THE EMERGENCE OF COMMON-PROPERTY REGIMES IN AMAZONIAN FISHERIES

Henrique Pereira
Universidade do Amazonas[1]

ABSTRACT

Natural resource management issues are one of the world's top concerns today and the involvement of local level institutions is of great importance for efficiently conserving natural resources. Recent drastic socioeconomic transformations underway in the Amazon region have affected local populations and have altered patterns of resource exploitation, notably in the commercial fishery sector. Unlike fisheries elsewhere, the intensification of commercial fishing in the Amazon has not yet led to the breakdown of subsistence fisheries. Since the 1970's, several Amazonian peasant communities have demanded political and legal support for their management practices and property rights. Sixty-two riverine communities of the Brazilian Amazon basin and their accomplishments in managing collective owned fisheries were studied from September/1997 to June/1999. Data on community organization and household economic strategy were collected in loco by means of discussion groups, structured interviews, mapping and participant observation. Each community's Common Property Regime (CPR) were classified and analyzed according to a combination of ecological and institutional economics theories. As predicted, territorial defense should increase with higher external competition for local resources and restrictions to individual level of appropriation should increase if resources become scarcer relative to internal consumption pressure. Complemented by the household's microeconomic perspective, these two sets of "environmental" factors seem to explain the arrangement of operationalization rules observed in each community. As expected, open-access regimes (CPR I) were found at situations where perceived resource scarcity is at its highest and competition pressure at its lowest level. Fully developed management schemes (CPR III) were found at situations where fish resources were moderately abundant and internal competition more intense. Household's economic structure and opportunities (age structure, land tenure, and source of income) are shown to be correlated to household's decisions with respect to adherence or not to the community's management scheme. The potential conserving aim of each type of CPR are highlighted and discussed. Suggestions are made on how the local society could move towards a model of fisheries co-management where public policies are designed to encourage partnerships, local incentives for sustainable use and sharing of power and responsibility for resources management and conservation.

[1] Universidade do Amazonas. Faculdade de Ciências Agrárias. Campus Universitário. Av. Gal. Rodrigo Jordão Ramos, 3000. Aleixo. CEP: 69077-000. Manaus, AM. Brazil. Email: hsp2@buriti.com.br.

INTRODUCTION

One clear result from more than two decades of research is the finding that people do not always follow the inexorable logic of the "Tragedy of The Commons" metaphor (Hardin 1968; Berkes 1985; McKean 1992; Simmons & Schwartz-Shea 1993). Users of Common-pool resources such as peasant communities have repeatedly shown their capacity to organize themselves. Members make credible commitments to monitor each other's behavior and impose sanctions on those who display inappropriate behaviors. Thus, the idea of decentralizing natural resource management to local communities is increasingly gaining acceptance in policy making and in people-centered development projects (Ostrom 1990; Cernea 1991; Carney & Farrington 1998).

There are, however, two kinds of problems that may make local self-regulation less likely to be successfully achieved than it appears at first sight. Regulation of appropriation level may seriously limit a household's income, and, for this reason, is liable to generate strong opposition from some resource appropriators. Additionally, regulation may have organizational costs for participant households making the management scheme costly to achieve and maintain (Baland & Platteau 1996). Despite an impressive growth of theory and empirical research during the last several decades, the origin and dynamics of collective action remain disputed (Heckathorn 1996). As pointed out by Taylor (1992), it is necessary to provide a better explanation of why some groups of users are able to solve their own collective action dilemma endogenously - without external help - and other groups are not.

The artisanal fishing communities of the Middle Amazon River provide a "natural laboratory" in which it is possible to explore these issues. In this region, some communities have autonomous local resource management schemes to regulate their fishing practices while others do not. Of those that do, some control only access to fishing grounds, while others control both access and individuals' level of resource appropriation. In some communities, there is widespread adherence to the management scheme, and in others opposition threatens to destroy the management institution and to deplete the local fish stocks.

The hypotheses tested here link the emergence (or lack thereof) of local management institutions to the intensity of resource competition experienced by the community. They also link the successful maintenance (or failure) of these institutions to social attributes of the community, and to the economic behavior and structure of households within the community. Most of the analytical tools used in formulating a conceptual framework for this study come from New Institutional Economics and the emergent theory of Common Property (Bates 1988; Wheelock & Oughton 1996; McCay & Jones 1997). Together these hypotheses form an integrative approach of ecological theories of human territoriality under the paradigm of rational-choice theory of collective action (Ostrom 1997). This work is an attempt to establish epistemological connections between the human component and the environmental components of a Common-pool Resource situation.

The conjunction of the ecological, the social and the microeconomics contexts in which each community is embedded is thought greatly to influence the emergence and performance of Common-pool Resource institutions. Thus, resource physical attributes, intensity of competition, initial community social capital and wealth stratification, and household economic behavior are predicted to explain why some groups of users are able to solve their own collective-action dilemma endogenously while other groups are not.

This research also intends to unveil the reasons for the failure of local management institutions. To attain this goal, communities where the predictions of the "Tragedy of the Commons" are fulfilled are also examined. In those CPR situations, the custodian communities desired regulatory norms and access rules to govern local fisheries but failed in implementing and/or supporting a local management institution.

This study presents an in-depth understanding of the dynamics of the existing innovative and spontaneous self-help organizations and suggests how this understanding could be used as a base for developing local alliances and coalitions among rural communities, municipal institutions and national development agencies. Such alliances would allow locally managed small-scale fisheries to be incorporated into natural resource management policies.

LITERATURE REVIEW

Theories of Human Territoriality - These theories relate property regimes to the physical characteristics of the resource and to the economics of its defense. Local management institutions often require the defense of a territory within which the resident group controls or restricts use of resources. Ecological theories hold that no benefits accrue from territorial defense unless there is competition for resources, and that competition is expected to increase as resources become scarcer, relative to population density (Dyson-Hudson & Smith 1978; Cashdan 1983). From this perspective, when a resource is locally abundant in relation to the local population needs and competition is at a minimum, a resident group is less likely to bear the costs of creating and maintaining a social institution for governing the exploitation of its resource.

Predictability is another important environmental variable that has been associated with territoriality, since resources that are unpredictable, transient, or highly mobile should be less economical to defend. Thomas (1996) has found empirical evidence to support these theoretical predictions. His studies of patterns of fisheries tenure of the Hadejia-Jama'are floodplain have shown that rights of access to fish at a particular location change with the status of the flood. At the height of the flood, the area inundated is extensive and the fishery is open access. Similarly, in the Amazon, diversity of aquatic habitats, fluctuations of water level and fish species life history must play an important role in defining the temporal and spatial dynamic of the cost/benefit relation of territorial defense.

Physical attributes of fish as a resource, such as high mobility, generate obstacles to complete privatization and conventional management. Nevertheless, Amazonian fishers, like many other fishers around the world, have developed a deep knowledge of fish and fishery ecology that allows rational allocation of their conservationist efforts. Knowing the behavior of the species and the ecological attributes of a local environment, fishers can predict very accurately where and when reproductive adults and pre-reproductive juveniles will concentrate during certain periods of the year. Traditional community-based management schemas are based primarily on defense of fishing grounds rather than on control of collective or individual extraction levels. For the same reasons norms of restricted access, where they exist, are discriminated according to type of fishing grounds and phases of fish species life history.

Common-pool Resource Theory - In addition to these considerations, there is another series of attributes, that of the social group of appropriators, that may affect the expected relationships between environmental variables and territoriality (Cashdan 1983). Ostrom (1992) points to one of the variables critical to the survival of community-based management

institutions: ownership status of the resource. Ownership status refers to the sustainable and certain rights that appropriators have to access, use, and potentially, to exclude others from resources. This definition implies the existence of culturally accepted mechanisms that allow resident appropriators to claim property rights over resource stocks. A pre-condition for the exercise of property rights is the definition of clear-cut boundaries of the Common-pool resource. An important aspect to be investigated is the cultural mechanisms by which communities claim ownership over fishing grounds in floodplain areas where landscape features such land-water interfaces are changing continuously. In other words, how is a water tenure system articulated by those communities and how it is related to the land ownership regime and legal system?

Other social components of a Common-pool resource situation refer to internal attributes of the custodian community. Ostrom (1992) pointed out that the existence of a general-purpose organizational structure, such as a village council or a cooperative organization, facilitates the emergence of Common-pool resource institutions. If a resident group of resource appropriators is to create a local management scheme, it must be able to meet the required transaction costs, i.e., the costs of creating, negotiating, monitoring and enforcing a collective agreement. Rural sociologists have long recognized that positive interaction and problem sharing characteristics of successful local management institutions are also core aspects of community development processes (Swaney 1990; Wilkinson 1991). A community's social capital in the form of norms of reciprocity, mutual trust, and networks of community engagement (Coleman 1990; Putnam 1993) is expected to lower the cost of achieving an endogenous solution for local social dilemmas[2], such as a fishery management conflict (Singleton & Taylor 1992; Taylor & Singleton 1993).

The transaction costs originate from finding and reinforcing solutions for two kinds of collective dilemmas: (1) **Resource appropriation dilemma -** how access to a resource is controlled and how resource flow is shared among accountable appropriators so that the collective withdrawal is maintained at an acceptable level; and (2) **organization provisioning dilemma -** how the costs of providing and maintaining the management institution are to be shared among potential beneficiaries. Resolutions to both types of dilemmas involve the coordination of collective action (Heckathorn 1996). Resolution of resource appropriation dilemmas requires that the devised management scheme satisfy both individuals' needs and the viability of long-term collective use of the resource stock. In self-governed common-pool resource institutions, resolution of the organization provisioning dilemma requires that the potential beneficiaries themselves bear the costs of providing and maintaining the management institution.

Common–property Regimes Typology - Access rules are inherent aspects of common-property regimes[3] (henceforth CPR) and human territoriality and are expected to be constant in most communal fisheries. However, local institutions may also include withdrawal norms, that is, restrictions on individuals' resource consumption level. The design of a management institution corresponds to a combination of access rules and resource withdrawal norms; the

[2] A social dilemma is defined as a situation in which actions that are individually rational can lead to outcomes that are collectively irrational (Heckathorn 1996).

[3] Current convention denotes resources as 'common-pool' while management structures/systems are known as 'common-property' regimes (Carney & Farrington 1998).

possible combinations can be used to establish a typology for the study of Common-pool resource situations (Table 1).

A Common-pool resource situation is defined here as the combination of a group of people and the resources they use collectively. Based on resource access rules and withdrawal norms, four types of Common-pool resource situations can exist. Resource access rules can be of two types: open access for all potential appropriators or restricted access for non-community members. Withdrawal norms impose limits on catch size and fishing technology used by authorized appropriators. Withdrawal norms can thus be either present or absent. Absence of withdrawal norms means that the community does not directly control an individual's capture effort. Nevertheless, communities can control collective withdrawal effort by restricting the fishery to pure subsistence.

Table 1 - Typology of Common-pool Resource situation with respect to institutional basic design.

	Withdrawal norms	
Access rules	*absent*	*Present*
flexible or open access	Type I	Type IV
Restricted to community members	Type II	Type III

Source: adapted from Baland & Platteau (1996).

The Type IV case, flexible access rule and conservation, is problematic because in the absence of strict access rules it may prove difficult to ensure that conservation measures are followed by resource users. Type IV situations are unlikely to arise when common-pool resources are well localized and local communities define access rights. Type IV was not encountered in this research. However, it is worth stressing that the Type IV combination points to a potential solution to complex problems of environmental management in the context of non-excludable resources or resource domains (Baland & Platteau 1996).

The combinations of rules and norms (Table 2) describe the three actually occurring types of Amazonian Common-Property Regimes (CPR). Communities classified in Type III CPR presented diverse sets of operational rules. For that reason, CPR III agreements were subdivided according to two sets of main rules: commercialization forbidden (1) or allowed according to particular rules (2) and absence of restrictions on capture techniques (0) or presence of restrictions (1). The combination of these two rules creates 4 subtypes of Type III CPR (Table 3).

