

ADJUSTING TO CHANGE: THE CRAFTING OF COMMUNITY LAKE MANAGEMENT SYSTEMS IN THE BRAZILIAN AMAZON¹

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Introduction

Central questions of the theory of common-pool resources are related to the erosion and survival of community-based management systems (CBMS), and how they can increase ecosystem resilience (Ostrom 1990, Ostrom et al. 1994, Berkes and Folke 1998). Evidence from case studies indicates CBMS can be undermined when the pace of change is greater than the ability of local populations to respond efficiently (Berkes 1985, Smith 1985, Ostrom 1990, Bailay and Zerner 1992, Ascher 1995, McCay and Jentoft 1998), while survival of CBMS depends on the features of the social group as they are related to their ability to respond promptly to environmental change as well as the resilience of the biophysical system as it allows for mistakes during the constant adjustment process (Ostrom 1990, Pinkerton 1994a). Surviving CBMS evolves through two major processes: 1) *reshaping* of older institutional arrangements to cope with continuous slow environmental change, leading to long-enduring local institutions such as the communal meadows of the Swiss peasants (Netting 1981), and the fishing territories of Cree Indians in Canada (Berkes 1977), and 2) *emergence* of new institutional arrangement in response to social changes at the local and regional levels such as the salmon co-management system in the Canadian Atlantic coast (Pinkerton 1994b) and the lobster territories of Maine (Acheson 1988) and the extractive reserves of rubber tappers in the Amazon (Allegreti 1990)⁵.

The survivorship of CBMS depends on the ability of local populations to respond to environmental change in a preservationist fashion, which depends on the ability of the commoners to organize and constantly reshape local patterns of resource use so that they are compatible with the ecological characteristics of the system. In this regard, as social system becomes more complex, the survival of a CBMS depends on the ability of the users to reshape the institutional design, or re-create new designs, in order to cope with local and external pressures.

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⁵ For other cases of CBMS, see the collections by McCay and Acheson 1987, Berkes 1989, Cordell 1989, Ostrom 1990, Bromley 1992, Redford and Padoch 1992, Dyer and McGoodwin 1994, Berkes and Folke 1998).

Although artificial, the distinction between long-enduring and new CBMS is useful for evaluating the role of local institutions in increasing ecosystem resilience, in which relationship between institutional change and resource conservation is considered in a dynamic perspective. According to North (1990), institutions tend to evolve through the reshaping of older forms since the cost of adjusting to new institutions is high. In this regard, new CBMS's that have been successful represent living experiments in social resilience under complex environmental conditions. These cases can help to explore questions on the conditions necessary for both emergence and success of CMBS, by revealing the social and ecological dynamics behind these new enterprises and how they affect the ecological resilience of the system as a whole. In short, the historical analysis of new CBMS is important for teasing out the factors that influence the performance of such local institutions in conserving natural resources (Berkes and Folke 1998).

In this paper, we analyze the process of crafting a CBMS for lake fisheries by a floodplain community in the Lower Amazon in order to tease out the local and external factors that influenced the development of this collective action. The paper is divided into 6 parts. The first two parts describe the methodology and the study site. The third sections describe the process of emergence of the local management of fishing at the region level, while the fourth and fifth section describe the emergence of local management of fishing at the community level, and its ecological outcomes, respectively. The sixth section discusses the social, ecological, and institutional aspects of the CBMS, and lastly, the seventh section present a brief conclusion on the major factors leading to the success of this CBMS.

Methodology

Data collection included a preliminary socioeconomic survey, non-structured interviews with local resource users, participant observation, and a monthly structured interviews on household fishing activity. In 1991, a socioeconomic survey was carried out among 30 households in order to obtain a general picture of patterns household of resource use in the community.

Interviews and direct observations were carried out during several periods of more intensive fieldwork between 1992 and 1997. Non-structured interviews were conducted with focal groups (community leaders, fishers, and elderly residents) in order to obtain information on the history of the community, the fishing accord, and fishing activity. In addition, we participate in fishing trips over the course of the year to observe different fishing strategies and the decisions made at the fishing spots.

Data on household fishing activity were collected during two periods — 1992 (by F.C.) and 1995-1997 (by M.C.), with distinct methodological designs. The 1992 survey was based on a sample of 25 randomly chosen households (Castro 2000). The methodology for data collection in the 1995-1997 survey was based on a total sample of eight families consisted of two parts — four families were randomly chosen each month, while the other half was interviewed every month for the entire period. In both periods, fishing activity was monitored for seven consecutive days each month. Interviews were conducted by trained community members and questionnaires contained information on the previous day's fishing activity including data on the fishing trip (place, gear, crew, time) and catch size and composition (species and quantity). In addition, data on the commercial fish catch was obtained from local fish buyers between 1994 and 1997, whereas in 1992 commercial fishing was indirectly estimated from household fishing data.

Study Area

The community of Ilha de São Miguel (ISM) is located on an island of the same name of approximately 3,676 ha. The island is located in the main river channel in between the towns of Santarém (40 km) and Alenquer (20 km) on the south and north banks respectively (Figure 1). The island consists of four main landscape features: branches of the river channel form islands within the floodplain, natural levees separate the island interior from the river channel. Inland the levee slopes gently downward towards the lake system which occupies the low lying areas of the island. The slopes between the permanent lake system and the forested levees consist of seasonally inundated savanna. The floodplain landscape varies dramatically over the course of the year, due to the variation of 5 meters in the river level. At the height of the flood season all but trees tops and houses on stilts are under water, while in the dry season only the river channels and deepest lake basins contain water.

ISM has a population of approximately 164 inhabitants distributed in 40 households.⁶ The island population consists primarily of smallholders known as *caboclos*.⁷ Most of the smallholder population is descended from three major families.

⁶ Population size was estimated from the socioeconomic survey answered by 75 percent of the community residents who were present at the time the survey was conducted.

⁷ *Caboclos* are an ethnic group that emerged after the 18th century, from the miscigenation of local Indigenous groups, European colonizers and African Brazilians (see Parker 1985).

