-Solimões River is considered. Deducting our estimate of the number of commercial fishers (48 198) would leave a total of 54 672 subsistence fishers. This estimate is about half the one presented above. If one corrects for population growth over the last twenty years, Bayley and Petrere's estimate would increase to about 70 percent of that presented here. Since their extrapolation is based on an estimate of population density for a region in the

Peruvian Amazon, outside the present study area, we use here our estimate for the Brazilian Amazon.

Finally, based on landing data available for the regional markets of seven Amazon cities (Figure 2) the total volume of fish landed in urban centres along the Amazon-Solimões rivers is estimated at 46 269 tonnes (based on a log-log regression of catch and population of  $a = -1.72$  and  $b = 0.959$ ). The total commercial landings along the Amazon-Solimões River are estimated at 83 847 tonnes when the value of the catch landed at processing plants is included (37 578 tonnes; Cabral and Almeida 2003).

#### INCOME AND EMPLOYMENT GENERATED

Total income of the fisheries sector is estimated at R\$389 million (Table 2). The activities generating this income include the commercial fishing fleet, fish processing plants, fish markets, boatyards, ice factories, commercial establishments, gas stations and fish restaurants. There are significant differences

between activities in their contribution to total sector income and employment. Fish restaurants, businesses selling fishing equipment and boatyards specialized in building fishing boats each contribute 1 percent of the total income generated by the sector. Ice factories and gas stations specialized in selling to fishing boats contribute between 3 percent and 6 percent, respectively. The activities that contribute most to total sector income are fish processing plants (36 percent), subsistence fishing (33 percent) and the commercial fleet (16 percent) (Table 2).

The relative importance of fish processing plants, despite the small number operating in the Amazon, is due to their large size and high income per plant (averaging R\$10 million in sales) (Table 2). Fish markets, in contrast, were not as important despite the large number of vendors and markets.

Fish processing plants account for a large part of the generated income. In 2001, for example, 20 fish

**Table 2: Annual income and employment along the Amazon and Solimões riverbanks, Brazil, 2001.**

	Annual Income (R\$)		Annual Employment		
	Total for riverbank	Percent	Average per Business per year	Total for riverbank	Percent
Subsistence fishers (1)	127 485 060	33		111 829	66
Commercial fishing fleet (2)	62 000 460	16		48 198	29
Fish markets (3)	12 468 950	3	1.3	2 839	2
Commerce	4 120 027	1	2.8	324	0
Ship yard	3 859 594	1	4.63	124	0
Ice factory	12 918 190	3	9.61	397	0
Fish processing plant (4)	139 993 060	36	147.47	4 044	2
Gas station	21 578 166	6	4.29	301	0
Fish restaurant	4 364 332	1	6.93	259	0
Total	388 787 839	100		168 315	100

1) 111 829 families \* 1 583 kg per family (based on Queiroz 1999; McGrath *et al.* 1998) multiplied by R\$ 0.72 per kilo (Almeida and McGrath 2000).

2) Consider total landings in cities (46 269 tonnes, see text) multiplied by the average price of Santarém, Manaus and Belém (R\$1.34; Ruffino 2002).

3) Consider 30 percent of the total income of fish market from Table 1.

4) Total income of fish processing plants estimated in Table 1 subtracted by the value paid to commercial fishers (40 000 tonnes times the price R\$1.34; Ruffino 2002 and Almeida and Cabral 2003).

processing plants received approximately 38 thousand tons of fish (Cabral and Almeida 2003). Most of these plants are located in Belém, Manaus and Santarém (70 percent) and the main species processed included piramutaba (*Brachyplatystoma vaillantii*) and dourada (*Brachyplatystoma flavicans*).

Subsistence (66 percent) and commercial fishing (29 percent) generated 95 percent of total employment in the sector. The remaining 5 percent was divided between fish processing plants (2 percent) and all other activities.

## DISCUSSION

The results of this study show that the total income of R\$389 million generated by the commercial fishery sector, is about four times greater than earlier estimates based on fish landings and subsistence catch (Mitlewski 1997). The study also found that subsistence and commercial fishing fleets are the major contributors to sector employment (95 percent). Other activities, such as fish markets, establishments selling fishing gear, gas stations, ice factories and restaurants, make a comparatively limited contribution to total sector income and employment, together generating only 15 percent of the total, or R\$60 million annually. It is likely that because of the sampling methodology employed and because some types of businesses were not considered, such as supermarkets - an increasingly important outlet for fish in the three major cities, this figure underestimates the contribution of these activities. In addition, because we sampled only cities along the main river, employment and income generated by boatyards, many of which are located on tributaries with better access to wood, may also be underestimated.

This study also supports observations made in an earlier study; that the last twenty-five years of fisheries development have led to the growth, but only partial transformation of the sector. Employment has grown with the expansion of the commercial fisheries, but is still overwhelmingly concentrated in the capture of fish. The low level of capitalization of the fleet is reflected in the limited employment and income generated by activities that support the fishing fleet and by

the muted presence of downstream activities. Every commercial fisher, for example, generates only 0.17 jobs in the rest of the sector. While processing activities are the second largest source of employment, they are still a small fraction of the total for the sector.

The importance of the subsistence fishery often goes unrecognized in terms of both its contribution to total catch, as well as, to the overall floodplain economy. The subsistence fishery accounts for 65 percent of the total catch in the Brazilian Amazon, twice the commercial catch. The subsistence fishery also accounts for a comparable proportion of employment (66 percent).