Table 2 - Characteristics and indicators of Common-Property Regimes (CPR).

Type I - Non-managed CPR	**Type II - Regulated CPR**	**Type III - Managed CPR**
Withdrawal rights of non-community members (commercial or subsistence fishers) are *unrestricted* or obtained by informal arrangements.	Withdrawal rights are *denied* to non-community members according to community rules.	Withdrawal rights are *denied* to non-community members according to community rules.
No formal norms regulating capture technique and effort are applied to potential appropriators.	*No* formal withdrawal norms are applied to community members other than those regarding resource flow allocation.	Formal *withdrawal norms* are Applied to all potential appropriators.

Source: adapted from Baland & Platteau (1996).

Table 3 – Typology of communities according to type of CPR.

CPR Type	Sub-type	Defense of exclusive territories	Commercialization allowed according to rules	Restrictions on capture techniques
I	a(*)	no	N/A	N/A
I	b(*)	no	N/A	N/A
II	-	yes	N/A	N/A
III	1.0	yes	no	no
III	1.1	yes	no	yes
III	2.0	yes	yes	no
III	2.1	yes	yes	yes

(*) **a -** communities that never tried a fishery agreement, **b** – communities whose former agreement failed or was never effectively implemented. **N/A** = not applicable.

RESEARCH PLAN

Research Site

The natural environment - The Amazon Basin is the largest drainage area of the world, covering nearly one-third of South America. The gentle inclination of between 1 and 2 cm/km and the marked seasonality of the river discharge contribute to form a complex aquatic system in its valley. The main sources of primary production sustaining the aquatic biota are the areas periodically flooded by whitewaters, known as *várzea* (Forsberg *et al*. 1993). These areas border the Amazon River from Pucallpa in Peru to the ocean, with an average width of 20 to 100 km; they are estimated to cover a total area of 180,360 sq.-km.

Várzea lentic habitats are essential for maintaining high levels of secondary production, especially fish, in the river ecosystem (Bayley 1995b). Phytoplancton is the main source of organic carbon for the aquatic trophic chain and its production is only of relevance in the whitewater rivers' floodplain. In a large part of the river complex conditions are more lentic than lotic because water movements occur gradually during approximately six to nine months each year (Bayley 1995b). Floodplain lakes are the habitat for sedentary fish species. During flood peak, shallow waters on the forested levees are seasonal food habitats and refugia for migratory species.

In contrast with the turbid and eutrophic waters of the Amazon main channel, blackwater tributary rivers are oligotrophic because of the soil chemistry composition of the catchment area. Blackwater streams do not form extensive floodplain deposits because their load of suspended sediments is very low. In this type of river, lentic habitats are formed only at main channel itself at its downstream most portion at their confluence with the Amazon (Bayley & Pretere 1989). These remarkable differences are also reflected in terms of fish productivity. Comparable data on gillnet catches/unit effort in whitewater and blackwater floodplains (Junk *et al* 1997) shows productivity five times greater in the eutrophic whitewater habitat compared to the nutrient poor blackwater floodplain. In the várzea an average of 210 $g.m^{-2}$ day^{-1} was captured in contrast to 41g m^{-2} day^{-1} in the blackwater inundated forest.

The social environment - Brazilian Amazon flood-plain communities were studied by the author in two previous research projects (Pereira & Lescure 1993, Noda *et al.* 1995). The economic strategy of Amazonian fishing communities is very similar to what Pollnac (1991) has described in general and cross-cultural terms as small-scale and part-time fishers' societies. These communities comprise familial groups, varying on average from 10 up to 30 households,

sparsely located along the Amazon River banks. Agroforestry systems that combine annual crops such as cassava (*Manihot esculenta* Crantz), fruit crops, extraction of non-timber forest products and fisheries are the major subsistence and commercial economic activities of these local populations.

Recent drastic socioeconomic transformations underway in the Amazon region have affected local populations and have altered patterns of resource exploitation, notably in the commercial fishery sector (Bayley & Pretere 1989; Bayley 1995a, 1995b). Fishing has traditionally been one of the most important resource procurement activities in the Amazon region; it represents the main source of animal protein for local populations. The transformation of commercial fishing in the Amazon began in the 1950's with a series of developments that revolutionized fishing technology and the transportation and storage of fish products. During the 1960s and 1970s, commercial exploitation expanded due to federal tax incentives for fleet expansion and acquisition of new fishing techniques. These technological changes were accompanied by a great increase in urban demand for fish within the Amazon, and the development of national and international markets for Amazon fish products (Hartmann 1992; McGrath *et al*. 1993, 1996; Isaac 1995; Barthem 1995; Parente 1996).

The area chosen for the present research is located in the portion of the Middle Amazon fishing zone that belongs to Amazonas State, an area which is not included in any of the above research or development projects. The micro-region selected for this study centers around the municipality of Itacoatiara. This municipality is located downstream from Manaus, the capital of Amazonas State and its most important regional fish market. This region was chosen because it has recently attempted to implement municipal legislation promoting community guardianship of aquatic resources (Appendix a – Map of the study sites).

Origin and formation of Itacoatiara's rural communities – Today's rural "communities" as a concept and form of political organization are a recent innovation in the social life of Amazonian rural populations. The Brazilian Catholic Church and its main political organization[4] introduced the concept of CEBs (Ecclesiastical Root Communities) in 1962. There was no formal political organization prior to the foundation of the rural CEB's among the riverine natural settlements. However, some form of social annual grouping existed at localities where a "Festejo de Santo" (Festival of the Saint) and its brotherhood or a local soccer team required a permanent organization. The concepts of "locality" and of "territoriality" were thus already established and served to delineate the future CEB's as a territorially based social organization (Wilkinson, 1991).

Most CEBs were created in the early 1970's, a period that corresponds to intense political activity by the Itacoatiara Catholic Church. The second peak in the late 90's corresponds to recent actions of the Secretary of the Interior of the Itacoatiara Municipal Government. Since 1997, all assistance from the government and state banks to rural communities and familial producers has been conditioned on the formation of a non-profit association of rural producers. Familial producers and local government adopted the "original" formula of the CEB's to create new communities in many zones.

Present day CPR regimes in Amazonian fisheries are best viewed as the most recent in a long history of adaptive responses that evolved to counteract natural and economic changes in the riverine environment (McGrath *et al*. 1993). For Hartmann (1992), the Amazon continental fisheries underwent technological innovations from 1950 to 1970. Smith (1985) and Hartmann (1992) identify four main innovations that were responsible for the "modernization" of

[4] The CNBB: National Confederation of Brazilian Bishops.

Amazonian fisheries: (1) labor specialization and division of labor; (2) introduction of synthetic twine; (3) increase in of ice manufacturing; and (4) use of Diesel engines to power fishing boats. The expansion of the commercial fishery was legally supported by federal decree No. 221 (02/28/1967) which is the base for the Brazilian fishery legislation. Together, these technological innovations made it possible for multi-species stocks to be exploited up to their exhaustion, for the first time. In Itacoatiara, a few fishery agreements had arisen in the early 1970's, together with the newly organized CEBs. By that time, the effects of such innovations were already noticeable so that a SUDEPE[5] normative decree (#466, 02/08/1972) was sanctioned to proscribe several predatory capture techniques (Falabella 1994). The year 1968 is recalled as being the beginning of predatory fishing by large fishing boats ("pesqueiros") in the middle Amazon (Ribeiro 1991). Smith (1979) studied fisheries in Itacoatiara in 1977 and briefly referred to conflicts and informal arrangements between lake residents and commercial fishing boats for access to restricted fishing spots. Some fishery agreements were made in the 1980s. By that time, rural artisanal fishers had started to exploit their own communal stocks with commercial purposes. By the mid-1960 the post-war jute boom had peaked, due in part to the introduction of synthetic fibers that replaced jute in many of its former markets. In the late 1980s the jute economy collapsed, for the Brazilian government permitted imports of south Asian jute, causing the price of Amazonian jute to drop precipitously. Formerly the main floodplain cash crop, the jute bankruptcy led riverine producers to turn their productive efforts to the fish market.

In 1989, SUDEPE and IDBF were dissolved and their mandates were incorporated into the newly created IBAMA[6]. In 1996, Itacoatiara's municipal congress sanctioned a decree to forbid commercial fishing in Serpa Lake. Nevertheless, it took eight years for the Amazonas' superintendence of IBAMA (IBAMA/AM) to acknowledge the conservationist efforts of riverine communities and municipal governments with respect to protection of local fish stocks. In 1997, IBAMA/AM proposed a partnership between riverine communities, Itacoatiara's municipal government, and its local office for implementation of a participatory fishery management program. This partnership is an ongoing process of negotiation. Despite the newness of this experience, the "boom" of fishery agreements conveyed in 1997 denotes the potential for implementation of co-management regimes.

Research design

A contextual and multilevel analytic approach (Boyd & Iversen 1979) was adopted to explain the variation among community management institutions and household behaviors, as the response variables. At the community level, the predictor variables are organizational contribution and resource competition and abundance. The predictor variables at the household level are household economic opportunity and structure. To control disjunctive causes statistically, observation units, that is, CPR situations, must be similar in most aspects except with respect to their local resource management practices. It is possible to find such natural configurations if all communities to be compared are located within a homogenous geographic and social milieu. In such case, each CPR situation can be treated as a natural experimental unit to which management practices have been applied (Pelto & Pelto 1993).

Phase One: Community inventory - During the first phase of research, lasting one year, an inventory of communities was conducted. I used a combination of diverse sources of

[5] SUDEPE: Superintendence of Fishery Development, created in 1962.

[6] IBAMA - Brazilian Institute of Environment and Renewable Natural Resources, created by Decree # 7735 (02/22/89).

information and *ex-situ* data-collection techniques to avoid problems of selectivity and sample bias and to ensure that effectively all established fishing communities were included in the inventory. Information was obtained with respect to geographic location, probable natural resource abundance[7], and prevalent type of fishery, community age and population size, and type of political organization. Satellite images and cartographic maps were used to obtain limnological and geographic information about the fishing grounds exploited by each community. Data on territoriality, fishing management and other community practices were obtained by interviewing community leaders and other key informants. From this inventory, communities were then classified according to the CPR typology (Table 2). The data gathered in this first phase of research were submitted to an exploratory cluster analysis. The resulting clusters of similar communities were used as the sample frame for the next phase of research.

Two major source for information were used in order to create a list of communities that could be used as a reference for the inventory: The Office of the Secretary of the Interior of Itacoatiara City and the Catholic Prelacy of Itacoatiara. The Prelacy counts only the original "Catholic" communities that are presently active. The office of the Secretary of the Interior has a database that started in 1993 and that also includes the non-Catholic "social" communities. The inventory created by this procedure included 62 communities - about 70% of all fishing communities within the 211 rural communities of the municipality of Itacoatiara.

Phase Two: Households' socioeconomic survey - In this phase, a sample of CPR situations was chosen from each homogenous cluster of communities (Kalton, 1983). They were selected according to the following hierarchical requirements:

1) Stratum sample proportional to stratum size.
2) Inclusion of at least one example from each sub-stratum.
3) Maximization of the diversity of aquatic environments and geographic regions represented by the totality of the sampled communities.

Total sample size was defined according to an estimate of the number of communities that could be properly surveyed in a 12-month period. A total of 12 communities were selected. Data were obtained in each community using household surveys by means of in-*situ* structured interviews, self-reported data, and participatory data collection techniques. Every effort was made to survey all households within each sampled community, if possible. In all cases, every family reachable at the time of the visit was interviewed.

Research hypotheses, data collection and analysis - In the generation of testable hypotheses, the evolution of local management institutions is divided into two stages: **emergence** and **maintenance**. Three nested levels of approaches are suggested for investigating the dynamics of common property institutions: (A) the **ecosystem** level; (B) the social or **community** level; and (C) the microeconomic or **household** level. In this paper, I present only results and discussions about hypotheses of emergence of CPR institutions at the ecosystem and household levels.

