The Influence of Community Management Agreements on Household Economic Strategies: Cattle Grazing and Fishing Agreements on the Lower Amazon Floodplain

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Paper Submitted to:

The Eleventh Biennial Global Conference of
The International Association for the Study of Common Property
(IASCP)

Survival of the Commons: Mounting Challenges & New Realities
June 19 – June 23, 2006
Bali, Indonesia

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Abstract

While the organizational dynamics of collective management systems have received much attention, relatively little work has focused on how households adapt their economic strategies in response to collective management regulations that impose constraints on the range of options available to households. In this paper we investigate the evolving interaction between household management strategies and collective management regulations for one or both of two ecologically interdependent floodplain resources, lake fisheries and seasonally inundated grasslands. Smallholder management strategies involve varying combinations of three main activities each associated with one of three main floodplain habitats: annual cropping on river levees, cattle ranching on natural grasslands and fishing in lakes. These three activities play complementary roles in the household economy. Annual cropping is both subsistence and market oriented, with cash from crop sales often invested in purchase of cattle. Fishing, in addition to providing animal protein, generates income for household purchases while crops are growing. Cattle ranching is the main savings strategy for smalholders, providing funds for family emergencies and capital investments. Despite the fertility of soils and the higher productivity per hectare of fishing, cattle ranching has expanded steadily on the floodplain at the expense of farming and fishing.

Over the last two decades, communities throughout the Amazon floodplain have developed and implemented collective agreements to regulate access to and use of local lake fisheries. Depending on the measures included, the impact of these agreements on household management strategies can range from negligible to highly significant, requiring major adjustments to compensate for reduced fishing income. Expansion of smallholder cattle ranching has taken advantage of unregulated access to community grasslands. Unregulated access to community grasslands has been a major factor in the growth of smallholder ranching, and many households have far more cattle than could be sustained on their own property. The result is a classic tragedy of the commons in which growing numbers of cattle are overgrazing grasslands and degrading the productive capacity of floodplain fisheries. Concerned with the impact of cattle on floodplain habitat and conflicts between cattle owners and farmers, many communities have developed collective agreements to regulate grazing on grasslands. As with fishing, the impact of these agreements on household economic strategies varies depending on the degree to which they limit the number of cattle families can graze on grasslands. In this paper, we investigate interactions between smallholders household economic strategies for two major common pool resources and their respective management regimes. A major objective here is to identify factors that lead households to reduce investments in ranching and increase investments in more intensive management of local fisheries.

The Influence of Community Management Agreements on Household Economic Strategies: Cattle Grazing and Fishing Agreements on the Lower Amazon Floodplain[1][2]

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I. Introduction

Fisheries management agreements are designed to resolve problems caused by unrestricted access to local resources, such as resource depletion, excessive competition and conflict. While collective agreements may resolve the collective problem, this resolution may entail significant short and even long-term costs for some or all users. How users adapt to the new rules and the success of their new economic strategies are both cause and consequence of the efficacy of the new management regime. Even when the overall impact of rules is insignificant, the impact on individual families can vary significantly, creating pockets of resistance and free-riding in an otherwise well supported management system.

The impact of management regimes on household economic strategies can be even more complicated when users have access to two distinct, but interrelated common pool resources. Here implementation of rules controlling exploitation of one resource may simply lead to more intensive exploitation of the other. If the productivity of one or both resources depends on the other, then intensified exploitation of one resource may reduce the productivity of the second. In these cases, sustainability of the management system may depend on management of the system as a whole. Where two resources play different roles in the household economy, the implications for the second resource of managing the first can be more complicated, since it may or may not be possible to compensate for loss of the original resource by intensifying exploitation of the other. For example, where one resource generates savings rather than income, if a management agreement reduces income from the second resource, households do not have the option of intensifying exploitation of the first resource. Instead, they are likely to sell off part of their herd to compensate for the reduction in income until the lost income is recovered through other activities.

