

Impact of co-management agreements on the exploitation and productivity of floodplain lake fisheries in the Lower Amazon

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Abstract

Community initiatives to regulate the exploitation of lake fisheries have proliferated in the lower Amazon, and may now be legalised as co-management agreements whereby the government endorses and enforces community rules. Most agreements aim to raise stock abundance and thereby the productivity of lake fisheries by limiting exploitation by larger, often external commercial boats as well as by local fishers. This study evaluates the perceived and actual impact of co-management agreements on fisheries exploitation and productivity by comparing lake fisheries within and outside agreements. A survey was conducted in 18 paired communities with and without co-management agreements (i.e. 9 pairs of a co-managed and non-managed fishery each). Rules in co-managed fisheries typically comprised restrictions on the use of gill nets, daily catch limits and limits on the size of boats. A total of 259 households (13 or 18 per community) were surveyed to estimate local fishing effort and catch. Non-managed fisheries were subject to additional fishing by external commercial boats which could not be quantified independently, but has been accounted for in the analysis. Results showed a reasonable degree of perceived and actual compliance within the communities with co-management agreements. The productivity (catch per unit of effort) of managed fisheries was significantly higher, by about 60%, than that of non-managed fisheries even though no significant difference in household fishing effort was detected. An empirical model relating fishing effort and yield per unit area was derived for a sub-set of lakes (both managed and non-managed) where lake area could be clearly delineated and fishing was carried out predominantly by communities covered in the survey (i.e. excluding lakes shared by several communities). Fishing effort explained much of the variation in yield between lakes. Managed lakes showed significantly higher levels of yield and productivity (by about 70%) than non-managed lakes for the same level of fishing effort. This difference is likely to reflect the additional, non-quantified fishing effort and catch by external commercial boats in non-managed lakes. We conclude that the co-management agreements have brought significant yield and productivity benefits to the communities implementing them, largely as a result of reduced commercial fishing by outsiders. The yield predictive model derived in this study provides a quantitative tool for assessing effects of effort regulation within co-management fisheries.

Kew words: co-management, fishing, floodplain lakes, productivity, Amazon.

Introduction

Co-management, the sharing of management responsibility for fisheries by resource users and governments is widely seen as a key to improving fisheries management and reducing overexploitation (Sen & Nielsen 1996, Pomeroy & Berkes 1997). In the Brazilian Amazon, community initiatives to regulate the exploitation of floodplain lake fisheries have proliferated, and may now be legalised as co-management agreements whereby the government endorses and enforces community rules. Most agreements aim to raise stock abundance and thereby the productivity of lake fisheries by limiting exploitation by larger and often external commercial boats as well as local fishers (McGrath 1993, De Castro 1999, Almeida *et al.* 2001, Oliveira & Cunha 2000, Pereira 2000, Smith 2000). The Lower Amazon is one of the regions where community management has expanded rapidly, with 69 accords involving 100 lakes and 137 communities in place by 1999 (De Castro 1999).

A number of recent studies have focused on the socio-economic context and on institutional aspects of the fishing agreements (McGrath 1993, De Castro 1999, Oliveira & Cunha 2000, Pereira 2000, Smith 2000). However, despite the widespread support for co-management agreements among local communities and governmental as well as non-governmental conservation organizations, the effectiveness of the agreements in raising productivity and conserving resources has not been rigorously evaluated. Among the factors that may limit their effectiveness are the difficulties of setting and enforcing appropriate exploitation limits, and migration of stocks between managed and non-managed areas. The present study aims to provide a rigorous evaluation of the productivity and conservation benefits of co-management agreements in the lower Amazon, based on a replicated field survey.

Following a brief description of general attributes of communities and management agreements, we evaluate the perceived and actual level of compliance with management regulations, and the yield and productivity effects of management agreements. Finally we derive an empirical yield model to assess the relationship between local fishing effort and yield, and the impact of exploitation by external commercial boats on non-managed lake fisheries.