The Ecosystem and emergence CPR Institutions – According to theoretical predictions, severe competition and prolonged resource scarcity tend to lead the corporate custodian community to adopt norms that both restrict access to resources and limit resource withdrawal. Thus, it was expected that internal and external competition levels should be higher

[7] The types of aquatic habitat exploited by the community: whitewater or blackwater tributaries, main channel or floodplain lakes, were used as indicators for fish natural abundance.

in Type III CPR situations than in Type II and Type I CPR situations. The following hypothesis was proposed:

> **H_A**: Management institutions (Type III CPR) are more likely to emerge in situations where resource relative abundance is lower and competition is higher.

Level of competition among resource appropriators was indirectly measured by means of surrogate variables. The frequency of invasion by outsiders (larger commercial fishing boats or small-scale fishers from other communities) was used as an indicator of the level of external competition pressure. During each community inventory, interviewees were asked to recall episodes of invasion and report the dates, origin of the invaders, number and size of invading boats, how the community reacted to the invasion, and if the conflict had a resolution or not. Intensity of violation of fishing rules by local residents and number of local commercial fishers were used as indicators for internal competitiveness. Resident population size was also used to indicate level of internal competition. In order to estimate the relative abundance of local fish stocks, communal fishing spots were visited and plotted on a cartographic map and remote sensing images were used to determine environmental characteristics of the fishing grounds such as shape, location, hydrological regime (seasonal or perennial), and type of water.

Households and the emergence CPR institutions - A household is a crucial unit of analysis for studying economic behavior because the rationale for choices individuals make about their subsistence strategies reflects how a household's livelihood is maintained and reproduced (Wheelok & Oughton 1996). Because of this dependence, one expects to find causal relationships between a household's economic strategy (response variables) and its economic structural opportunities (explanatory variables). However, since households that are members of a community share the benefits and duties of a collective social organization, it is questionable whether households can be considered only as atomized units of economic decision-making. According to CPR theories, household's decisions must also be influenced by decision-making at the collective level.

For this study, a household economic strategy refers to how each family allocates its working time (either to wage labor and on-farm activities such as agriculture, animal husbandry, and extraction of forest products, or to fishing). Household economic structural opportunities refer to endowments of human capital and physical capital.

Appropriation dilemma and household structural opportunities - The initial costs that a management scheme imposes reflect the reduction in resource extraction level generated. This economic penalty will not be compensated for if individuals cannot switch to some other commercial or subsistence activities through which they can profit. Previous studies of the relationships between household structure and economic production strategies have suggested that households will select strategies that match their labor availability and access to land and other means of production (Schumann 1985). Compared to other farming activities, fishing requires fewer prior investments (such as land preparation and weeding) and less endowment of fixed capital (such as arable land). Thus, it is predictable that violation of fish withdrawal norms can become part of an economic strategy adopted by a household. Households will make rational decisions to rely heavily upon fish harvesting when there is a shortage of arable land and/or labor that otherwise would have been used to engage in compensatory activities, such as manioc agriculture, horticulture, or extraction of forest products. As a hypothesis, these theoretical considerations read:

> **H_B**: An individual household' compliance with a community management scheme depends on its economic structure and alternative opportunities to fishing as source of cash income.

Household economic structural opportunity was assessed in terms of size and quality of arable land available to the household, composition of familial labor force by age and sex, and presence/absence of equipment for production such as tools, machinery and other forms of fixed physical capital. Household economic behavior was assessed in terms of the composition of household annual income. Data on fishery practices and income were obtained during interviews when individuals were asked to recall their previous fishing expeditions and report the sites, duration, capture (quantity and fish species captured), and fishing techniques used during these expeditions, as well as the value of the catch or its sale price. I used an economic survey questionnaire that was developed in my previous study of floodplain traditional production systems to gather these data (Noda *et al.* 1995). Univariate analysis techniques were used to compare current households' economic structure and their corresponding economic production strategies. The economic structures of households with higher economic dependence on commercial fishing were compared with those who were less dependent.

RESULTS

Environmental Factors and the Emergence of CPR Institutions - The great majority of the studied communities presented some type of CPR regime, but a minority, about 32%, managed their fish resources in a regimen characteristic of open access (Type I CPR) (Table 4). It is interesting to note that about half of the communities of the open-access group already had evaluated the possibility of implementing a collective fishery agreement (Type I/b CPR).

Communities classified in Type III CPR presented diverse sets of operational rules. The most frequent subtype was subtype III/1.1, with which the communities aimed to restrict internal fish consumption through rules that reduce capture effort and increased fishery selectivity in communal waters. The decision between this or that regimen of common property was partly influenced by the geography and the ecology of the local resource and partly by the intensity of internal and external competition. The characteristics of the fishing spots (physical accessibility, dimensions, location with relation to the individual properties), and the abundance and concentration of fish stocks, largely determined the existence of territoriality, while the level of competition between authorized appropriators seemed to be the main factor affecting the presence or absence of measures to reduce resource exploitation rate.

All of the rules and practices used in the 62 communities regulated how fishing was done. That is, they limited location, time or technology. Only one community (62 V), and solely during one year, limited the amount of various species that could be caught. Acheson & Wilson (1996) analyzed fishing practices of 39 tribal and peasant societies of diverse geographic and cultural origins and reported similar findings. A general identification and classification of all inventoried communities are provided in appendix B.

Table 4 – Classification of the inventoried communities according to type of CPR (*).

CPR Type	Sub-type	Defense of exclusive territories	Commercialization allowed according to rules	Restrictions to capture techniques	total	%
I	a(**)	no	N/A	N/A	10	16.1
I	b(**)	no	N/A	N/A	10	16.1
II	-	yes	N/A	N/A	7	11.3
III	1.0	yes	no	no	6	9.6
III	1.1	yes	no	yes	18	29.0
III	2.0	yes	yes	no	0	0.0
III	2.1	yes	yes	yes	11	17.7

(*) For a complete list of communities refer to Appendix B.
(**) **a** - communities that never have had a fishery agreement, **b** – communities whose former agreement have failed or have never been effectively implemented. **N/A** =not applicable.

Operational regulations of CPR regimes

In this section several aspects of the operationalization of common property regimes are discussed. It is suggested that operational regulations must be a response to fishing spots' tenure regime, the perceived abundance of local resources, and the intensity and source of competition and disputes. Eight variables (questionnaire items) were analyzed comparatively in order to detect any possible pattern in answers (Table 5).

Open-access: Type I/a CPR I/a versus Type I/b CPR - The profile of average responses of Type I/a communities was quite distinct from those of Type I/b, despite the fact that the current common property regime was open-access in both groups (Figure 1). In Type I/a communities, community members tended to evaluate the abundance of local fish resources less favorably than in those of Type I/b communities; at the same time that there were fewer commercial resident fishers and a lower internal and external competition on average. Type I/a communities tended to own fishing spots that were shared by two or more communities (Figure 2 - SHARE). Shared fishing spots were generally large. This type of common-pool resource situation represented a double difficulty for the agreement to a collective contract of preservation. The dimensions of the area to be kept must be negotiated and negotiation involves different groups of appropriators. In Type I/a CPR (Figure 1, first bar), the lower competitiveness (upper column) seemed compatible with the absence of a scheme of collective property. On the other hand, in Type I/b communities, where in the past there had been attempts at implementing a regimen of collective property, the degree of internal and external competitiveness was similar to those of the communities of Type III. In Type I/b CPR (Figure 1, second bar), there was a distinguishably higher incidence of invasion by artisanal urban fishers (invUA) and of artisanal fishers of the neighborhoods (invNgb). These fishers were responsible for a small-scale commercial fishery that was active during all seasons. Perhaps the pressure of these commercial fishers was one of the reasons for the backtracking of the CPR regime of these communities to a situation of open-access. Also, Type I/b communities seemed to have a broader set of fishing opportunities outside their community territories. Together, Type I/a and Type I/b communities seemed to evaluate their local fishery abundance in a less favorable way than any other type of community, on average. This may also be related with their decision of not bearing the costs of a local management institution.

Table 5 - Variables and response code for assessing resource ownership status, perceived abundance, competitiveness and fishing opportunities.

Variable	Question as stated	Response codification
TENURE - Exclusively owned fishing spot	Does the community claim collective property rights on any fishing spot (lake, igarapé etc) in its territory?	(0) None (1) at least one
OPEN	Is commercial fishery allowed (free) in any of the community's lakes?	(0) No (1) Yes
CONFLICT	Participant observation, focus group interviews. Unsolved conflicts may exist that prevent the community from reaching a mutual agreement. Or, conflict may have raised between discontent appropriators and the collectivity.	(0) None (1) Unsolved conflicts
ABUNDANCE	Open–ended question: How good (bad) has fishing at community's fishing spots been?	Scale (3) Abundant (2) Normal (regular) scarcity between harvest seasons (flood peak) (1) Moderate scarcity during harvest season (0) Frequent zero capture fishing events
SHARE - Commonly shared fishing spot	Does the community share any of its fishing spot with any other community (ies)?	(0) None (1) At least one
FISH OTHER – Exploitation of other community's fishing spot	Do fishers from your community fish at any other community's lake?	(0) None or a few, only occasionally (1) Yes, several, many, very often
Fisher's categorization: SUBS COMMERC PROF	Does any community's fisher sell his fish crop? Fishers were classified into three category: Subsistence, Commercial, Professional (unionized)	(0) none (1) some (2) all
Type and intensity of invasion: (A)CM (B)Ngb (C)UA (D)FB	Invaders were classified into four categories: (A) Community members (B) Neighbor (rural artisanal) (C) Urban based artisanal (D) Commercial Fishing boats	(0) Not cited (1) Few, not so often (2) Many, consistently

Exclusive Fishery Territories: Type II CPR - Communities where the regimen of collective property only prescribed the exclusiveness of the access to communal areas registered a lower degree of competitiveness and greater degree of perceived abundance than any other group of communities (Figure 1 - ABNDC). These communities tended to depend on surrounding fishing spots that were exclusively used by the community (Figure 2). Besides the low index of fishery conflicts (Figure 1 - CNFLT), fishers of these communities generally did not fish in territory of other communities (Figure 2 - FISHOTHER), while at the same time they did not share their fishing spots with fishers of neighboring communities (Figure 2 -SHARE).

In circumstances of larger perceived abundance of local resources and lower internal competitiveness, it was more viable to remain a regimen Type II than to change to Type III. Professional fishers (Figure 1 - invFB) were cited as the main invaders by these Type II communities. These fishers used equipment of larger capacity (lampara seines) capable of

completely depleting a lake's fish stock during a single season. Perhaps, therefore, these communities did not regulate the capture effort of the group of authorized appropriators (rural artisanal fishers), but only denied access to those not authorized, especially urban professional fishers from Manaus and neighboring states, mainly from Pará and Amapá states.

"Lake Preservation": Type III/1 versus Type III/2 CPR - The risk of scarcity of a collective use resource, despite being a sine qua non condition, does not by itself justify the implementation of a management scheme (Type III CPR). It is necessary that the level of internal competition among authorized appropriators be raised to a point that justified the effort not only to restrict access but also to regulate the intensity of resource exploitation. Internal withdrawal restrictions may increase the level of invasion by authorized appropriators (Figure 1 - invCM) and may explain why Type III communities had the highest incidence of resource cheaters.