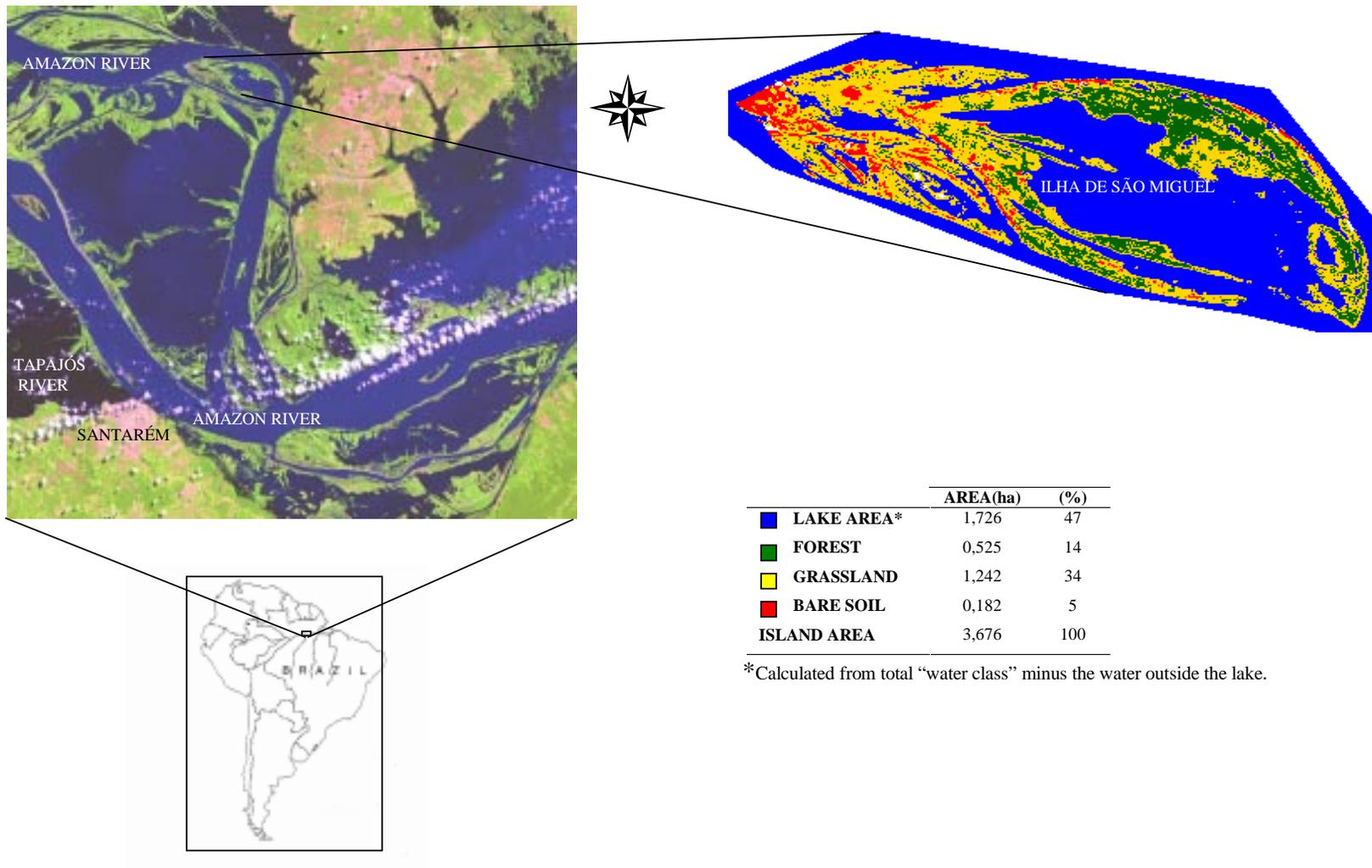


Figure 1. Study area.

Social institutions include a soccer club, two churches (Catholic and Pentecostal), and a community association. Community association is based on a committee elected every two years, composed by individuals from different family groups. ISM's economy relies upon a combination of fishing, farming, small animal husbandry, cattle raising, employment and retirement pensions. Farming is the dominant commercial activity (carried out by 89 percent) of smallholders, followed by commercial fishing (62%) and cattle ranching (60%). Commercial fishing is based on the seasonal exploitation of catfish and the *pirarucu* (*Arapaima gigas*). About two thirds of cattle owners are community members who raise up to 15 head each while the remainder are small with up to 60 head each.

The combination of economic activities employed by individual households varies with some concentrating on only one or two activities while others employ more diversified strategies. Households farm during the low water season, and manage their cattle and fish all year round. The larger cattle ranchers move their herds to the nearby uplands during the flooding season where many also cultivate annual and perennial crops.

Fisheries Intensification and Community Organization Development- The Dual Process of Emergence of CBMS for Floodplain Lakes

Fishing has always been a major subsistence activity of Amazon floodplain populations (Roosevelt 1989). However, commercially oriented fishing gained importance from the seventies on due to a combination of increased demand for fresh fish, improvements in fishing technology, and the decline of jute cultivation which had been the basis of the floodplain economy since the 1950's (McGrath et al. 1993a).

Due to its relatively low entry cost and the absence of other alternatives, commercial fishing served as a "labor sponge" attracting not just floodplain smallholders but also the urban unemployed. With the creation of SUDEPE⁸ in 1962, the government took over responsibility for regulating Amazonian fisheries and developed incentive programs to promote development of regional commercial fisheries. The major lake systems in the vicinity of the largest urban centers such as Belém and Manaus became the focus of fairly intensive commercial fishing by the late 1960's (Chapman 1989).

At around the same time, the Catholic church launched a major effort, known as the MEB⁹ (Grassroots Educational Movement), to organize and educate rural populations

⁸ SUDEPE – Agency for the Development of Fisheries (Superintendência de Desenvolvimento da Pesca).

⁹ Movimento Educacional de Base.

throughout the Amazon. MEB implemented adult literacy and leadership development programs, and through these efforts created a variety of community organizations including soccer clubs, mothers' groups, youth groups, catechist groups and finally community governing bodies, all operating under the guidance of church leaders and within the context of the regional organizational structure of the Catholic Church. One other result of these efforts was the development of the community infra-structure which physically defines the Amazon community including the school, church, and community shelter.

The Amazon community, then, was literally invented by the Catholic Church. Two key institutions in this process were the catechists, who are responsible for organizing church related activities and the community councils, who are responsible for community affairs (Almeida and Gomes 1993). These community councils, which took various forms, represented the first explicit "community-based" political institutions in rural Amazon, shaped the social boundaries for decision-making, and creating a political identity (Lima 1999).

In the 1980's MEB and the Catholic Church in general assumed a much more explicitly political role helping to organize the rural labor movement in support of land reform and, more generally, resistance to the military government (Leroy 1991). Most rural Amazonian leaders today received their training through participation in Church sponsored activities often beginning in youth groups, later becoming catechists and community and regional leaders. Through these activities they gained the leadership and organizational skills needed to lead major rural labor organizations at municipal and state levels such as the Rural Workers' Union (Sindicato dos Trabalhadores Rurais) and the Fishers' Union (Colônia de Pescadores).