The subsistence fishery is a central element of the household economy that contributes directly and indirectly to total household income. Almeida, Lorenzen and McGrath (2003) found that 84 percent of floodplain households in the Santarém area fish for subsistence and occasional sale. The protein obtained from fishing is by far the most important source for floodplain populations (Murrieta 1998). Income from subsistence and commercial fishing represents 37 percent of total household income, providing food and cash that enable these households to generate at least the same income from other activities such as farming and ranching (Almeida *et al.* 2003). Furthermore, families with more diversified household economies tend to earn more as they take fuller advantage of the floodplain resource base. The subsistence fishery, then, is a strategic factor in the smallholder floodplain economy that policymakers should take into account in designing development policies for floodplain development (Allison and Ellis 2001; Cowx 2003; Hanley *et al.* 1997).

This study also reveals the deficiencies in official statistics for the fisheries sector. Table 3, for example, shows employment per activity in the primary sector. According to this table there are 1.2 million people employed in the primary sector in the states of Amazonas and Pará and only 17 742 employed in the fisheries sector. However, comparison of these government employment statistics with the number of fishers

calculated in this study (160 027) shows that the official figure grossly underestimates employment in the sector. See also estimates by Bayley and Petrere (1989). The difference between official estimates and reality is actually even larger because the data in Table 3 cover two entire states while the estimate used here is only for the Amazon-Solimões River corridor.

processed by the fish processing industry, then the total area exploited would be 134 150 ha (half the area for half the catch). Based on present patterns of exploitation, this same area of forest would provide roundwood for 6 sawmills (134 150 ha/242 ha/90 year rotation cycle system (Almeida *et al.* 1995, Veríssimo *et al.* 1992) and generate an annual income of 4 million

**Table 3: Number of people occupied in primary sector, Pará, Brazil, 1996.**

	Amazonas State	Percent	Pará State	Percent	Total	Percent
Annual crops	203 842	58	371 794	42	575 636	47
Horticulture	8 458	2	7 323	1	15 781	1
Perennial crops	67 953	19	91 743	10	159 696	13
Ranching	30 858	9	175 900	20	206 758	17
Agriculture and ranching	7 762	2	95 465	11	103 227	8
Silviculture and forest exploitation	20 444	6	128 766	15	149 210	12
Fishing and aquaculture	10 525	3	7 217	1	17 742	1
Production of vegetable coal	597	0	5 717	1	6 314	1
Total	350 439		883 925		1 234 364	100

Source: IBGE (1997)

It is interesting to compare the relative contributions that the fisheries and forestry sectors make to the regional economy. This comparison hinges on the relative sustainability and long-term productivity of the two sectors in municipalities where a substantial part of their total area consists of floodplain and upland forest, as in the municipality of Santarém.

To compare the forestry sector with the fishing sector some assumptions have to be made. The total floodplain area of the municipality is estimated at 268 300 ha (Pro-Várzea, PPG7). Half of the commercial catch, of 3 500 tonnes is landed in local markets and the other half at fish processing plants. We consider the catch landed at local markets and consumed by the local population to be equivalent to roundwood production by the timber industry, as both are sold unprocessed. Likewise, the catch landed at the fish processing industry is equivalent to sawnwood production for the region. If we only consider the catch

dollars. By comparison, the main fish-processing factory in Santarém generates a gross annual income of R\$10.5 million, almost twice that of the forestry sector for an equivalent area. While a more rigorous comparison would need to be refined to account for the importance in the annual catch of migratory species from outside the region, the basic point stands: when dealing with floodplain and upland areas of roughly equal size, floodplain fisheries generate more income and employment than forestry. Furthermore, unlike the forestry industry where most of the original forest area will not be available for a second cut, fisheries production can be maintained indefinitely. This example shows the enormous income generating potential of floodplain fisheries when properly managed; underscoring the strategic role they can play in the sustainable development of municipalities located along the Amazon floodplain.

## CONCLUSION

Earlier we referred to Amazon fisheries as the invisible sector whose contribution to the regional economy is grossly under-estimated and consequently under-appreciated by government policymakers. Here we present the results of a first attempt to estimate the actual magnitude of the sector in terms of employment and income generation for the Amazon-Solimões River corridor. Results of this analysis show that income generation by the sector is four times larger than previous estimates (Miltewski 1997, considering present dollar parity and only the Amazon-Solimões corridor), while direct employment is 8 times that in published government statistics. The study also reveals that the major contributors to sector employment are the subsistence and commercial fisheries. Fish processing plants are the major contributors to sector income. The contribution of other activities, both upstream and downstream, is just 15 percent of total income. As these results suggest, total job creation per commercial fishers is estimated very low, 0.17 and even lower if subsistence fishery is also included, underscoring the artisanal nature of the fishery. While the magnitude of the subsistence fishery is captured in this report, the sector's contribution to overall floodplain income and employment has not been adequately assessed, due to the absence of data on floodplain agriculture and ranching. However, data from the Santarém region indicate that it can be considerable. Finally, while at the basin level fisheries' income and

employment are dwarfed by that of the forestry sector, for municipalities along the Amazon-Solimões River corridor the relative importance of local fisheries can be significantly greater than that of the forestry sector in the medium to long term, at least for the municipalities along the Amazon river.

In conclusion, we hope that this study helps to make the sector more visible, so that policymakers have a greater appreciation for the sector's contribution to regional income and employment and stimulates them to adopt policies that enhance the sector's contribution to regional livelihoods and development.

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