Methodology

Data collection

The study was designed as a replicated, paired comparison of fishing effort and catch between communities with established and successful co-management agreements and communities without such agreements. At first, nine communities with established, successful co-management agreements were selected from a list of registered agreements. Only communities where co-management was perceived to be successful by community leaders, the commercial fisher's union, the federal environmental agency (IBAMA), and NGOs alike were selected. For each such community with a co-management agreement, a similar local community without a functioning management agreement was selected for the paired comparison. Pairing was based on similarity in terms of geographical proximity, dominant land type (upland or floodplain), and the size of lakes in the vicinity of the community.

Detailed interviews were carried out with 259 families in 18 communities during the period of October to December 2000 (low water season), and again during July 2001 (high water season). Questions covered general household social and economic aspects, and detailed information on fishing activities carried out and catches obtained during the previous week. Additional interviews were carried out with community leaders in most of the communities with co-management agreements in order to establish their motivation for setting up agreements.

Analysis

Descriptive statistics were used to provide an overview of community characteristics and perceptions of management success.

Fishing effort expended with different gear types was standardized to units of gill net soak time, based on within-lake comparisons of catch per unit of effort (CPUE) (Gulland 1983). Household effort and catch were averaged for the two periods and scaled up to a full year. Paired t-tests were used to compare fishing effort, catches and CPUE between households in communities with and without co-management agreements. Total fishing effort and yield per unit of area were determined for a sub-

set of lakes (both managed and non-managed) where lake area could be clearly defined and fishing was carried out predominantly by communities covered in the survey (i.e. excluding lakes shared by communities for which no data were available).

An asymptotic yield model was used to evaluate the relationship between yield, local fishing effort and management status:

$$\text{Log}_{10}(y_i) = \text{Log}_{10}(y_{\max}) (1 - \exp(-a f_i)) + b m_i$$

Where

y_i is the yield of lake i

f_i is the fishing effort in lake i

m_i is the management status of lake i (managed =0; non-managed =1)

y_{\max} is the maximum (asymptotic) yield

a describes the steepness of the yield curve

b is the coefficient of management status

The model is similar to that proposed by Lae (1997), but includes an additional term to account for the impact of additional, non-quantified fishing by external boats in the non-managed lakes.

Results

Description of communities and households

The surveyed communities ranged in size from 18 to 156 households, with a median of 67. The major sources of household income found in the survey can be grouped into four categories: fishing, farming, cattle ranching, and salaried employment and government benefits. Most residents received income from several sources. About 84% of households engaged in fishing, mostly for subsistence (only 3% of households owned a fishing boat, representing the more commercial fishers). On average, fishing accounted for about 40% of total household income in cash and in kind.

Some 66% of households engaged in agriculture, producing mostly beans, watermelon, manioc and corn in an area smaller than 0.5 ha. About 48% of households engaged in cattle ranching, with a typical herd size of 22-32 heads. Just over half of all households (51%) received income from the government either as wages or as retirement pensions.

There were no significant differences in the frequency of different income sources, land area cultivated, or cattle herd size between communities with or without fisheries co-management agreements.

Fishing agreements: rules and perceived compliance

Interviews with leaders of communities operating successful co-management agreements indicated that most agreements had been established with the objective to safeguard fish supply for the subsistence needs of the community, while restricting commercial fishing, in particular by outside boats.

All fishing agreements banned gill net and drag net fishing in the low water period, and many agreements also set daily catch limits or limits to the size of boats allowed to enter the lakes. Some agreements explicitly restrict commercialisation of the catch.

In the household survey, most interviewees (85%) correctly reported the main rules set out in the local agreement. Other details of the agreements, such as the year an agreement had been legalized were less commonly known (36% of the respondents). The majority (80%) of interviewees in communities with co-managed fisheries considered the agreements successful. When asked about the proportion of community members complying with the rules, 70% thought that more than 50% complied (Table 1).

Table 1. Percentage of how much does the residents thinks that the agreement is complied.

Interviewees (%)	Perceived percentage of residents complying with the agreement
24%	> 90%
46%	Between 50 and 90%
30%	< 50%
100%	

Impact of co- management on exploitation by local households

There was no noticeable difference in standardized household fishing effort between communities with and without co-management agreements (Figure 1).