The dual processes of the intensification of commercial fisheries, which has often been described as a major external factor eroding local management systems (Berkes 1985, McCay and Acheson 1987b, Bailey and Zerner 1992), was offset by the strengthening of community organizational capacity at local and regional scales. As a result, the threat represented by the fishing intensification to the floodplain communities' control of local lake fisheries set the stage for constant confrontations between the local residents and outsider fishers over the appropriation of floodplain lake fisheries (Goulding 1983, Hartmann 1989, McGrath et al. 1993a, Furtado 1993). Community resentment of the exploitation of local lake fisheries by better equipped commercial fishers flared into sometimes violent confrontations between the two groups. The first incidents occurred in a major lake system near Santarém in the mid-sixties. Later in 1973, a "fish war," broke out between community

members and commercial fishers in lake Janauacá near Manaus which and led to the destruction of gear and boats, and to the death of several people (Goulding 1983). Fisheries conflicts, though rarely of this level of violence, have flared up regularly throughout the Amazon ever since (Hartmann 1989).

The proliferation of conflicts between commercial fishers and floodplain communities led to the development of more formal approaches to the community level control and management of lake fisheries, often with the support of the Catholic Church. This new institution, known as the “fishing accord” (*acordos de pesca*), is a formal agreement among members of communities sharing a given lake fishery which defines access to and use of the fishery. The accord consists of a document formulated at community meetings which lists the rules for the fishery, may or may not specify procedures for enforcement and punishment, and includes the signatures of all those who participated in the definition of the accord. Despite the fact that until recently there was no legal basis for these fishing accords, the system has spread throughout the Brazilian Amazon and have become a de facto ruling system based on the concept of community property rights over local lake fisheries (McGrath et al. 1993b, 1999; Lima 1999; McGrath 2000; Castro 2000).

The establishment of fishing accords aggravated the tension between community and outside commercial fishers and caught the attention of both government agencies and non-governmental organizations (NGO's) in the late 1980s. In addition to the political agenda of alleviating local conflicts, NGO's increased pressure for a more ecologically and socially oriented approach to fisheries management. Projects combining research and extension programs in support of community-based management have been developed in various parts of the Brazilian Amazon, such as the Mamirauá Project (Lima-Ayres 1994) on the middle Solimões, and the Várzea Project and Iara Project in the Santarém region (McGrath 1995). As a result of interaction with these initiatives, IBAMA, which replaced SUDEPE as the governmental agency responsible for fisheries management in late 1980s, has come to recognize the legitimacy of fishing accords and in recent years has established criteria and procedures for legalizing fishing accords (IBAMA 1995, Isaac et al. 1997, McGrath 2000). The Pro-Várzea Project of the Pilot Program for the Conservation of the Amazon rainforest (PPG-7) has adopted the explicit objective of supporting the development of a basin-wide framework for the co-management of floodplain fisheries which builds on the accord model and local community management initiatives along the entire length of the Amazon river within Brazil.

In sum, the dual process of fishing intensification and local organizational development has led to the emergence of a new type of CBMS. Yet, the establishment of fishing accord did not represent only a response for ecological change (lake productivity) but also a claim for property rights (Castro 2000). Therefore, the performance of such institutions depends on the consonance between local rules and the social and ecological local systems as well as the robustness of the organization in address constant environmental change (Ostrom 1999).

While community level fishing accords have increasingly become the basic institutional unit upon which the regional co-management system is expected to be built (Hartmann 1991; McGrath et al. 1993a, 1994; 1999; Isaac et al. 1997; McGrath 2000), only a few community groups have been successful in crafting really effective management systems that have endured for a significant period of time. The next section describes one example of a community fishing accord that has successfully addressed social and ecological pressures over twenty-five years and keeps been adjusted according to new environmental scenarios.

Fisheries Intensification, Local Organization, and the Fishing Accord in the Ilha de São Miguel

The Ilha de São Miguel fishing accord has developed over a twenty-five year period beginning in the mid nineteen seventies and extending up to the present. Over this period, four overlapping phases can be distinguished. A first phase in which the former local fishing strategies were affected by the regional process of fishing intensification. A second phase in which the incipient management system was developed and consolidated. A third phase in which rules regulating the fishery were refined to address problems that arose. A fourth phase extending up to the present in which the community is beginning to work with outside organizations and to assume greater control over marketing of fish products as an integral part of the organization of the management system.

Period 1 - Experiencing Production Change - (1960 - 1975)

Before fishing intensification, ISM residents relied upon fishing techniques that had relatively low efficiency. The major impact of fishing intensification on the local fishing was the introduction of synthetic-fiber gillnets. It did not take too long until gillnet was adopted by ISM residents, and commercial fishing rapidly became the most economically important activity in the community.

A decade later, bean cultivation was included in the economic repertoire of some floodplain households due to their relatively good market price and suitability to the floodplain soils. At the same time, the community residents were involved in the protection of a turtle nesting beach on the island. A group of bean farmers, angered over damage to their crops caused by turtle poachers, closed access to the turtle nesting beach adjacent to their fields and prohibited the capture of nesting turtles. For several years the bean farmers protected the beach during the nesting season without any formal support from the government. Finally, in the early 1980's the beach was incorporated into the regional system of protected turtle nesting sites.

While independent of the lake fishery, the establishment of a turtle nesting sanctuary seems to have enhanced the concern for the conservation of lake fisheries, first awakened by the perception of fish productivity decay. In addition, the opportunity of bean cultivation, which backed up the household economy in the face of fish production decrease, create the stage for the establishment of the fishing accord in the ISM. Two members of the group involved in protecting the nesting beach, who were also two of the main commercial fishers of the island, became concerned with the depletion of island lake fisheries, when, as they said, their "catch was composed only of piranhas."

Since the effort to establish the first fishing rules until the consolidation of this local institution, a long process of solving internal and external conflicts took place.

Period 2 - Developing the Fishing Accord - (1975-1985)

The fishing accord in ISM has its origin from two major commercial fishers who proposed to the rest of the community that they 1) prohibit commercial fishing; and 2) establish a gillnet ban in community lakes. Thus began a process lasting almost five years in which a growing group of supporters of the proposal strove to convince their neighbors to adhere to the accord.

To pressure recalcitrant members to sign the accord, leaders used several strategies which illustrate the complex interaction between individual and collective property rights which underlies community management of lake fisheries in the region. Those who insisted on ignoring prohibitions were prohibited from fishing in portions of the lake system outside their own property, and if outsiders chose to fish in their areas they did not have the right to call on community leadership for support in removing offenders from their property, for as the agreement states, "we consider that if the said land owner breaks the rules of this accord he gives others the right to do so also." While the original agreement does not specify

measures for monitoring compliance with the accord, it does specify graduated punishments. First offenders are given a formal warning by community leaders. If caught a second time their gear will be apprehended and handed over to SUDEPE or other legal authorities for punishment. Eventually all island residents, with the exception of two ranchers, agreed to sign the accord, ending internal disagreement over fishing regulations.