The distinction between III/1 and III/2 Types of CPR is the total prohibition of commercialization in the first. Artisanal fishers from the neighborhoods and urban areas were more intensely cited as invaders in Type III/1 than in Type III/2 communities. In the majority of cases, invaders were associated with local residents with whom they had privately negotiated access to the community's resources. This kind of invasion was severely fought against and frequently generated conflicts and disagreements in the communities. Communities of Type III/1 were more dependent on exclusive fishing spots than those communities of Type III/2 (Figure 2 - SHARE, FISHOTHER). They did not share communal waters with other communities and fish less frequently in waters of their neighbors. Communities that adopted a Type III/1 regime considered their local fish stocks to be less abundant than those that adopted a Type III/2 regime (Figure 1 - ABNDC), following the trend of lower relative density of local resources. Communities that adopted a fishery agreement of Type III/2 were more likely to have other communal fishing spots that were managed in an open-access regime (Figure 2 - OPEN). This higher perceived abundance might explain why commercialization of fish captured in territorial waters was allowed according to rules in Type III/2 situations. In these communities, the level of unsolved conflicts was critical (Figure 1 - CNFLT) despite the fact that this kind of flexibility could reduce the level of tension (dissatisfaction) with rigid norms of appropriation.

The high incidence of invasion by professional fishers and resident fishers in these communities indicated that commercialization rules were not easily obeyed or enforced. It is probable that the majority of the CPR agreements of Type III (65%) were of the subtype I/1 because in these agreements the operational rules were simplified through a total prohibition of commercialization and large-scale fishing tools. Controlling how people fish minimizes information and enforcement costs, which makes it possible to generate more effective management institutions (Acheson & Wilson 1996). Controlling how much and which fish species people exploit and export, by way of contrast, tends to increase both kinds of costs, with detrimental effects on institutional efficacy.

Annual versus Seasonal CPR - A second group comparison of importance differentiated between annual and seasonal CPRs (Figure 3). For this comparison, only CPR Types II and III were considered. Invasion by professional fishers (invFB) and fishery conflicts were the main features that differentiated the average response of the annual group from that of the seasonal CPR group of communities. Invasion by urban professional fishers was more frequent among annual CPR situations. In these communities, fish agreements were valid not only during low-water season but also during the flood when teams of large-scale fishers transferred their activity locus from the river channel to the floodplain lakes. From December until March, after the end of the channel catfish harvest season, it was expected that commercial fishing boats from

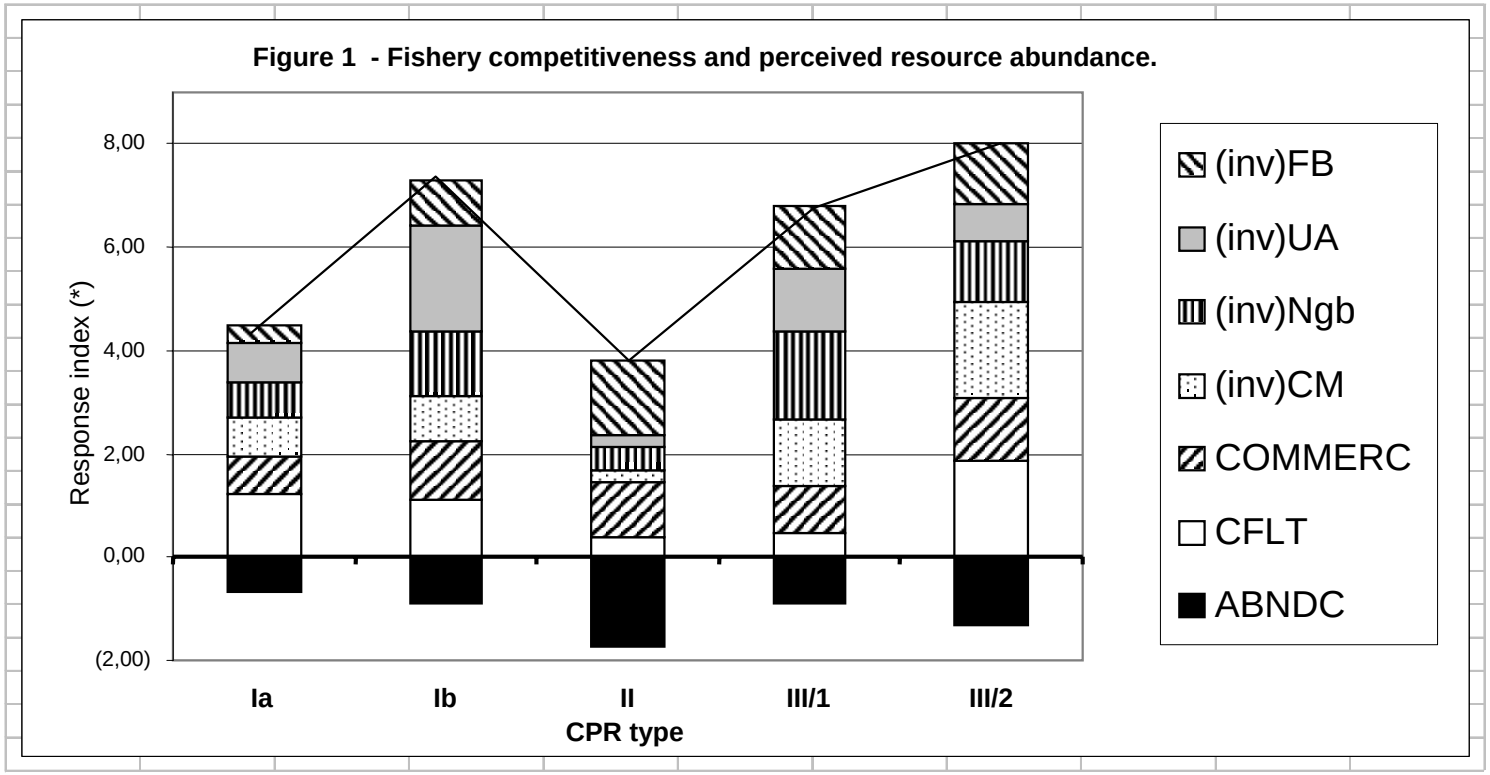
Manaus and Pará State would invade Itacoatiara's flood deposit lakes to capture mapará (*Hypophthalmus* sp.) and pescada (*Plagioscium* sp.) (Isaac 1996).

In seasonal CPR situations, artisanal fishers were the main invaders (invART = Community member + Neighbor + Urban). Communities with seasonal CPR regimes defended smaller and more exclusive fishing spots (bar-and-meander lakes) that were targeted by small-scale fishers from Itacoatiara City and its rural area. Rural artisanal fishers from the communities' neighborhood were more often cited as the main invaders in these situations. This type of invasion was more likely to generate unsolved internal conflicts since invaders and claimants were of similar social and residential status. Community members and neighbors were blamed for harvesting fish from the community's reservoirs to sell their clandestine crop in Itacoatiara or to the "*recreio*"[8] boats that take fish to Manaus. These fishers targeted two main fish species: pirarucu (*Arapaima gigas*) and tambaqui (*Colossoma macropomum*). Tambaqui and pirarucu species are listed as endangered and thus are protected by federal laws. The pirarucu fishery is now closed until the year 2000 and tambaqui has a minimum size for capture. From 10/01/92 till 03/31/93, 15.7 tons of pirarucu were landed at Manaus. This period corresponds to the species' reproductive season and the amount captured comprised 51% of all commercial species (Fallabela 1994).

Artisanal lake fisheries were much more productive during low-water season, i.e., when fish stocks were locked in the shrinking floodplain pools. Thus, during low-water season, the community had to enforce withdrawal norms because the lakes become more tempting to opportunistic fishers. When channel water invades the flood plain during the inundation, all lakes become interconnected and the levees become submerged. At that point, fishery productivity decreases and the lakes' boundaries are no longer distinguishable. Another key point is the alteration of physical access to floodplain lakes. During the flood, invaders can approach communal lakes "backwards" and not be noticed. All together, it sounds quite logical to loosen the fishery agreement during flood season to reduce its enforcement costs. Thomas (1996) described similar behavioral patterns for an African floodplain communal fishery and Brabo (1981) for continental fisheries in the estuarine zone of the Amazon River.

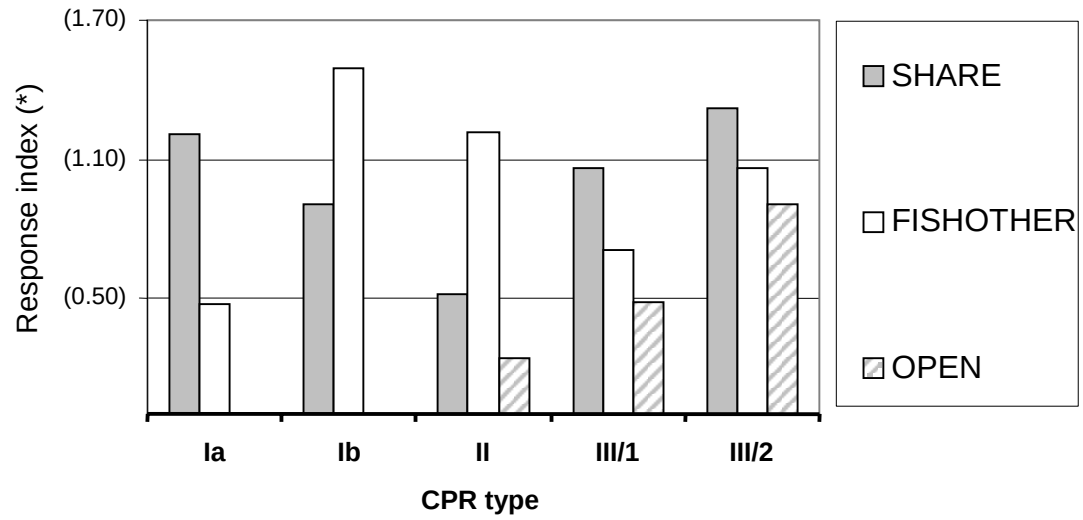
Abundance is a minor difference between annual and seasonal CPRs. Community members from annual CPR situations consider their local fish stocks to be more abundant than those that adopt seasonal fishery agreements. This difference might also be related to a higher incidence of invasion by professional fishers reported by annual CPR communities.

[8] Recreios are large regional boats that transport passengers and cargo between riverine towns and localities.



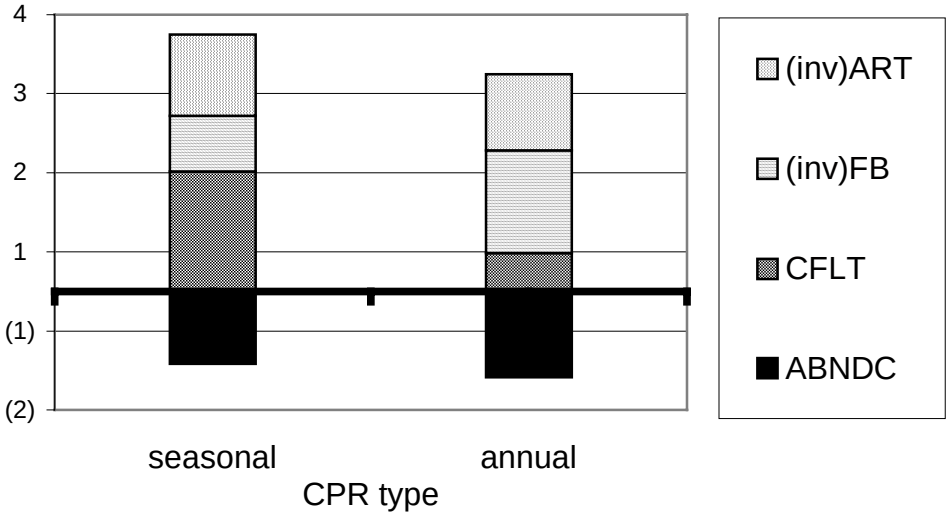
(*) Response index = group average response divided by overall average response. (inv)FB= Fishing Boats; (inv)UA = Urban Artisanal; (inv)Nbg = Neighbors; (inv)CM = Community Members; COMMERC = Commercial resident fishers; CFLT = Conflict; ABNDC= Perceived Resource Abundance. Type II CPR (exclusive fishing territories) communities showed the largest perceived abundance of local fish resources (lower bar) and the weakest internal competitiveness (upper bar). Type I/a (open-access) communities had the lowest level of perceived resource abundance and the weakest external competitiveness. Type I/b (failed CPR) communities had a profile similar to those of Type III CPR communities. Type III/2 CPR communities profile were distinct from that of Type III/1 CPR for their higher levels on internal competitiveness and perceived local resource abundance.