The Lower Amazon floodplain provides an excellent laboratory for investigating these relationships between management regimes and smallholder economic strategies. Here in addition to farming, smallholders exploit two overlapping resources, floodplain lake fisheries and grasslands for grazing cattle. Over the last decade or so a regional co-management system has been created consisting of eight regional lake fisheries councils representing some 170 communities and 35-40,000 people. Within this regulatory framework, a number of communities have developed their own management systems, often with more stringent regulations, that are focused on one or more species of high commercial value. In addition, to collective agreements for fisheries, some communities have also implemented agreements to regulate grazing of cattle on floodplain grasslands. In this paper we investigate the relationship between household economic strategies and management regimes for both lake fisheries and grazing of cattle on community grasslands. The paper is divided into four parts. In the first we

[1] The research summarized in this paper has been funded by the World Wildlife Fund, Department for International Development (DFID), The European Commissions Tropical Forest Program, the Conselho Nacional de pesquisa (CNPq), The Global Environmental Facility and United Nations University;Tokyo.

[2] A significantly revised version of this paper we will be able at the time of the conference. Please contact dmcgrath@amazon.com.br for a pdf copy.

provide a general overview of the study area including the floodplain environment and smallholder economic strategies. In the second we investigate how implementation of management regimes for fishing and ranching affect household strategies for that resource. In the third section we investigate the interaction between household fishing and ranching strategies under different combinations of fishing and ranching management agreements. Finally, we discuss the implications of these preliminary investigations into the interaction between management rules and household economic strategies for the design of management policies and intervention strategies.

II. Methodology

The research on which this paper is based has been carried out over the last fifteen years in the Santarém area of the Lower Amazon, at the confluence of the Tapajós and Amazon Rivers approximately 500km from Manaus in the West and Belém in the East. Over this period the authors have been involved in a longterm project studying the development of participatory management systems and working withn local smallholder and fisher organizations to develop collective management systems for floodplain fisheries and other resources. The main data source for this paper is a socio-economic survey of 259 households undertaken by Almeida (2004) in 2001 in which she compared household economic activities in 9 matched pairs of communities in which one pair managed its lake fisheries and the other did not. In addition to this data set, the results of other studies conducted over this period, including an ongoing study of household fishing activity in 5 floodplain communities, a study of the regional co-management system, studies of other community management initiatives and separate studies of cattle ranching and its environmental impacts. This paper is largely an exploratory study which we will use in designing a research strategy for investigating more closely the interactions described in the following pages.

Figure 1: Location of Study Area

A. Study Area: Location and Characterization

The Lower Amazon is a largely cultural term for a of region within the state of Pará extending from the Amazonas state border in the West to the mouth of the Xingu river in the East at the beginning of the delta region. It does, however, largely coincide with a slightly larger region extending further westard to Itacoatiara at the confluence of the Madeira and Amazon rivers. This larger region forms one of the two major floodplain regions of the Amazon River between the estuary and the Andean foothills. The western region is characterized by predominantly channel-shaped lakes, and forests constitute 70% of the vegetation cover. In contrast, disk-shaped lakes predominate in the eastern, Lower Amazonian, region and forests constitute only about 10% of floodplain vegetation.

Figure 2: Major Habitats and :and use Activities of Lower Amazon floodplain

From the perspective of local resource management strategies, the Lower Amazon floodplain consists of four main components: the main river channel and its ramifications;; natural levees, often forested, which border river channels; seasonally inundated grasslands that occupy the transition zone between forested levee and permanent lakes; and the network of irregularly shaped lakes that occupy the interior of the floodplain. Unlike the parallel rows of

narrow ox-bow lakes characteristic of the floodplain of the upper reaches of the river, lakes in the Middle Amazon tend to be wider and shallower. As a result, floodplain topography is less complex with fewer distinct habitats than is typically found upstream. Forest cover is also much more limited and consists mostly of secondary forest of varying age. The dominant vegetation of much of the floodplain is a natural grassland composed of a variety of species of semi-aquatic macrophytes.

Land use patterns are closely associated with topography and vegetation. Settlement is spread out along the levee. Most agricultural activities are also concentrated on the levees as the frequency and duration of flooding is lowest. The grasslands inland from levees are used for grazing cattle. Most fishing activity takes place in floodplain lakes although river fisheries are important at certain times of year. (McGrath et al 1998).