From the beginning an important element of the lake management system has been the clause permitting the commercial exploitation of the *pirarucu* (*Arapaima gigas*) and catfish during the six-month open season defined by the government. The *pirarucu* is a largely sedentary species, which in addition to being one of the largest species of fish in the basin, which can exceed 3 meters in length and 100 kilos total weight. The *pirarucu* is a large air gulping fish, with relatively sedentary behavior, at least with regard to reproductive behavior. Because *pirarucu* cares for their young during for several months of the year, they are highly vulnerable to capture during this period. Furthermore, while the offspring is not dependent on parents for food, they do depend on them for protection from predators, so capture of breeding couples not only eliminates mature adults but also increases the mortality rate of their offspring. The breeding season extends for much of the seven-month period of rising water.

The *pirarucu* has been heavily exploited for centuries and a recent study established that in the Santarém region, at least, the species can be considered overfished (Crossa and Petrere 1999). Ironically, it is also one of the most valuable in the commercial fishery. In order to protect the species during the breeding season SUDEPE established a six-month closed season initially between October 1st and March 31st, and later moved to the period December 1st and May 31st. In addition, since 1991 a minimum length of 1 meter was established for *pirarucu* fishing (Isaac et al. 1993). The commercial exploitation of *pirarucu* and catfish in ISM has followed the legal fishing closure, but has not been equally strict to the minimum size rule. The commercial fishing has been an important income source for island families, thereby reducing pressure on the subsistence fishery.

Unlike most of the fishing accords in the region, the original accord permitted outsiders to fish in community lakes as long as they respected the accord, including the prohibition of gill nets, and fishing for subsistence only, whereas commercial fishing of *pirarucu* and catfish was restricted to ISM residents. However, despite the fact that the fishery was open to outsiders, the establishment of the accord met with considerable opposition from outside fishers who resented the restrictions on fishing activity. The municipal Fishers' Union supported local opposition to the islands fishing accord, causing

community members to withdraw from the Union. However, conflict with outsiders has continued up to the present, leading the community to adopt increasingly severe measures to discourage outside fishers from breaking local rules, which further inflamed hostilities toward the community.

Partially in response to the intense pressure from neighboring communities and the Fishers' Union, community leaders sought formal governmental recognition to legitimize the accord through support from individuals with political influences such as former residents living in the city and farm owners. Toward this end, the accord was approved by the community in 1983 and presented in a formal document signed by 39 community members in 1985 and sealed by the symbolic burning of all gillnets in the community. This document was then submitted to the State Department of Justice (Procuradoria Pública do Estado) and finally signed by a judge of the state court system in 1987. Approval of the accord meant that the State now was committed to enforcing the measures. To the best of our knowledge, this was the first and only time such a procedure has been adopted to obtain legal support for a fishing accord.

Period 3 - Working out the Local Organization (1985-1997)

By 1985 the basic structure of the management system had been established, and community support for the fishing accord consolidated. The main elements of the system included: 1) prohibition of the use of gill nets, 2) prohibition of commercially oriented fishing, and 3) a six month open season for commercial fishing of *pirarucu* and catfish. Since then, this basic framework has undergone further modifications with the objective of strengthening control over the fishery and adjusting the management system to the social and ecological context in which it is developing.

In terms of the institutional base of the management system, the main innovation in this second phase has been the creation and strengthening of a community association responsible for management of community affairs. The Association of Natives and Residents of São Miguel Island (Associação dos Nativos e Moradores da Ilha de São Miguel, or ANMISM) was founded in 1989 and obtained legal status in 1995. All island residents are members. The association is the governing body of the community and is responsible for organizing most community activities including maintaining trails between houses, maintenance of community buildings and management of lake fisheries, and more recently, marketing of fish. Following the conventional model, the Association leadership consists of a president, vice-president, two secretaries, two treasurers and three-member Fiscal Council,

all elected to two-year terms. All members pay monthly dues of one real (approx. \$0.50) and must participate in tasks such as clearing of trails and the river channel in front of the community. Those who do not participate in these activities must pay a fee of five reais (approx. \$2.50) to the association. The biannual general assembly decides what measures to impose on those who do not comply with these regulations.

An important feature of the association is the inclusion of former residents of the island who now live in the city or adjacent upland areas and of the more politically influential ranchers of the island. Integration of urban relatives of ISM families and of ranchers has been especially important for representing the community in negotiations with government officials whether in support of the association, fishing accord or other community needs such as infrastructure for schools, electricity and health services. This informal political support has been especially important for maintenance of the fishing accord substituting the lack of support from the main formal organizations responsible for fisheries management.

Over this period the system for monitoring and enforcing the fishing accord has been gradually systematized. Regular nightly patrols are conducted three times a week during the six month closed season, December 1st to May 31st. Community fishermen are organized into three patrols of 18 members each under a patrol leader. To have the right to participate in the commercial fishery, members must participate in a total of 30 patrols over the course of six months. The graduated system of sanctions continues in effect, although due to the pressure of outside fishers, punishments have become increasingly severe. Frustrated with the constant poaching, the community has resorted to burning gillnets and occasionally even canoes rather than turning them over to authorities as stipulated in the accord. This is illegal and is the source of additional problems when angry fishers complain to local authorities.

One major change in the structure of the management system over this period was the decision to exclude outsiders from fishing in the lake. This decision was made in response to the relentless pressure from outside fishers and the difficulty of insuring that these fishers were complying with restrictions on use of gillnets and sale of fish. Interestingly, this measure does not apply to relatives of community residents who now live elsewhere, many of whom return regularly to the island to fish. The decision to close the lake system to outsiders had the effect of exacerbating tensions between the community and neighboring communities.

Finally, a new element of the management strategy, introduced in 1989, is the assertion of control over the marketing of the *pirarucu* and catfish caught in island lakes. This measure was apparently introduced initially to reduce the possibility of outside fish

buyers encouraging fishers to poach in the lake system. At first the community designated individuals in the community to purchase fish, recording for each purchase the name of the fisher and the number and total weight of fish sold. At the end of the season, the total quantity sold was reported to the community in the monthly community meeting. The community specified the purchase price as a percentage of the market price in Santarém with the buyer keeping whatever profits after selling the fish in Santarém. The association did not receive a share of the sale price and limited its role to designating the buyers. Because of the need for capital to purchase fish and ice and of a boat to transport fish to market, only a few people in the community were in a position to serve as fish buyers, and the main buyers for most of this period were a local merchant, a rancher supportive of the accord, and later another absentee rancher who owned the land surrounding the most productive lake of the island *pirarucu* fishery.

In addition to these changes in the organization of the fishery, the community has also instituted changes in fishing regulations. The first such change was in response to IBAMA's decision to change the open season for the *pirarucu* fishery from April 1st to October 31st to June 1st to November 30th. The purpose of this change was to protect the breeding period of the *pirarucu* which generally coincides with the period of rising water, December to June. Another change in the *pirarucu* fishery was a limitation on the use of fixed hooks called *rapazinhos*, a technique which involves tying lines with single baited hooks to trees or poles in locations where *pirarucu* are likely to pass. This change was motivated by two concerns. First, fishers became concerned that the technique was catching an excessive number of immature fish. Second, since an individual fisher can greatly multiply the level of effort by easily setting too many hooks daily, the community decided to set a limit of 25 hooks per fisher.