Figure 2 - Ownership status and fishing opportunities



(*) Response index = group average response divided by overall average response SHARE = Fishing spots shared with other community; FISHOTHER = Exploitation of other community's fishing spots; OPEN = community's fishing sport exploited commercially. Type I/a communities tended to share the ownership of their community fishing spots. Type I/b communities had more opportunities to exploit other communities' fishing spots. Type II CPR communities were more dependent on exclusively owned fishing spots. Type III/2 communities had more fishing opportunities than Type III/1 communities did. They also were more likely to make some of their fishing spots accessible to outsiders and for commercial exploitation

Figure 3 - Resource competitiveness and perceived abundance.



(inv) ART = urban and rural artisanal fishers; (inv)FB = Fishing Boats; CFLT= Conflict; ABNDC = Abundance. Small-scale artisanal fishers were more important as invaders for communities that adopted seasonal CPRs. Large-scale commercial fishers were the main invaders of communities with annual CPRs. Unsolved fishery conflicts were twice as much common in seasonal than in annual CPRs.

Population size, internal competition and type of CPR regime

The population growth analysis did not disclose any regularities with regard to type of CPR with possible exceptions in the case of the communities with CPR of Type II (only positive growth) and III/1.0 (only negative growth) (Figure 4). Communities with both negative and positive growth existed in all other sub-groups of CPR. However, it seemed that a broad demographic trend might exist. In the figure, the thicker vertical line divided the communities in two grand groups: on the left (CPR I/a + CPR I/b + CPR II + CPR III / 1.0) and on the right (CPR III/1.1 and CPR III/2.1). Communities on the right possessed fishing agreements that limited individual capture effort; these communities were once larger in size than average, with exception of only six communities (6/22). No community to the left of the graph was larger than average in 1987 with exception of two communities (2/17).

Communities' decision-making on type of CPR regime and especially on inclusion of withdrawal norms is based on internal population pressure. The probability that these ratios were due to random factors was less than one tenth of 1% (Fisher's exact p two-tailed < 0.001). As foreseen in the theoretical models, less populous communities experienced a lower pressure of internal competition for resources and therefore they did not need to limit the capture effort of their members. On the other hand, populous communities suffered higher pressure of internal competition, which justified the inclusion of operational rules that limited individual capture in the communal fishing spots.

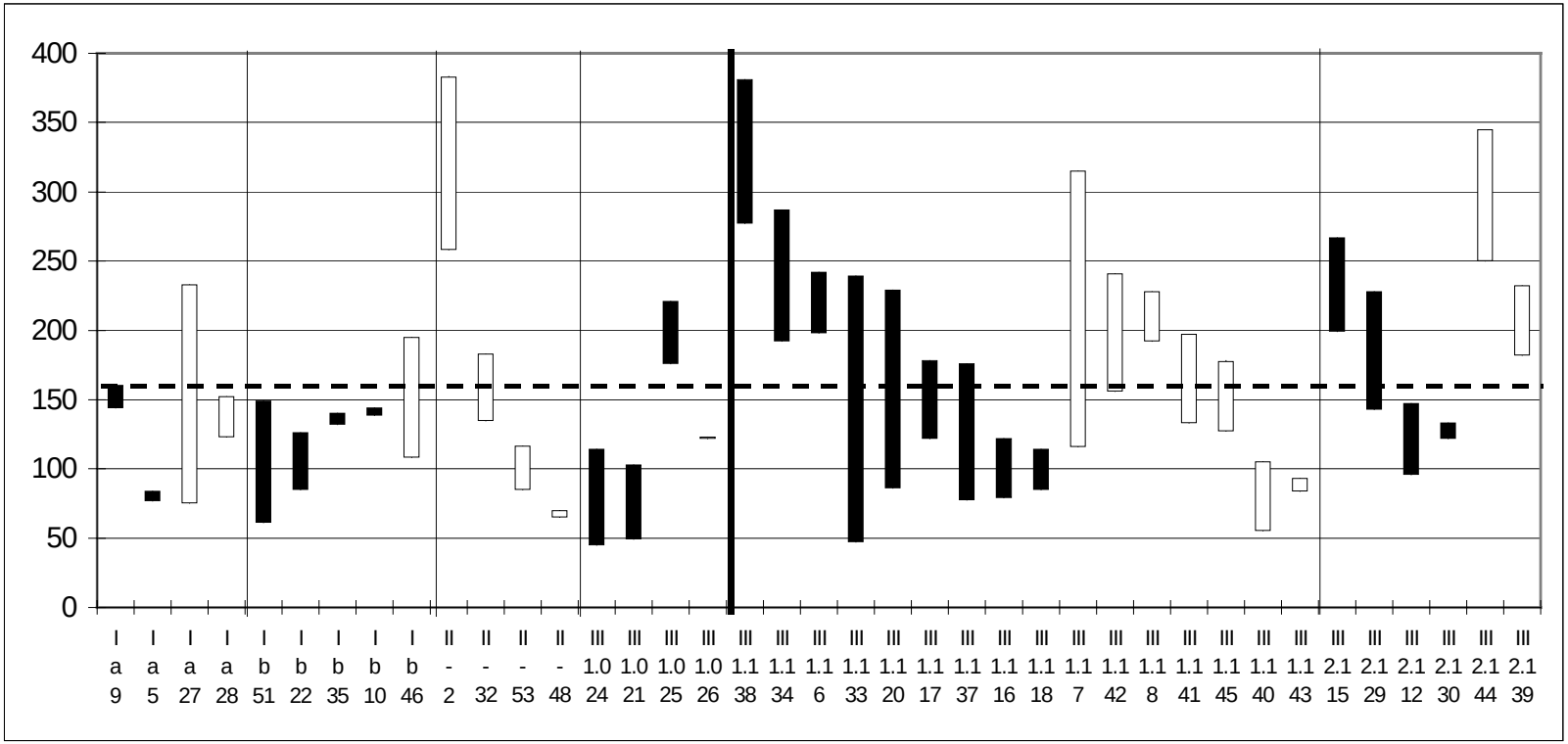
Higher population density, *per se*, can lead to greater internal competition. In addition, reduced natural abundance of resources also causes greater competition among resource appropriators at similar population densities. This problem seemed to be the case for at least two of the exceptions found among CPR Type III/1.1. Communities 40th (São Miguel do Igarapé do Bonifácio) and 43rd (São Sebastião do Lago Moura) were located on small black-water tributaries where fish stocks are normally less abundant.

Household economic factors and emergence of CPR Institutions

One of the greatest difficulties for communities that adopted the management of lakes was the internal pressure of fish consumption. In many cases, the management scheme are impeded because the community's members themselves were dependent on commercial fishing to support their households, without other economic alternatives. In Itacoatiara, the absence of economic alternatives generally was associated with the impoverishment of the households after the decline of jute industry because of restricted access to arable land suitable for other agricultural crops and cattle raising. For acceptance of fishing restrictions, it is essential that land and capital be available so that families can invest in economic activities alternative to fishing, such as agriculture, animal production, and collection of forest products.

The results of the socioeconomic survey of 174 riverine households of the Itacoatiara region were used to compare the structures of economic opportunities and economic strategies of two different groups of households: commercial and subsistence fishers. Two different analyses were made: one included all surveyed households; in the other, households of CPR Type III/1.1 were excluded. The need for this second analysis comes from the fact that in CPR III/1.1 situations, households were "forced" to adopt an economic strategy that excluded fishing for a profit. The category of "*pescador*" (fisher) was used by the riverine people to differentiate families who "live by fishing" from those others who live by domestic animals ("*criadores*" = ranchers) or plant products ("*feirantes*" = market sellers).

Figure 4 - Demographic trends of communities (1987-1998) and their present CPR regimes.



On the horizontal axis is the information that identifies each community and its type of CPR. The vertical axis expresses the number of inhabitants in each community in the years of 1987 and 1998, in absolute numbers. The dashed horizontal line indicates the average population of the communities, including all shown communities (1987 = 160 inhabitants; 1998=154 inhabitants.). Each vertical line divides the communities in sub-groups in accordance with the type of CPR. White bars mean positive while those dark bars indicate negative growth. The size of the bars indicates the population variation of each community in the referred period.

Eighteen variables that accounted for the economic strategy and structural opportunities of households were assessed (Table 4). Households' economic strategy was interpreted as being the group of activities a family engaged in order to obtain cash income. The amount of productive effort dedicated to a given activity was measured as the actual revenue gained by the household in each activity engaged in during the past production cycle and the monetary (exchange) value of animal and plant stocks. The amount of available land, ownership status, and the age structure of the familial labor-force depicted the structural opportunities.

Table 4 – List of variables used to characterize household economic strategy and structural opportunity.

VARIABLE	DESCRIPTION
Strategic	
stock$	Market value of all domestic animal herds owned by the household.
Animal	Annual revenue obtained from selling animal products: cheese, milk, meat and eggs.
Agriculture	Annual revenue obtained from selling plant products: agriculture and silviculture.
Stock2$	Market value of the product of perennial and semi-perennial plantations (one production cycle).
Retire	Annual revenue from governmental pensions (social security) ("*aposentadoria*")
Salary	Annual revenue from formal jobs held in the community: e.g. local schoolteacher.
Off/farm	Annual revenue obtained from temporary jobs ("*diarias*"): carpenters, rural workers etc.
Structural	
Goods	Total estimated value of production goods: house, canoes, machinery, tools etc.
M>60	Number of resident males older than 60 years
F>55	Number of resident females older than 55 years
14<M<60	Number of resident males 14 to 60 years old
12<F<55	Number of resident females 12 to 55 years old
M<14	Number of resident males younger than 14 years old
F<12	Number of resident females younger than 12 years old
TFLand	Area of land available in terra-firme areas
Tftenure	Ownership status of terra-firme land
VZLand	Amount of land available in várzea areas
Vztenure	Ownership status of várzea land

Commercial fishers' households, on average, had similar performance in all the evaluated economic strategies with the exception of "Stock2$" (Table 5). Subsistence fishers' households had a stock of perennial crops almost five times greater than that of commercial fisher's families, on average. When Type III/1.1 communities were excluded, the analysis showed another significant difference between the two groups. In communities where fishery for a profit was allowed, commercial fisher's households tended to sell a greater amount of their plant harvests. In addition, most commercial fisher's households still cultivated and sold jute, a non-food agricultural product. Jute corresponded to 10 to 40.5% of the annual agricultural income of a community.

Riverine families can exploit two different types of ecosystems: the floodplain (várzea) and the dry-land (terra-firme). One notices that the average composition of the families' land holdings inverts when the two groups are compared. Families of subsistence fishers possessed on average 40 ha of terra-firme land and 20 ha of várzea, while commercial fisher's families possessed on average 10 ha of terra-firme and 28 ha of várzea. Floodplain areas are workable only for 4 to 5 months of the year; their seasonal inundation is a strong obstacle to the cultivation of perennial or semi-perennial species. In the floodplain, the culture of banana, the main agricultural product after cassava, is very susceptible to annual floods.

Table 5 – Kolmogorov-Smirnov two-sample test: subsistence fisher's vs. commercial fisher's households.