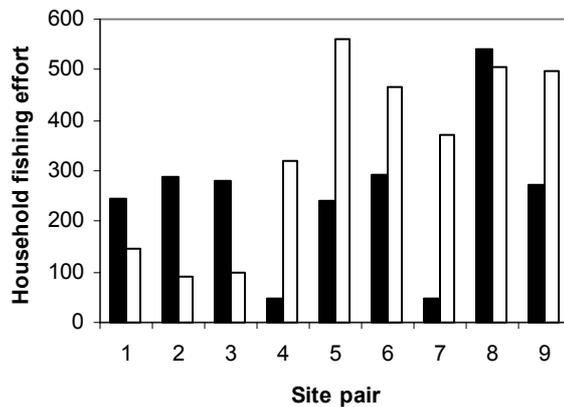


Figure 1. Comparison of standardised household fishing effort in communities with and without co-management agreements. Communities with (solid bars) and without (open bars) co-management agreements.

The proportion of fishing effort expended by gill nets was significantly lower in communities with co-management agreements (38% on average) than in those without (76%) (Figure 2). This indicates a reasonable degree of compliance with restrictions on gill net use. However, the reduction in gill net effort appears to be compensated to a large extent by an increase in effort expended with other gears. This may explain the lack of overall reduction in fishing effort within communities operating agreements.

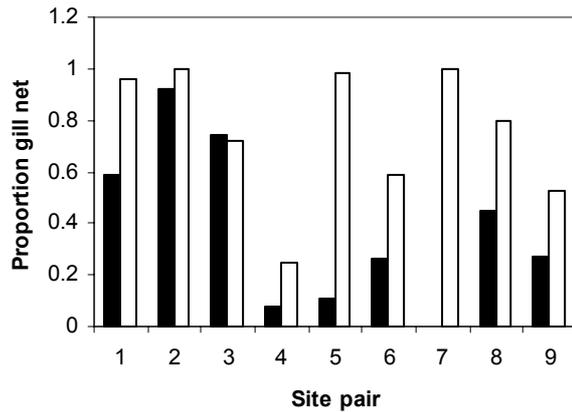


Figure 2. Comparison of the proportion of fishing effort expended with gill nets in communities with and without co-management agreements. Communities with (solid bars) and without (open bars) co-management agreements.

Impact of co-management on fisheries productivity

Fisheries productivity as measured by catch per unit of effort (CPUE), was significantly, and very consistently higher in communities with co-management agreements than in those without (Figure 3). On average, CPUE was 60% higher in managed fisheries.

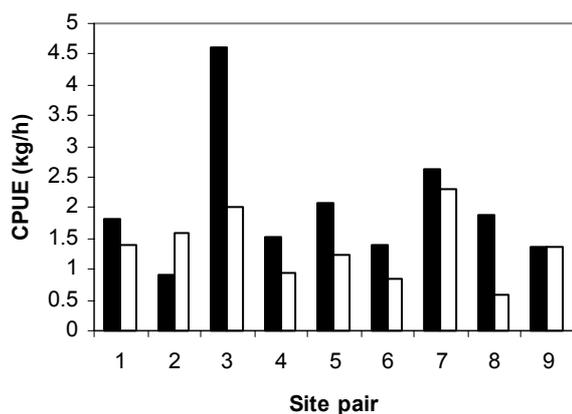


Figure 3. Comparison of fisheries productivity (catch per unit of effort, CPUE) in communities with and without co-management agreements. Communities with (solid bars) and without (open bars) co-management agreements.

The asymptotic yield model provided an excellent fit to the data, with parameter estimates of $y_{\max} = 106 \text{ kg/ha}$, $a = 0.069$ and $b = -0.241$. The management coefficient b was significantly different from 0, indicating that for a given level of local fishing effort, yield and CPUE are significantly lower in non-managed fisheries than in co-managed ones. This is likely to reflect the impact of additional fishing by external commercial boats in non-managed fisheries. The relationship between local fishing effort and yield is shown in Figure 4, differentiating between managed and non-managed lakes. Note that the relationship between CPUE and effort in these multi-species fisheries is complex and non-linear, as opposed to the continuous reduction in CPUE with effort predicted by single-species production models (Gulland 1983).