Phase 4 - Recent Trends: 1997-2000

Over the last few years ISM has taken steps to increase the economic benefits derived from the fishing management. In this, the community is following a path observed elsewhere in the basin where community management systems are moving away from an exclusive emphasis on subsistence to incorporate commercially oriented objectives. In this regard, ISM has a somewhat different history from other comparable initiatives in that it has maintained a commercial *pirarucu* fishery since its inception.

Two important measures have been instituted recently. First, as *pirarucu* fishery became a major commercial activity in the community, the Association has taken over the

role of fish buyer, replacing local middlemen previously designated by the community. In addition, the Association has implemented a 10% tax on the sale of *pirarucu*, thus creating an income source for the Association which can be invested in improvements for the benefit of the community as a whole. In the past the community derived no collective benefit from the fishery with income derived from the sale of *pirarucu* and catfish being divided between participating fishers and fish buyers. While the Association has taken over the role of fish buyer, it has not yet taken full control of marketing and continues the practice of selling the catch to the absentee rancher who owns land surrounding the most important lake in the *pirarucu* fishery. This fact shows that, due to the heterogeneous political and economic power of smallholders and farm owners, internal negotiation between these two actors is constantly exercised in order to minimize internal conflicts (Castro 2000).

The second important change, instituted on an experimental basis this year, is the commercial exploitation of the *tambaqui* (*Colossoma macropomus*). Tambaqui is a migratory species which seems to remain in the lake a few years during its growth before carrying out river channel migration. Castro (2000) has observed a larger body size for the specimens in the ISM. This fishery is restricted to those who participate in the weekly lake patrols and takes place during one week each month. Fishers accumulate *tambaqui* during the week and sell the entire weeks catch in Santarém, dividing the proceeds among those participating in the patrols. The objective of this measure is to provide some economic compensation for the effort invested in patrolling the lakes during the six month closed season. This measure represents a potentially important step toward expanding the range of species exploited commercially within the management system.

While cohesion has been strong among ISM residents, an important characteristic of and its management system is its limited interaction with other organizations active in regional fisheries. For most of the last fifteen years, the community has tended to maintain other organizations at arms length. Reasons for this vary. With regard to governmental agencies, one reason is a perception that the community lost control of their turtle conservation initiative when IBAMA took control of the nesting beach. Another is the fact that IBAMA considers it illegal to close lake fisheries to outside fishers so that despite the fact that IBAMA is increasingly supportive of community-based management initiatives, the ISM accord cannot be recognized in its present form. More recently, a project linked to IBAMA, to develop a community management system for the island's capybara population, was rejected at least in part because of fear that IBAMA would take control of the effort as it had the turtle nesting beach. Likewise, resistance to the Fishers' Union derives from the

Union's support of those opposed to the creation of the community lake reserve. Since early 1980s, the Fishers' Union has been run by artisanal fishers and since the mid 1990s, it has been working collaboratively with NGOs and GOs in the design of co-management systems that acknowledge fishing accords. Until 1997, ISM residents had no affiliation with the Fishers' Union and no community representative from that organization, despite of benefits provided from the affiliation such as work compensation during the fishing closure seasons (*defeso*), medical assistance, and a retirement salary.

The one organization which has maintained a fairly long term relationship with the community is Projeto Várzea of the NGO IPAM (Institute of Environmental Research for the Amazon), based in Santarém. This project has studied island lake fisheries since the early 1990's and the data presented here are some of the results of this effort. However, despite interest in expanding efforts, the community has maintained the Project at arms length, limiting the kind of research it is willing to permit. In part this has been due to the Project's inability to demonstrate to the community the practical value of the research activities it is conducting, but also stems from the community's distrust of outsiders. As a result, despite several years of work, the Project has had minimal direct influence on the development of the management system.

In recent years, however, due in large part to the election of an association president with a more outward looking perspective, the community has begun to strengthen ties with outside organizations. For example, in 1997, a local chapter of the Fishers' Union was established and now has more than fifty members. The Várzea Project is also expanding its collaboration with the community. An agricultural extension project, a product of research on local fisheries (McGrath et al. 1994), has been started and the Project is also advising the community on legal options for obtaining formal recognition of the community fishing accord from IBAMA. Finally, a proposal to strengthen the Association's management and marketing infrastructure has been approved and is scheduled to begin this year (2000). These recent changes, together with the Association's initiatives in marketing and commercial exploitation of *tambaqui*, suggest the beginning of a new phase in the evolution of the community management system which builds on the social and ecological capital accumulated over the last fifteen years to intensify the sustainable economic benefits to be derived from fishery.

Ecological Performance

The consolidation of the fishing accord in ISM has been enhanced due to its positive ecological performance. Apparently, the fishing accord led to a rapid recovery of fish productivity. One measure of the success of the fishery is the perception of those who have been fishing in the lake system over the period in which the management system has developed. One fisher, for example, recalls:

Right before the establishment of the fishing accord, three partners and I took one week to catch about 60 kg of fish; one year later, I went fishing alone and caught about the same amount in a single day. (authors' translation)

The increase of lake productivity is also recognized by residents from neighboring communities who regard ISM residents as selfish and as who deliberately appropriated from a highly productive lake. Besides the local discourse, a quantitative analysis of fishing activity in two different periods also reveals improvement in fishing productivity after the establishment of the fishing accord.

Like any typical floodplain community in the region, ISM residents fish singly or in pairs in dugout or plank canoes powered by paddle. They rely mostly upon the lake system and secondarily on the river channels for both subsistence and commercial fishing, and fishers exploit a fairly wide number of fishing locations over the course of the year. About thirty lakes were used within the lake system, of which two accounted for about 57% of lake fish production.

The major difference among other communities with no solid fishing accords, is the prohibition of the most efficient fishing gear (gillnet), and the limited commercial fishing. Since fishing is geared toward immediate subsistence needs, residents tend to undertake a fairly high frequency of short duration trips with a low variance in catch per trip since they will stop as soon as subsistence and cash needs are met. In general, residents fish between three and four days per week, spend approximately between two and three hours fishing, and each household caught between 100 and 150 kg of fish per month.

The permanent gillnet ban in ISM forces residents to rely their fish upon a range of customary fishing techniques such as cast net, fishing pole, harpoon, hook and line (*rapazinho*), and bow and arrow. The type of gear employed varies seasonally in relation to the species sought and the types of habitat available as water levels rise and fall. Cast nets are mostly used in open water during the low water season, while fishing bows tend to

predominate in the flood season and are used in flooded forest and floating grasses. The harpoon is used primarily in the low water season for catfish and for *pirarucu* in both high and low water. The bow and arrow tends to be used in the high water season when visibility is better. By adjusting the gear used to the characteristics of the habitat and of the fish fishers are able to achieve a high degree of selectivity in their fishing strategies, concentrating effort on certain species at different times of year.