Figure 3: Seasonal Variation in Precititation and River Level in the Lower Amazon

B. Seasonal Variation in the Floodplain Habitat.

Seasonal variation on the varzea is driven by the twin rhythms of the flood and precipitation regimes. The river begins to rise in November, reaching its maximum height in May or June, then falls with increasing speed to reach its minimum level in early November. Annual precipitation, around 2200mm, is distributed over the year in a seasonal pattern that parallels that of the flood regime (Fig. 3). The rainy season extends from December to June with a peak in March/April, the dry season from July to November with September and October the driest months. The combination of these patterns results in two distinct seasons, referred to locally as verão (summer), the dry season when water levels are falling, and inverno (winter), the rainy season when water levels are rising. The relatively slow rise and fall have contributed to the evolution of a floodplain flora and fauna adapted to take advantage of both terrestrial and aquatic phases. Many plant species, for example, produce fruits and nuts during the flood season, and many species of fish have adapted to take advantage of these resources (Goulding 1980).

C. Land tenure and Household Economy

By Brazilian law, the Amazon floodplain is the property of the federal government, and residents do not have legal titles to the land they occupy (Benatti et al. 2005). However, informal property rights are recognized, and the Lower Amazon floodplain is divided into individual holdings that are regularly bought and sold on the regional land market. Properties are defined in terms of meters of frontage along the river and extend inland to the margins of interior lakes or channels. Smallholder properties average about 100 meters of frontage by 2.000 in depth for a total area of about 20 hectares, most of which is underwater during much of the year. It should be noted, though, that 25% of properties are up to 50 meters and over 50% less than or equal to100 meters of frontage, so a large proportion of smallholders have holdings with 50 meters of frontage for a total of only 10 hectares (McGrath & Gama 2005).

Figure 4: Property Rights Zones on the Floodplain

Within individual holdings, the three main habitat types are associated with different property rights and there is a continuum from private to common property as one proceeds inland

from levees to permanent lakes (McGrath et al. 1993, 1999). The river in front of the community is considered to be open access, though communities may object to the presence of outside fishermen. Levees are considered private property with lateral boundaries often fenced to protect house gardens and agricultural fields. Grasslands behind the levee are treated as common property on which community residents may graze their cattle, though lateral boundaries are recognized and families have the right to fence their portion of the grassland. Lakes are also considered common property available to all community residents, but outsiders may or may not be permitted access. This system of defining property in terms of frontage assures each household access to the river and to the main ecological zones of the floodplain. In terms of area exploited, households engaging in fishing and cattle ranching exploit overlapping common property resources that together occupy 90% of the floodplain interior. These are partially conflicting economic strategies, because ranching can degrade floodplain grasslands and forests that are important habitat for fish during the flood season, reducing the productive capacity of lake fisheries.

Table 1: Frequency of Income Sources in Sample Household

Smallholder Household Economy: Smallholder households on the floodplain employ diversified economic strategies involving varying degrees of emphasis on four main activities, fishing (84%), farming (81%), cattle ranching (45%), with small-scale animal husbandry (88%) (chickens and ducks) playing a secondary role in household subsistence. In addition, some 60% of households receive some kind of government benefit and another 16% some kind of salary (teacher or ranch hand). On average, fishing accounts for the largest share of household income (38%), followed by government benefits (31%), agriculture (18%) salaries (10%) and ranching (3%). Note here the small contribution ranching makes to household income despite the fact that almost half the sample raise cattle. Also, government payments are second only to fishing as an income source. Both of these points will be discussed later.

Most families (70% of sample) engage in two or more activities with some 39% engaging in two activities and 31% in three or more. It should be noted that the highest incomes are found in households which engage in three or more activities and that in the case of those families engaged in two activities, those raising cattle tend to have higher incomes than those who do not. Given ranching's low contribution to household income, this association is probably a result of cattle's role as an indicator of household wealth.

Table 2: Total Annual Family Income by activity.

The three activities play complementary roles in household economic decisions. Fishing provides a seasonally variable source of income and subsistence over the course of the year, sustains families through the agricultural season and excess income is invested in other economic activities. The fact that the low water period when most farming activity takes place coincides with the period of high *cpue* (catch per unit of effort) facilitates this role (McGrath et al. 1998). Farming, in addition to meeting subsistence needs, may generate discrete quantities of cash that can either be saved or invested in other activities such as fishing and ranching. For most smallholders cattle are seen as a means of saving income generated by other activities and also as a strategy for capital accumulation through herd growth. As a result of its strategic role in the household economy, smallholder ranching is expanding at the expense of fishing habitat,

undermining the major income source for the majority of floodplain households (Sheikh et al 2006).