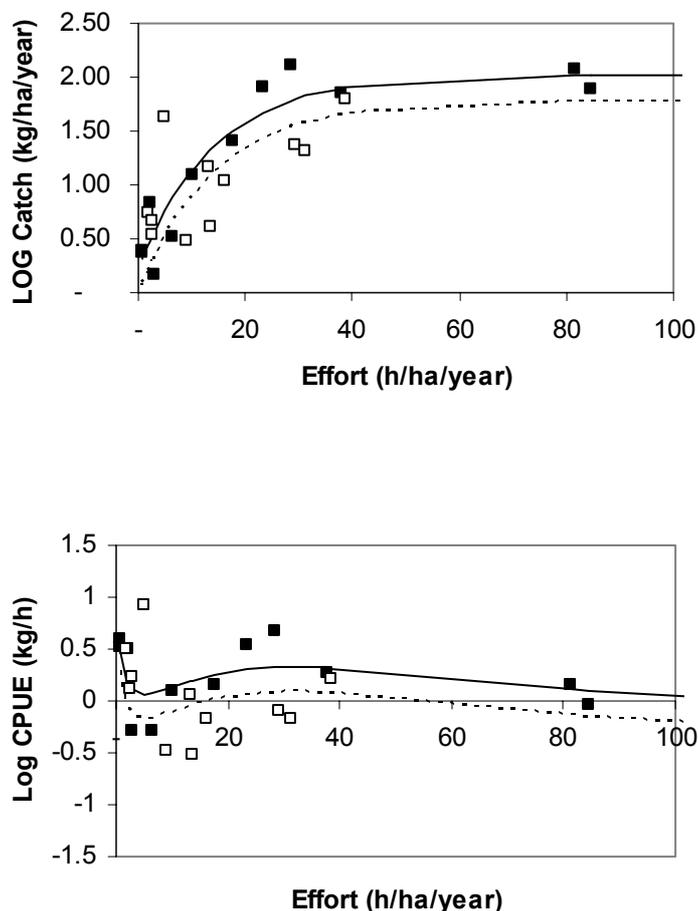


Figure 4. Relationship of yield (top) and productivity (bottom) to fishing effort in managed (closed symbols and solid line) and non-managed (open symbols and dotted line) floodplain lake fisheries.

Discussion

Fishing is of major importance to the livelihoods of rural households in the lower Amazon, contributing an average of 40 % to total household income. Participation in fishing is almost universal at 84%. Hence it is not surprising that many community and co-management initiatives for natural resources in the Amazon have evolved around fisheries (McGrath 1993, De Castro 1999). Under the new Brazilian federal fisheries law, rules devised by local communities may be formalized and enforced by government agencies, effectively creating one of the most far-reaching co-management systems for aquatic resources.

The present study provides the first rigorous evaluation of the productivity and conservation benefits of the co-management regimes. Results show that co-management of floodplain fisheries does indeed provide real and significant benefits to local communities. The estimated average increase in productivity (CPUE) by 60-70% in managed lakes over non-managed lakes provides very substantial benefits to local households. Underlying this increase in CPUE is a proportional increase in standing stock, and therefore an equally substantial conservation benefit.

Results suggest that the productivity and conservation benefits of co-management schemes are achieved primarily by excluding outside commercial fishers from the managed lakes. Exclusion of outside commercial fishers was the most frequently cited reason for entering into co-management agreements in the first place. Although explicit discrimination against outsiders is illegal under the federal fisheries law, rules tend to be designed so that they restrict fishing activities by external commercial boats more than those by local households. The communities co-operate for gain more than restraint, but still achieve an effective conservation benefit (cf. Ruttan 1998).

Where communities have gained effective control over their local aquatic resources, more active and outcome-oriented management of exploitation within the community may be expected to develop. The yield-effort relationships derived here may help communities to assess the effects of alternative management options.

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