Production of subsistence fishing has been relatively stable between 1992 and 1997 (Figure 2). Slight inter-annual differences in total catch may be a result of differences in methodological design (see Methodology), or variation in ecological features of the lake. In any case, even the year with the lowest production (1996), the estimated consumption per capita is over 500 grams.¹⁰ Despite the simplistic calculation, the catch per capita seems to be consistent with regional standards of 198 g in Itacoatiara (Smith 1981) and 350 g in L.G.M.^a (Cerdeira et al. 1997). Perhaps, the major difference with those other communities is the fishing time needed to achieve this standard, which can be shown by analyzing the fishing efficiency.

Fishing efficiency has steadily increased in the last years. The comparison between catch per fisher per hour in different months reveals an increased fishing efficiency through time, which suggests an increase fishing productivity in the community lake (Figure 3). This is a major evidence of impact of institutional change (fishing rules) in the productivity improvement (indirectly measured by fishing efficiency).

In addition to improvement in the subsistence fishing, ISM residents have sought for the improvement of commercial fishing through catfish and *pirarucu* fishing. Over the study period the annual catch of the *pirarucu* fishery has ranged from 7401 kg in 1992 to 15.849 in 1996 (Figure 4). While there is an apparent trend of increasing catches, the comparison between 1992-1993 period and 1994-1997 period should be cautiously analyzed, since in the former period the data suffer from serious limitation for extrapolation. In addition, intra-period comparisons are better understood when other environmental factors such as flood height can be integrated (Crossa 1999). Nevertheless, at the least, the data suggest that there is no indication of a decline in yields.

¹⁰ Consumption per capita was estimated by dividing total annual catch per estimated community population (200) and divided by total number of days (365). No weigh decay for fish bone was considered.

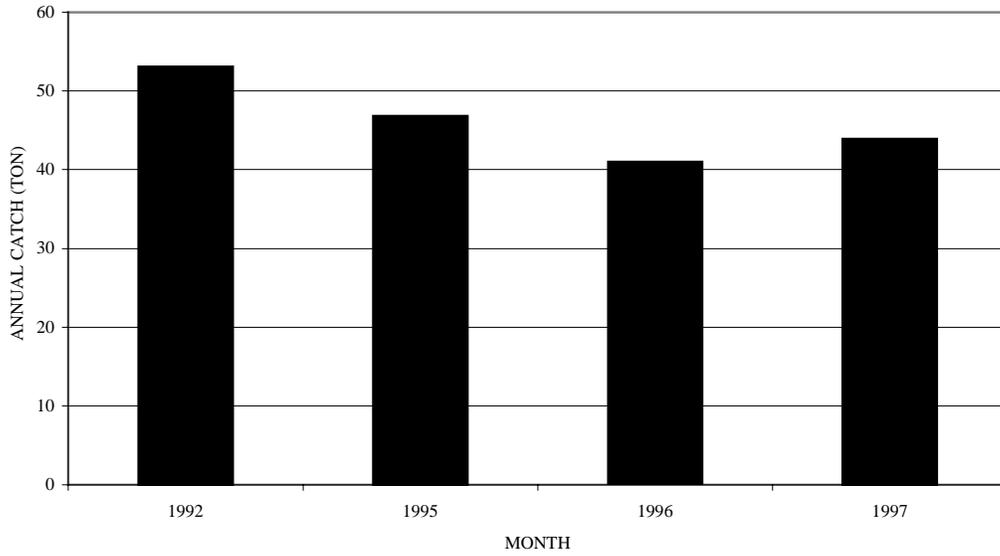


Figure 2. Annual production of subsistence fishing in ISM.

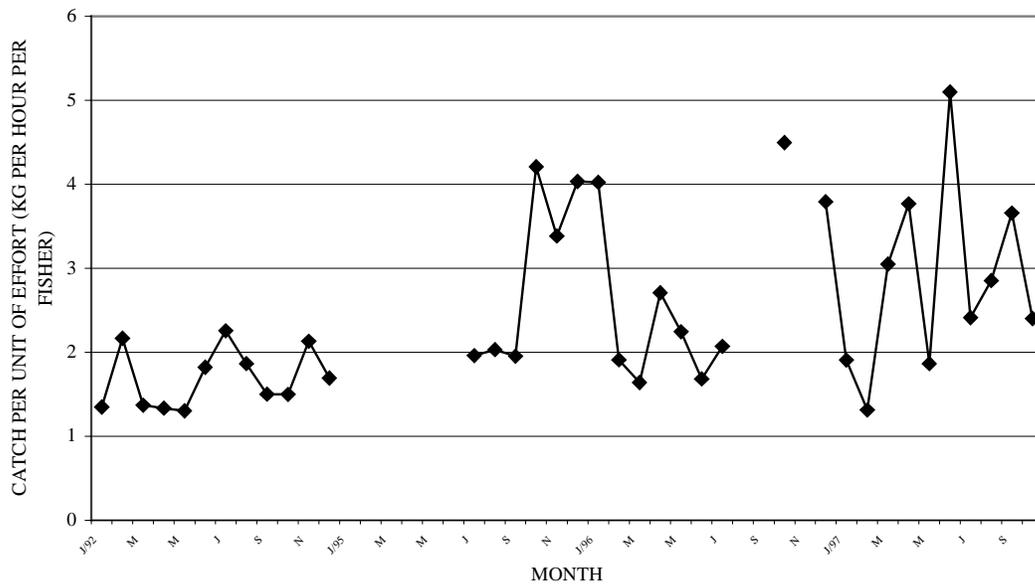


Figure 3. Monthly average of catch per hour per fisher in ISM in four different years.

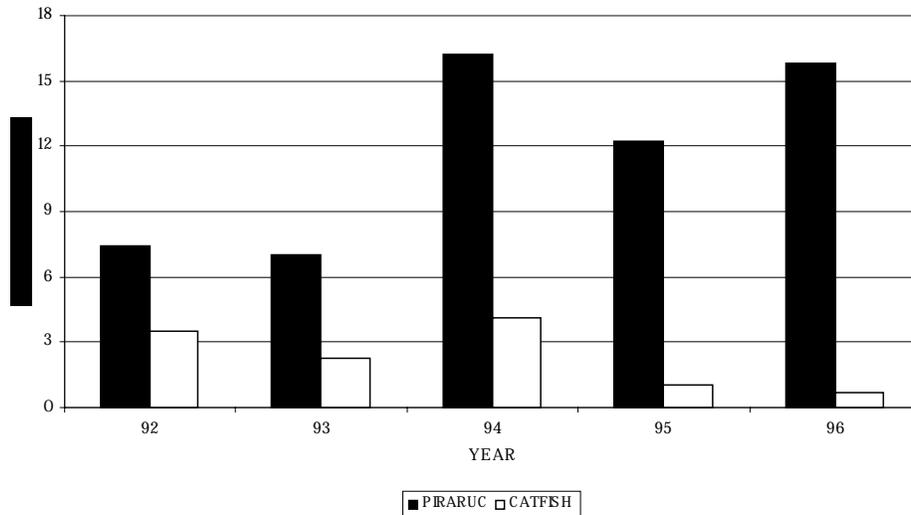


Figure 4. Annual production of commercial fishing in ISM.