	ALL CASES			CPR≠III/1.1		
VARIABLE*	SUBS FISHERS	COMM FISHERS	p-value <	SUBS FISHERS	COMM FISHERS	p-value <
Strategic						
stock$	-	-	n.s.	(4,416.02)	(3,288.20)	n.s.
(cattle)				(32)	(9)	(.29)
Animal	-	-	n.s.	-	-	n.s.
Agriculture	-	-	n.s.	1,136.33	1,926.73	.05
Stock2$	2,854.86	626.64	.001	2,434.27	652.27	.05
Retire	-	-	n.s.	-	-	n.s.
Salary	-	-	n.s.	-	-	n.s.
Off/farm	-	-	n.s.	-	-	n.s.
Structural						
Goods	-	-	n.s.	-	-	n.s.
M>60	-	-	n.s.	-	-	n.s.
F>55	-	-	n.s.	-	-	n.s.
14<M<60	1.84	2.56	.05	1.74	2.62	.05
12<F<55	-	-	n.s.	-	-	n.s.
M<14	-	-	n.s.	-	-	n.s.
F<12	-	-	n.s.	-	-	n.s.
TFLand	40.11	10.19	.001	31.35	10.60	.01
Tftenure	61.94%	23.07%	.001	56.86%	24.00%	.01
VZLand	20.52	28.11	.01	31.67	27.9	n.s.
Vztenure	35.71%	65.38%	.01	52.9%	66.0%	n.s.
N	113	52		51	50	

* Currency values are expressed in 1.00 R$ (~0.50 U$ dollars).

The size of animal herds, especially cattle, was on average 3.5 times greater in non-fisher's households. Domestic animals were an important source of income and food, mainly during the flood when fishing is less productive. To be able to augment their animal herds, riverine families needed to make use of areas in terra-firme where the animals could be transferred during the flood. However, only 24% of the commercial fisher's households possessed some area in terra-firme, against 72% of the families of "market sellers" and "ranchers". Moreover, families who did not hold the definitive ownership of areas of terra-firme that they occupy were not eligible for agricultural development programs (bank financing) and therefore did not receive incentives to invest in the increase of the agricultural production and animal husbandry.

With respect to familial labor-force, there was a clear distinction between the two groups of economic strategy. Commercial fisher's households had 50% more males of productive age and were "younger" than subsistence fisher's households, on average (Figure 5).

In fact, as respondents reported, bigger and younger households were more likely to engage in the commercial fishery than elder ones. Generally, households whose heads were younger couples did not possess their own land and depended on their parents' or parents-in-laws' land for a living. This feature may explain their lower rate of land tenure. Also, in younger households, most offspring still lived in the same house, causing the production/consumption ratio to be less favorable in these families (0.57±0.21 SD) compared to elder ones (0.63±0.25SD). In addition, younger families' land holdings were smaller and could not be

further divided among descendents. This dilemma was also an important reason for unmarried adults to stay with their parents.

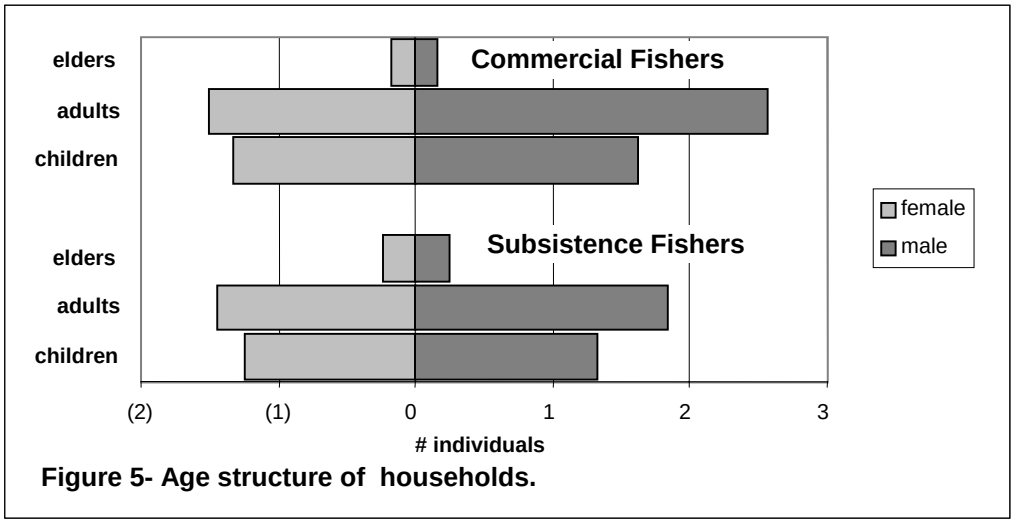


Figure 5- Age structure of households.

In commercial fisher's households, adult males tended to remain longer at their parents' house then females did. Females were more mobile than males since they could leave their parents' house to join their in-laws' family or migrate to the cities as housekeepers. An adult male will stay longer if his parent's lands are not large enough for him to constitute a separate household. In conclusion, it can be said that the structure of economic opportunities was a determinant factor for household decision-making and that the option for commercial fishery was a consequence of such a limited set of opportunities.

CONCLUSIONS

Rates of resource exploitation in less developed countries are often claimed to be exceedingly high; an allied claim is that the resulting pattern of management of natural resources is inefficient. This observation is the starting point of an abundant literature that identifies the main source of inefficiency in the absence of well-defined property-rights and in regimens of open-access. Garret Hardin used the expression "the tragedy of the commons" to restate this position in his seminal article (Hardin 1968). However, according to current anthropological thinking, traditional local management systems have been the rule rather then the exception in much of the developing world.

A common-pool resource situation was defined as the combination of a group of people and the resources they used collectively. Early analysis of this situation tended to be pessimistic and irregular, in that it was permeated with confusion about vital differences between open-access and common-property regimes. The two are distinguished by the regulations that govern

their use and by the power to exclude outsiders. Both of these considerations are the essence of common-property regimes (CPR).

Debate has now progressed, and one important focus for research is the internal and external conditions that make CPR institutions robust. It is believed that as long as these systems have been in existence, they have been fairly successful in conserving the natural resources at stake. Unfortunately, many of these systems have broken down as a result of the disruptive impact of external forces such as centralized government polices, population growth, and broad market forces.

The case of the CPRs of the Amazonian fisheries deserve special attention, for unlike fisheries elsewhere, the intensification of commercial fishing in the Amazon has not led to the breakdown of subsistence fisheries. Much to the contrary, it seems that such external forces have led the local groups of resource users to create new local management institutions or to reinforce and modernize pre-existing ones. In the Brazilian Amazon, since the 1970's, several riverine communities have demanded political and legal support for their traditional management practices and property rights.

It is not only in the Amazon River that CPR management groups have received increasing amounts of attention over the past two to three decades. CPR groups are active in all the areas of natural resource management: forest, water, and pasture resources. Reform in all these sub-sectors, and a renewed emphasis on collective action and user participation more generally has highlighted the importance of CPR groups. It is therefore critical that their strengths and weaknesses, and the likely boundaries of their activity should be well understood.

There seems to be growing consensus that, when groups function as intended, common-property regimes have been more effective than a central agency in managing resources. Unlike government bodies, CPR groups have a direct stake in the future of the resource that they are managing. They also have ready access to information about members' needs and can react quickly to changes. This combination of interest and efficacy means that both incentives for good management and the ability to manage well are enhanced. Thus, the idea of decentralizing natural resource management to local communities is increasingly gaining acceptance in policy making and in people-centered development projects. However, not all the outcomes of attempts to understand and encourage local management institutions have been positive.

My theoretical goal in this study was to form an integrative approach of ecological theories of human territoriality, under the paradigm of rational-choice theory of collective action. With this work I attempted to establish epistemological connections between the human component and the environmental components of CPR situations.

The first general conclusion was that Amazonian fishing communities, like many other rural societies, have the capacity to organize themselves. Further, their members were able to make credible commitments to monitor each other's behavior and impose sanctions on those who displayed inappropriate behavior. Each community devised its own management institution to fit its needs by a long process of negotiation. Each community had its own set of operational rules that had to be both socially and ecologically acceptable. Some of these communities were very successful in creating and maintaining their management institutions. And the most important mechanism for that success was a change in their assessment of the impact of their own harvest practices on local fish stocks, especially in Type III communities.

Amazonian riverine communities' way of life is very traditional. They have assimilated their indigenous legacy to cope with the challenges of an amphibious habitat: the flood plain. But these communities, as social organisms, are far from inert, as the term traditional often suggests.

Awareness of ecological stress under conditions of increasing human pressure on the environment has led these societies towards an increased causal understanding of natural phenomena. They have made radical revisions of old systems of beliefs so humans now are considered important agents of ecological change. In general terms, it seems that they have adjusted their traditional common-property regimes to be a more efficient social mechanism to assure their subsistence and cultural needs under situations where resources are under high exploitation pressure.

Contrary to what had been initially thought about the "lakes preservation movement" and its unexpected political nature, results of the first phase of the research suggested that this movement should be understood as being more than just individual reactions of riverine peoples to the changes occurring in their very local social and physical environments. Their common property regimes are better seen as adaptations of these communities as social institutions to the internal and external pressures and economic changes they experience with respect to the exploitation of their local stock of natural resources. In the case of the Itacoatiara region, the key resource is fish, a natural resource whose "use-value" is greater then its "exchange-value" for most of the riverine communities (Marx, 1995). The economic changes that occurred and are occurring in the region have reflected the large-scale political scenario in which these local communities are embedded. The conservationist attributes of many local fishery agreements also signify that the lake preservation movement should not be merely viewed as a "territorial" dispute between resident and non-resident fishers.

During the second phase of this research, each community selected was investigated in depth. The CPR regime of each selected community was studied from the households' point of view. By centering the focus on a single community at a time, it was possible to unveil the particularities of each situation, to refine and quantify the first phase findings, and to derive some conclusive answers to the research questions initially proposed. The evolution of a commercial fishery and of floodplain agriculture in the Itacoatiara region was studied and this information allowed a contextual interpretation of the final results.

As predicted, territorial defense increased with higher external competition for local resources, and restrictions on individual level of appropriation increased when resources became scarcer relative to internal consumption pressure. Complemented by the microeconomic household perspective, these two sets of "environmental" factors seemed to explain the arrangement of fishing rules observed in each community. As expected, open-access regimes (CPR I/a) were found in situations where perceived resource abundance was at its lowest level and internal and external competition pressure was moderate. Failed management schemes (CPR I/b) were found in situations where external competition pressure exceeded a point such that the community could not bear the costs of controlling resource exploitation. Type II CPRs were found where perceived local resource abundance was higher and competition pressure lower than the overall average. Management schemes (CPR III) were found in situations where fish resources were perceived as moderately abundant and internal competition more intensively felt. Household economic structure and opportunities were shown to be correlated with household decisions with respect to compliance with the community's management scheme. For a household, the quality and the amount of available land, ownership status, and the age structure of the familial labor-force were essential for acceptance of fishing restrictions.

The combination of ecological and economic theories and a more comprehensive contextual analysis allowed the elucidation of the complexity and the diversity of the common property regimes of Amazonian riverine communities. These communities have developed

institutions that differ from those of caiçara fishers in the Brazilian Atlantic coast (Begossi, 1998) and from those of lobster fishers of Maine (USA) (Acheson & Wilson 1996). Caiçara people and American lobster fishers based their management scheme on the "privatization" (individual ownership or ownership by groups - "harbor gangs" or extended families) of fishing spots or the products of the fishery, while the Amazonian riverine people, especially those of Type III communities, based their management schema on the collective ownership and defense of territories and the harvest of communal fishing spots. For Itacoatiarans, no individual or private group holds the right to alienate (to sell, to exchange, to transfer) a fishery territory. On the other hand, any individual belonging to the community holds the right to exclude non-authorized fishers and to influence management decisions. Therefore, they are “proprietors” not “owners” of the lakes in the terms of Schlager and Ostrom (1993).

While environmental factors, namely the relative density and level of competition for the resource in question, facilitated the emergence of regimes of collective property, internal microeconomic factors determined the degree of local compliance and success in maintaining such regimes. Household structures of economic opportunities sometimes made adherence to a conserving management scheme difficult by initially impeding its adoption or promoting its posterior dissolution. This defection happened when participant households could not change their economic strategies from commercial fishery to a purely subsistence fishery. However, being more than a simple result of human territoriality, many community management institutions (CPR III/1) were capable, either through relations of mutual aid, reciprocity, or advantages of exclusive use of local resources, to reach a high enough degree of compliance to maintain the internal fishery agreement.