Interesting enough, the production of catfish seems to be decreasing, despite of the local regulation. *Pirarucu* is a sedentary species and its fishery is carried out in the lake, whereas catfish encompass a group of migratory species and its fishery is divided between the lake and the river channels. Therefore, *pirarucu* fishery is more controllable while the productivity of catfish fishery depends on other factors out of local control. The decrease of catfish has been confirmed by ethnographic evidences (Crossa 1999).

With the depletion of *pirarucu* populations in recent decades, the value of the fish has increased so that now it is one of the highest priced fish on the market consumed by the urban middle and upper classes, fresh or salted. While the high economic value of *pirarucu* fishing creates incentives for fishers to carry out *pirarucu* fishing illegally year round, ISM follows the legal period (although do not follow strictly the minimum size rule). Over the course of the 1990's the *pirarucu* fishery seems to have intensified in the community. There are more fishers participating in the fishery towards the end of the period of study than at the beginning. The growth in the fishery is due largely to the entry of young fishers with little experience with traditional techniques such as the harpoon. As a result, simpler and less selective techniques such as hook and line and longline are accounting for an increasing proportion of the catch. This shift results in the multiplication of effort per fisher, since as noted earlier, fishers can employ a large number of hooks at one time but only one harpoon.

Since ISM management system has not been very concerned with the size restrictions, a significant proportion of the annual catch is below the legal minimum as is true of the regional fishery in general (Crossa 1999). The growing intensity of the fishery is also a

reflection of its importance as a source of cash during the period of falling water levels when income from agricultural activities is minimal. This supplemental income, while not very large can be critical in times of need. In this regard, another important feature is that while a large number of fishers participate in the fishery, a small number of specialists account for the major share of the annual catch. The great majority of fishers participate irregularly, probably in response to immediate needs. Another important characteristic of the commercial fishery is that it does not interfere with the subsistence fishery, in that subsistence focuses on different species. This is not the case of the recent commercial *tambaqui* fishery which could conflict with the interests of subsistence fishers in the future.

In summary, unlike the subsistence fishery, the commercial fishing is much more production oriented although gear and seasonal restrictions limit pressure, intensity has grown in terms of the number of fishers involved and level of effort per fisher; nevertheless, the *pirarucu* fishery remains its optimum point in terms of the age structure of the catch (Crossa 1999).

Discussion

Although fishing accords are pervasive CBMS throughout the Brazilian Amazon Basin (Castro 2000), and several authors argue that fishing accords should be considered in the fishing policy (Hartmann 1989, Furtado 1993, McGrath et al 1993b, Isaac et al. 1997) no case of combining economic and ecological success has been described until now.

The establishment of a fishing accord is a relatively easy task to accomplish. It requires a community mass meeting, a quorum (which can vary in criteria), and the formulation of a document endorsed by the majority. In many cases, meetings are not representative and fail to address appropriately the congruence of the rules formulated with the social and ecological reality. Therefore, the existence of innumerable fishing accords does not represent a success in the management of the fish resource in the region.

The analysis of ISM case offers a unique opportunity to understand under what condition CBMS emerge and under what conditions the CBMS can succeed in the floodplain Amazonian context. Over the last 25 years, the community of ISM has developed an effective organizational structure for managing local fisheries. In the process the residents have shown a remarkable ability to work together to devise and implement solutions to the different problems they have encountered. The question is to what can their success be attributed. Below, we discuss three major aspects of the fishing accords: the social structure of the

group, the ecological structure of the lake system, and the institutional structure of the fishing accord.

Social Structure of the Group

ISM has social particular features that has facilitated social organization toward the fishing accord. First, the community is the only settlement enjoying direct access to the lake managed. This feature particularly differs from most of the floodplain cases where lakes managed are usually surrounded by several communities. In addition, the relatively small number of households (40), which includes three major family groups who enjoy harmonious relationship and relatively homogeneous socioeconomy, helped to approximate all residents for the collective action. Residents are all smallholders employing diversified economic strategies based primarily on subsistence and commercial agriculture. As a result their economic interests with regard to the fishery are fairly uniform.

The recent increased religious heterogeneity in the community with the arrival of the Protestant evangelical church in the last decade, could be a source of internal conflict. Different from catholic, protestant evangelical families tend to isolate themselves from the rest of the community, often associated with the catholic church, and refuse involvement in community affairs. In many cases, they tend to take a pro-exploitation, anti-conservationist stance. On Ilha de São Miguel, however, members of the evangelical church were among the early leaders of the effort to conserve local fisheries. Also members of the evangelical church participate actively in community affairs. Perhaps the muted presence of the catholic church in the community has helped to minimize internal divisions.

Perhaps a major ingredient in maintaining the resident cohesion is due to the lack of a particularly dominant or charismatic leader or leaders, a characteristic that the organizational structure has tended to reinforce in the Amazonian rural communities. Members from different family groups, and religious belief, or economic interests, have been part of the institutional arrangement of the fishing accord.

While the internal social harmony in the community is important, it is no guarantee for collective mobilization. Actors enjoying relatively higher political and economic power in the island are represented by ranches, who have tended to support community efforts to manage the fishery. Since ranchers appropriates most of the island and enjoy access to the lakes, their support was essential to lower internal conflicts as well as to achieve political recognition in the regional arena.

Besides the supportive social structure of the commoners, three major historical facts have helped in the success of the fishing accord. First, the establishment of the turtle nesting reserve in the 1960s. It is not clear whether the original purpose of the reserve was to protect the turtle population or the bean fields, or both. Whatever was the motivation, the turtle reserve has created a sense of conservation among all community residents. The success of management efforts has reinforced their positive view of conservation objectives. They have seen how this management strategy works and compare their experience with that of their neighbors who continue exploiting their resources with little concern for long-term sustainability. As mentioned by a local resident:

They (residents from neighboring communities) have their own lakes to fish. Their lakes are out of fish because they overfished. We have been in the same situation before, but we did something to change that. They should do the same instead of accusing us. (authors' translation)

A second historical fact was the increased economic value of beans at the time the fishing accord was established. ISM has a large area suitable for bean cultivation which was used by more than 15 families during the early stages of the accord. The increased investment in bean cultivation during that period may have helped the families to balance their economic budget as the economic return from fishing dropped due to the commercial fishing ban.

Finally, in many cases, fishing accords are often initiated by ranchers who have other interests such as halting the entrance of outsiders in their properties, or agriculturalists who see commercial fishing as a secondary economic source. Oppositely, the initiation of the fishing accord in ISM came from the two major commercial fishers which facilitated the agreement between commercial fishers and other social segments in the community to establish the first fishing rules.

In short, there are intangible factors such as the strong sense of community, of mutual trust and commitment, that seems to be an important initial ingredient, and one which, like other aspects of social capital, has been fortified by the community's successful experience over the years. However, the credibility of the community as an institution and the willingness of members to submit to its determinations is exceptional in a situation where there are no legal means to force compliance, especially in the dubious legal context of the ISM fishery.

Ecological Structure of the System

While social features of the group are fundamental to the success of a local management, the ecological features of the floodplain system have been equally important in the ability to recover the productivity. The fact that ISM is geographically located far from the main route of the motor boats alleviate the degree of access to outsiders. Yet, the physical and ecological characteristics of the lake system may have been a particularly important role in allowing fairly rapid recovery once pressure on fish resources was reduced. For example, the size and depth of permanent lakes serve as refuges for fish at low water. In addition, island habitats seem to be in fairly good shape compared to those of other islands in the region. The impact of cattle and accidental fires has been less severe, and the island still has a significant amount of its original forest cover which help protect the lake environment from that of the surrounding river during the flood season (Figure 1).

In particular, the establishment of intensive commercial pirarucu fishing has been an ecologically wise decision. *Pirarucu* has an equilibrium reproductive strategy, which includes multiple spawning throughout its life span and a developed behavior of parental care. This species take about five years to reach reproductive age, and its fertility rate is up to 3000 eggs per reproductive season. Therefore, once its reproductive phase is ensured, the sedentary behavior of the *pirarucu* represents a locally manageable commercial fishing.

In short, while the ecological health of the floodplain system acts as a positive feedback mechanism for the community residents who see their efforts having results quite quickly, the local ecological knowledge backing up a combination of subsistence and commercial fishing has enable ISM residents to craft an ecologically efficient management system.

Institutional Structure of the Fishing Accord

Supportive social and ecological structures are fundamental for a CBMS but do not ensure its success if the institutional structure is not consonant to the ecosystem. The fishing accord in the ISM has succeed due to feature of the ruling system that has allowed an institutional crafting process based on constant reshaping of organizational and institutional arrangement.

A major feature of the fishing accord in ISM is related to its origin. As any new institution, the investment of time in designing, reshaping, and solving logistic tasks is specially high in the early stages of its establishment. During this period, the provision of set of leaders who invested personal time was fundamental to make the accord happen. Since the

leaders who first suggested the establishment of the fishing accord were the major commercial fishers, little effort was necessary to convince other fishers to join the collective endeavor. In addition, the participation of leaders who enjoyed political power in the community helped to solve external conflicts resulted from their local decisions.

Another important feature is that the organization of the fishing accord has been closely nested in the community social organization. As part of the whole community-based organization, the organizational structure of the fishing accord has a fairly large number of official positions which are changed every two years, so that leadership responsibilities tend to get shared aiming a fairly large percentage of the adults.¹¹ Leaders have been creative in the structuring of situations to encourage compliance. They sought for consensus, not only among residents but also including farm owners who owned the largest portion of the island. The insistence to obtain personal signatures from each household head on the fishing accord was a way to create a moral commitment to the collective action.

A particularly striking feature of the São Miguel experience is their ability to devise and implement solutions for free rider problems at various critical points in the development of the system. This can be seen in the kinds of measures they have introduced at key points in the development of their management system. One example is the strategy they used to enforce compliance with the original accord. Once the great majority had come to support the accord, they isolated remaining resistance by creating pressures in which the isolation be costly for them. Later, to strengthen participation in community activities, they tied participation in the benefits of management, the commercial pirarucu fishery, to participation in patrols to protect the fishery. Finally, with the recently established collective tambaqui fishery they have devised another mechanism for channelling benefits directly to those who are investing most in the maintenance of the system.

While social structure helped to keep the degree of violations low, residents created a ruling system that would address those who refused to play by the rules. Besides the organizational structure, commoners have accomplished compliance by having clear and low monitoring cost rules which are rigorously and uniformly enforced. For instance, while the establishment of gillnet ban, followed by a symbolic burning, forced residents to give up an ecologically efficient technology, it helped to keep the cost of monitoring low. Any rule on amount of fish caught, mesh size, or the number of gillnet per fisher would demand critical time effort for fishing monitoring. Similarly, the limited access to community residents,

¹¹ Perhaps, a major bias in the community organization is the participation mostly of males.

whose rule was established after several rule violations of non-residents in the lake, lowered the monitoring cost. Finally, the commercial ban, which is perhaps one of the most difficult rules to establish, has been informally monitored due to close social relationship among residents. In addition to low monitoring cost, fishing rules are well monitored by a patrolling system and violators are consistently sanctioned. The rigor and impartiality with which the accord is enforced, with no evidence of favoritism of family members up to date, differs from the informal laid back, individualist attitude which characterizes so much of most of the fishing accords in the region.

Once the local structure of the fishing accords has been consolidated, did commoners move to a more elaborated arrangement, including more complex organizational strategy and institutional arrangements. Collaboration with regional-based organizations (e.g., grassroots, NGOs, and GOs) has taken place only recently, but under careful negotiation process. Similarly, recently commoners have established new rules involving a higher monitoring costs such as the “collective *tambaqui* fishing”, “25 hook and line limit per person in the *pirarucu* fishing”, and “commercial fishing fee for those who do not cooperate in the patrolling system”. Therefore, the development of the fishing accord as a process in which rules are constantly checked and adjusted according to the social and ecological demands, has been one major reason of the success of the fishing accord in ISM.

Conclusion

In general, CBMS combine the social goal of maintaining local control to resource and the ecological goal of maintain system productivity. However, in many cases, there is tension between the them, and the economic goal often overweighs the ecological goal. Interesting enough, despite of high economically importance of fish in the floodplain in last thirty years, and the relatively few other economic alternatives, the local management of fishing in ISM has survived and become a solid institution.

The ISM case is useful for both policy and theoretical purpose. For the policy purpose, it represents an example to be followed by other communities seeking for similar outcomes. ISM is well known as a successful experiment in which several other communities are currently willing to try. Theoretically, it reveals that CBMS can enhance ecological resilience whenever the commoners have time enough to address local social and ecological problems before engaging in a larger management framework. Three major local dilemmas have been consistently addressed by the commoners: 1) how to achieve representation to

implement the rules; 2) how to tailor rules consonant with local ecological and social system, and 3) how to solve conflicts.

The combination of a social capital (ecological knowledge, historical co-livelihood, kinship ties, political organization) and ecological capital (preserved habitat, food source, favorable physical conditions) enable ISM populations to craft a solid CBMS which addresses both social and ecological dilemmas.

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