However, household economic decisions, when looked from the perspective of their communities, showed that the relationship between households, the individual units, and the community, the collective unit of economic decision-making, was dialectical in its nature. Households are the organic constituents of a democratic collective organization, the community, where social contracts are attained not only by undisputed universal consensus but also by peer pressures. Contrary to what has been unanimously suggested in the CPR literature, I do not think that the existence of an effective sanction system is a major determinant of success in CPR regulation schemes (Baland & Platteau 1996). Although eventually necessary, negative forms of coercion such as sanction and punishment can not be the internal mechanisms for the building a functional collectivity. Public punishments are costly actions not only to the violators but also to the prosecutors. In small social groups, such as rural communities, where person-to-person direct relationships are the bases for social life, ostracism is the most efficient form of punishment but it also represents a tremendous threat for the group's existence itself.

For instance, to make a common-pool resource management an attractive collective goal and to mitigate the initial impacts of its adoption, community membership should offer enduring advantages and economic alternatives to the familial units so as to lead them to take the necessary economic decisions, decisions that may be detrimental to them in the short term. The importance of such positive constructing mechanisms has received little attention in the institutional analysis of common-pool resource groups. These positive mechanisms may prove to be a more decisive mechanism for the establishment of successful common-property regimes.

To be able to save their fish stocks, the communities and their members reduced the commercialization of local fish stocks at the same time that they invested in agricultural and animal production activities as substitute sources of cash income. These institutions possessed an unquestionable conservationist character for they implied "subsistence decisions that are costly

to the actor in the short term but aimed at increasing the sustainability of the harvests in the long term" (Beckerman & Valentine, 1996).

For Aguilera-Klink (1994) common property is not a tragedy as long as it exists as an institution or a set of rules appropriate for its management. These community institutions are based on the right of collective appropriation of fish spots. The contending parties, professional fishers, and community members alike, generally recognize such a right, despite its illegality. It appears to be based on shared cultural values. This recognition confers to the parties the authority to negotiate an endogenous solution for their disputes.

Fishing communities of the Middle Amazon are eloquent examples of the fact that common property is not necessarily a tragedy as long as it exists as an institution or a set of rules appropriate for its management. If an implacable tragedy exists, it is the tragedy of a state and of a society who ignores this logic and subverts traditional local institutions that adequately govern their common-pool resources.

References

Alguilera-Klink, F. 1994. Some notes on the misuse of classic writings in economics on the subject of common property. *Ecological Economics* 9 (1994): 221-228.

Acheson, J. M. & J. A. Wilson. 1996. Order out of chaos: The case for parametric fisheries management. *American Anthropologists* 93(3): 579-594.

Baland, J-M. & J-P. Platteau . 1996. *Halting Degradation of Natural Resources: Is there a role for Rural Communities?* FAO/Claredon Press.

Barthem, R. B. 1995. Development of Commercial Fisheries in the Amazon Basin and Consequences for Fish Stocks and Subsistence Fishing. In *Brazilian perspectives of sustainable development of the Amazon region*. / edited by M. Clusener-Godt and I. Sachs. Paris, Unesco; Carnforth, Lancs, UK; Pearl River, N.Y., USA, Parthenon Pub. Group. Series: Man and the biosphere series, v. 15. Chapter 9.

Bates, R. H. 1988. Contra Contractarianism: Some reflection on the New Institutionalism. *Politics and Society*, 16(1988): 387-401.

Bayley, P. B. 1995a. Sustainability in Tropical inland fisheries: the manager's dilemma and a proposed solution. *In* M. Munasinghe and W. Shearer (eds.), *Defining and measuring Sustainability: the biogeophysical foundations*. The World Bank, Washington, DC 321-328.

_____ 1995b. Understanding Large River-Floodplain Ecosystems. *BioScience* 45(3): 153-158.

Bayley, P. B. and Pretere, M. 1989. Amazon Fisheries: Assessment Methods, Current Status and Management Options, p. 385-398. In D. P. Dodge [ed.] Proceedings of the International Large River Symposium. *Can. Publ. Fish. Aquat. Sci*. 106.

Beckerman, S. & P. Valentaine. 1996. On Native American Conservation and the Tragedy of the Commons. Current Anthropology (37) 4: 659-661.

Begossi, A. 1998. Property rights for fisheries at different sacles: applications for conseration in Brazil. *Fisheries Research* 34(1998): 269-278

Berkes, F. 1985. Fisherman and 'The Tragedy of the Commons'. *Environmental Conservation* 12(3): 198-206.

Boyd, L. H. & Iversen, G. R. 1979. Contextual Analysis: Concepts and Statistical Techniques. Wodsworth: Belmont, California.

Brabo, M. J. C. 1981. Pescadores, Geleiros, Fazendeiros: Os Conflitos de Pesca em Cachoeira do Arari. *Boletim do Museu Paraense Emílio Goeldi, Nova Série* : *Antropologia*, Belém (77) : 1 -22.

Carney, D. & J. Farrington. 1998. *Natural resource Management and Institutional Change*. London: Routledge. 120p.

Cashdan, E. 1983. Territoriality among Human Foragers: Ecological Models and an Application to Four Bushman Groups. *Current Anthropology* 24(1) 47 - 66.

Cernea, M. M. 1991. *Putting people first: Sociological Variables in Rural Development*. 2 ed. A World Bank Publication.

Coleman, J. S. 1990. *Foundations of Social Theory*. Harvard University Press: Cambridge.

Costa, L. R. F. 1998. *Subsídios ao manejo do Tambaqui (**Colossoma macropomum** Cuvier, 1818) na várzea do Médio Solimões: Pesca, Dinâmica de População, Estimativa de densidade e dispersão*. Master Thesis. Manaus: INPA/FUA. 77 p.

Dyson-Hudson, R. & E. A. Smith. 1978. Human Territoriality: an ecological Reassessment. *American Anthropologist* 80 (1): 21-41.

Fallabela, P. G. R. 1994. A pesca no Amazonas: Problemas e soluções. 2nd. ed.Manaus: Imprensa Oficial. 180 p.

Forsberg, B. R. *et al*. Autothrophic Carbon Sources for Fish of the Central Amazon. *Ecology* 74(3): 643-651.

Hardin, G. 1968. The Tragedy of the commons. *Science* 162:1243-48.

Hartmann, W. 1992. Por uma co-administração de recursos pesqueiros em águas interiores da Amazônia: o caso das comunidades ribeirinhas e pesqueiras do lago Grande de Monte Alegre. *In* Populações Humanas, rios e mares da Amazônia, proceedings of the IV Encontro de Ciências Socias e o Mar no Brasil. June 6-9th 1990, São Paulo. (mimeo)

Heckathorn, D. D. 1996. The Dynamics and Dilemmas of Collective Action. American Sociological Review 61(April):250-277.

Isaac, V. J. 1995. Reflexões sobre uma politica de desenvolvimento da pesca na Amazônia. In: MMA/IBAMA/DIREN, *Programa piloto para proteção das florestas tropicais do Brasil*: Manejo dos Recursos Naturais Renováveis. Brasilia, julho 1995. Dossier, 21 p. (mimeo)

Junk, W. J. Soares, M. G. M. & Saint-Paul, U. The Fish. In Wolfgang J. Junk (ed.). *The Central Amazon Floodplain: Ecology of a Pulsing System*. Ecological Studies 126: Springer. pp. 385-408.

Kalton, G. 1983. *Introduction to survey sampling*. Series: Quantitative applications in the social sciences, no. 35. Sage University Publication.

McCay, B. J. & Jones B. Eds. 1997. Proceeding of the Workshop on Future Directions for Common Property Theory and Research. New Jersey: Ecopolicy Center for Agricultural.

McGrath, D. G., F. de Castro, C. Futemma, B. Amaral & J. Calabria. 1993. Fisheries and the Evolution of Resource Management on the lower Amazon floodplain. *Human Ecology* 21(2): 167-195.

McGrath, D. G.; F. de Castro; E. Câmara & C. Futemma. 1996. *Community management of floodplain lakes and the sustainable development of Amazonian fisheries.* Paper presented at the conference "Diversity, Development, and Conservation of the Amazon Floodplain", Macapá, Amapá, Brazil, 12-15 of December, 1994.

McKean, M. A. 1992. Success On The Commons: A Comparative Examination of Institutions for Common Property Resource Management. *Journal of Theoretical Politics* 4(3): 247-281.

Marx, K. 1948. *Capital: a critical analysis of capitalist production.* Tr.from the 3d German ed. by Samuel Moore & Edward Aveling and ed. by Frederick Engels. New York: International Publishers. 886 p.

Noda, S. N., Pereira, H. S., Branco, F.M.C. & Noda, H. 1995. Os Processos de Trabalho nos Sistemas de Produção de Agriculturas Familiares na Várzea do Estado do Amazonas. In: *Anais do II Encontro da Sociedade Brasileira de Sistemas de Produção*. Londrina, Paraná, Novembro, pp 148-167, 1995.

Ostrom, E. 1990. *Governing the Commons*. Cambridge University Press, Cambridge.

_____ 1992. The Rudiments of a Theory of the Origins, Survival and Performance of Common-Property Institutions. In *Making the Commons Work*, ed. D. W. Bromley, 293-318.

_____. 1997. A Behavioral Approach to the Rational-Choice Theory of Collective Action. Workshop in Political Theory and Policy Analysis.41p.

Parente, V. M. 1996. *A Economia da Pesca em Manaus*: organização da produção e da comercialização. Universidade Federal Rural do Rio de Janeiro (Master's dissertation).

Pelto, O. J. and G. H. Pelto, 1995. *Anthropological Research: The structure of Inquiry*. 2 ed. Cambridge University Press, 333p.

Pereira, H. S. & Lescure, J-P. 1993. Extractivism and agriculture: the choice of one population on the Rio Solimões. In: M. C. Hladik, A. Hladik, O. F. Linares, H. Pagezy, A. Semple & M. Hadley (eds.), *Tropical Forest People and food; biocultural interactions and applications to development.* MAB Series # 13, Parthenon Publ., Paris, Carnforth, New York: 775-778, 1993.

Pollnac, R. B. 1991. Social and Cultural Characteristics in Small-scale Fishery Development. In Cernea, M. M. 1991. *Putting people first: Sociological Variables in Rural Development*. 2 ed. A World Bank Publication. 259 - 303.

Putnam, R. D. 1993. *Making Democracy Work: Civic Traditions in Modern Italy*. Princeton University Press.

Ribeiro, S. A. O. 1991. *Vida e Morte no Amazonas*. Itacoatiara. Sao Paulo: Edicoes Loyola. 191p.

Schlager, E. & E. Ostrom. 1993. *Property-rights regimes and coastal fisheries*: an empirical analysis. *In* The Political economy of customs and culture: informal solutions to the commons problem/ edited by Terry L. Anderson and Randy T. Simmons. Rowman & Littlefield. 13-41.

Schuman, D. A. 1985. Family Labor Resources and Household Economic Strategy in a Mexican Ejido. *Research in Economic Anthropology* 7: 277-287.

Simmons , R. T. & P. Schwartz-Shea. 1993. Method, Metaphor, and Understanding: When Is the Commons Not a Tragedy ? In *The Political economy of customs and culture: informal solutions to the commons problem*/ edited by Terry L. Anderson and Randy T. Simmons. Rowman & Littlefield. 1-12.

Singleton, S. and Taylor, M. 1992. Common Property, Collective Action and Community. *Journal of Theoretical Politics* 4(3): 309-324.

Smith, N. J. H. 1979. A Pesca no Rio Amazonas. Manaus: INPA/CNPq. 154 p.

_____. 1985. The Impact of Cultural and Ecological Change on Amazonian Fisheries. *Biological Conservation* 32: 355-373.

Swaney, James A. 1990. Common property, Reciprocity and Community. *Journal of Economic Issues*: 24(2): 451-462.

Taylor, M. 1992. The Economics and Politics of Property Rights and Common Pool Resources: A Review Essay. *Natural Resource Journal* 32 (summer): 633 - 648.

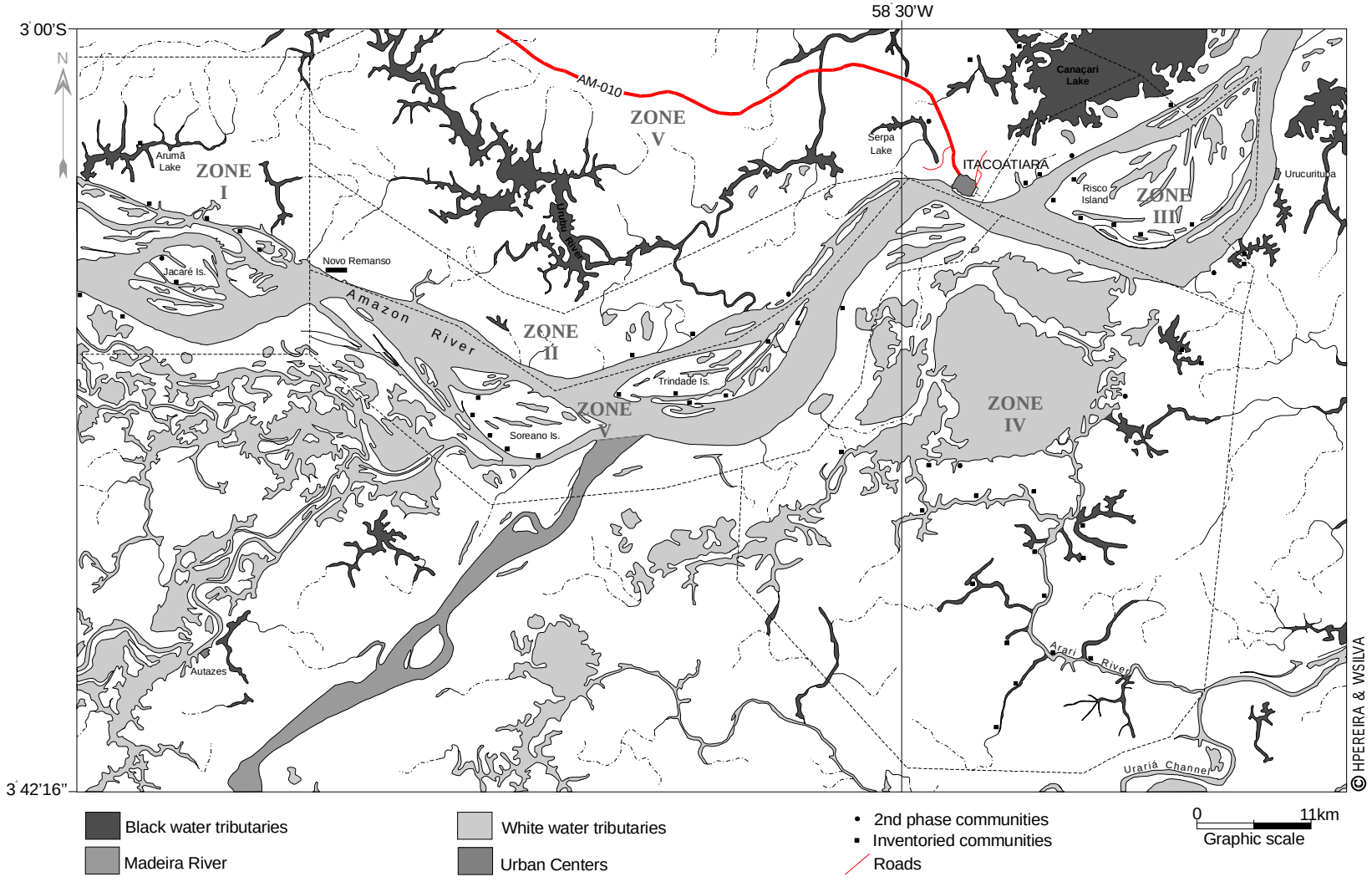
Taylor, M. and Singleton, S. 1993. The Communal Resource: Transaction Costs and the Solution of Collective Action Problems. Politics & Society 21(2): 195-214.

Thomas, D. H. L. 1996. Fisheries Tenure in an African Floodplain Village and the Implication for Management. *Human Ecology*, (24) 3: 287-313.

Wilkinson, K. P. 1991. The community in Rural America. Greenwood: New York.

Wheelock, J. & Oughton, E. 1996. The Household as a Focus for Research. *Journal of Economic Issues* 30 (1): 143-159.

Sioli, H. 1968. Hydrochemistry and geology in the Brazilian Amazon region. *Amazoniana* 1:267-277.


3 00'S
58 30'W
3 42'16"
N
AM-010
ZONE V
ZONE I
ZONE II
ZONE III
ZONE IV
ZONE V
Arumã Lake
Serpa Lake
Canaçari Lake
ITACOATIARA
Urucurituba
Risco Island
Jacaré Is.
Novo Remanso
Amazon River
Trindade Is.
Soreano Is.
Autazes
Arari River
Urariá Channel
© HPEREIRA & WSILVA
Black water tributaries
Madeira River
White water tributaries
Urban Centers
2nd phase communities
Inventoried communities
Roads
0
11km
Graphic scale

Appendix B – Localization and classification of 62 communities inventoried in the research first phase.

#	Zone	Community	Locality	Geographic reference	CPR	Case	Ann/Seas	2nd phase
3	I	São José	Paraná da Simplícia	Boca de cima	I	a	-	
27	III	Espirito Santo	Paraná de Serpa	Paraná do Pai Tomás	I	a	-	
28	IV	Santa Rosa de Lima	Rio Arari	Arari Grande	I	a	-	
36	IV	São Lázaro	Rio Arari	Ig. Do Chocolateira	I	a	-	
5	I	São Sebastião	Paraná do Rio Preto	Lago do Arumã	I	a	-	
9	I	São João	Varre Vento	Rio Amazonas	I	a	-	
55	VI	São Francisco	Ilha do Cumaru	Ressaca do Cumaru	I	a	-	
23	III	Nova Esperança	Paraná de Serpa	Ilha de Risco	I	a	-	**X**
14	III	São Francisco Xavier	Costa do Tabocal	Rio Amazonas	I	a(*)	-	**X**
57	VI	Santo Antonio	Ilha do Cumaru	ressaca do Cumaru	1	a(*)	-	
1	I	São Seb. do P. União	Paraná da Eva	Ilha do Camaleão	I	b	-	
10	II	Na. Sra. P. Socorro	Costa da Conceição	Igarapé do Padre	I	b	-	
22	III	São João Batista	Paraná de Serpa	Igarapé do Carão	I	b	-	
35	IV	Tiradentes	Rio Arari	Furo do Arapapá	I	b	-	
51	VI	Santa Rosa	Ilha Grande do Soreano	Ilha Grande do Soreano	I	b	-	
52	VI	São João	Ilha Grande do Soreano	Ilha Grande do Soreano	I	b	-	
54	VI	São Raimundo	Ilha Grande do Soreano	Paraná do Sucumbira	I	b	-	
46	VI	Na. Sra. das Graças	Costa do Arapapá	Costa do Arapapá	I	b	-	
56	VI	Monte Sinai	Ilha do Cumaru	Ressaca do Cumaru	I	b	-	**X**
60	IV	Ipixuna	Igarapé do ipixuna	Lago do Batista	I	b	-	
2	I	Sagrado Coração	Paraná da Eva	Lago do Engenho	II	-	Annual	
31	IV	Na. Sra. P. Socorro	Rio Arari	Ararizinho	II	-	Annual	
32	IV	Monte Cristo	Rio Arari	Ararizinho	II	-	Annual	
48	VI	São José	Ilha da Trindade	Paraná da Trindade	II	-	Annual	**X**
53	VI	D. Pedro II	Ilha Grande do Soreano	Ilha Grande do Soreano	II	-	Annual	
13	III	São Sebastião	Costa do Siripá	Rio Amazonas	II	-	Seasonal	**X**
58	VI	São João	Ilha do Cumaru	Rio Amazonas	II	-	Seasonal	
24	III	São Sebastião	Paraná de Serpa	Ilha do Risco	III	1.0	Annual	
25	III	Divino São Sebastião	Paraná de Serpa	Ilha do Risco	III	1.0	Annual	
50	VI	Santa Luzia	Ilha Grande do Soreano	Boca do Autaz	III	1.0	Annual	
21	III	São Lázaro	Paraná de Serpa	Igarapé do Assacu	III	1.0	Seasonal	
26	III	São Raimundo (Alvor.)	Paraná de Serpa	Paraná de Serpa	III	1.0	Seasonal	**X**
49	VI	Cristo Redentor	Ilha da Trindade	Ressaca do Cumaru	III	1.0	Seasonal	
6	I	Na. Sra. P. Socorro	Paraná do Rio Preto	Paraná do Rio Preto	III	1.1	Annual	
7	I	S. Fco. Pr. Do Jacaré	Paraná Jacaré	Paraná do Jacaré	III	1.1	Annual	**X**
18	III	Nova São Sebastião	Ilha do Risco	Paranazinho Ilha Nova	III	1.1	Annual	
19	III	Corpo de Cristo	Lago do Agostinho	Lago do Agostinho	III	1,1	Annual	
20	III	Santo Antônio	Lago do Agostinho	Lago do Agostinho	III	1.1	Annual	
37	IV	São João	Rio Arari	Ig. Do Chocolateira	III	1.1	Annual	
41	IV	São Fco. De Assis	Rio Arari	Igarapé do Pahí	III	1.1	Annual	
42	IV	São João do Araça	Rio Arari	Lago do Araça	III	1,1	Annual	**X**
43	IV	São Sebastião	Rio Arari	Lago do Moura	III	1.1	Annual	
45	V	Sagrado Coração	Lago de Serpa	Lago de Serpa	III	1.1	Annual	**X**
47	VI	Boa Esperança	Ilha da Trindade	Ilha da Trindade	III	1,1	Annual	
8	I	S. Fco do Varre Vento	Varre Vento	Rio Amazonas	III	1,1	Annual	
16	III	Santa Maria	Ilha do Risco	Paraná do Boqueirão	III	1.1	Seasonal	
17	III	Machado de Assis	Ilha do Risco	Paranazinho Ilha Nova	III	1,1	Seasonal	
33	IV	São Raimundo	Rio Arari	Boca do Curuça	III	1.1	Seasonal	
34	IV	São Paulo	Rio Arari	Boca do Jacaré	III	1,1	Seasonal	
38	IV	Vila Fátima	Rio Arari	Ig. Do Tucunaré	III	1.1	Seasonal	
40	IV	São Miguel	Rio Arari	Igarapé do Bonifácio	III	1.1	Seasonal	**X**
11	II	Na. Sra. da Conceição	Costa da Conceição	Paraná da Trindade	III	2.1	Annual	
12	II	Na. Sra. Aparecida	Costa da Conceição	Paraná do Limão	III	2.1	Annual	**X**
30	IV	São José	Rio Arari	Ararizinho	III	2.1	Annual	
44	IV	Na. Sra. do Livramento	Rio Arari	Lago do Stanislau	III	2.1	Annual	
29	IV	Natária	Rio Arari	Arari Grande	III	2.1	Seasonal	
4	I	Na. Sra. de Fátima	Paraná do Amatari	Ilha do Amatari	III	2.1	Seasonal	
15	III	Divino Espírito Santo	Ilha do Risco	Ilha do Risco	III	2.1	Seasonal	
39	IV	Rosental	Rio Arari	Ig. Terra Preta	III	2.1	Seasonal	**X**
59	IV	Vila Batista	Lago do Batista	Rio Arari	III	2.1	Seasonal	
61	V	Santo Antonio	Lago do Canaçari	Cabeceira do Canaçari	III	2.1	Seasonal	

62	V	Santa Fé	Lago do Canaçari	Macuará	III	2.1	Seasonal	

(*) Privatization of lakes.