While the three main activities of the household economy are potentially complementary, as the above comment suggests, in practice they are often in conflict. For example, to the extent that most agricultural activities take place on the forested levees, farming contributes to deforestation within communities reducing the quality of habitat available for fish. Ranching leads to the degradation of both floodplain forests and grasslands, degrading floodplain habitat on a larger scale than agriculture. Furthermore, cattle invade fields and damage crops and when feeding on aquatic macrophytes in lake shallows frequently damage fishing gear. These negative interactions reduce the overall productive capacity of the smallholder management system. One important objective of management agreements is to reduce these negative interactions and strengthen complementarities among activities.

II. Impact of Fishing and Cattle Management Agreements on Fishing and Ranching Strategies

A. Fishing and Fisheries Management regimes

The main productive unit in the Lower Amazon fishery is a canoe powered by sail and or paddle, one or two fishers and their gear (McGrath et al. 1998; Almeida et al. 1999). Fishers use a variety of types of gear depending on the season, the species and the habitat. Overall, gillnets of two main types are responsible for 70-80% of the catch depending on the community, followed by cast nets, fishing poles, harpoons, longlines, bow and arrow, and fixed hook and line. There are three main types of fishing trips, daily trips to nearby lakes, daily trips to nearby river channels when migrating schools of fish pass through and longer distance trips of several days to fish in more distant lakes and river channels. These latter trips usually involve a motorized boat that tows or carries canoes of participating fishers and one or more insulated boxes for storing ice and fish for the duration of the trip. In this paper our main concern are the local fishing activity in surrounding lakes, which account for around 70% or more of the catch in a typical floodplain community, depending especially on the relative importance of the channel fishery.

The distinction between subsistence and commercial fishing tends to be one of degree in the sense that all commercial fishers reserve some of the catch for household consumption, and virtually all subsistence fishers sell fish on occasion. But while there is a wide intermediate range between the poles of pure subsistence and pure commercial orientations, Almeida (2004) did find that subsistence and commercial fishers employ quite distinct strategies consistent with the Chayanovian logic of the relationship between labor productivity and total effort, with subsistence fishers spending less time fishing as productivity increases and commercial fishers more time. While the discourse of fisheries conflicts blames outside commercial fishers, the evidence indicate that both strategies are well represented in most floodplain communities of the Lower Amazon.

Fishers devote on average about 17 days per month to fishing with trips averaging 7 hours. Annual household catch ranges from 1-2 tons for subsistence-oriented fishers to 3-4 tons for the more commercially oriented (McGrath et al. 1998). While a wide range of species are caught in the region, the fishery is highly selective. A single species often accounts for almost 30% of the annual catch, the top five 5 species account for 80% and the top 10 for about 98%, so that fishing pressure is concentrated on a small number of species. There is strong seasonal

variation in the fishery and fishers recognize four main seasons: falling water when migratory species form schools and move out of lakes into the channel and move upstream, low water when remaining fish are concentrated in deeper lake basins, rising water when many species breed so larvae are washed into floodplain lakes and the flood season when fish move into flooded grasslands and forests to feed and care for young. Fishing strategies vary over the course of the year to focus on species and habitats that are most productive at each time of year. Overall, there is a peak in the productivity of the fishery during the periods of falling and low water, declining as water levels rise. The peak in the productivity of the fishery overlaps with the agricultural season. The higher productivity of the fishery at this time of year permits households to allocate more labor to farming activities (Fig. 5).

Figure 5: Seasonal Variation in the productivity of Fishing Effort (cpue).

Fishing agreements grew out of the concern that commercial fishers and especially larger scale outside commercial fishers were depleting local lake fisheries. In response communities throughout the region organized to expel outside commercial fishers and define rules to regulate fishing in community lakes. Agreements had several objectives. First, they seek to maintain or increase the productivity of the fishery (cpue). Second, they seek to insure more or less equal access to the fishery by removing more highly capitalized fishers and discouraging what are considered to be "predatory practices". Third, many agreements seek to reduce pressure on the fishery during the low water season when fish are concentrated in shallow bodies of water and are vulnerable to overexploitation. Fishers are less concerned about the spawning season because it coincides with the period of rising water when fish disperse in an expanding volume of water that provides natural protection.

A productive fishery is sought because, as noted earlier, smallholders employ diversified economic strategies and need to allocate labor among different activities as efficiently as possible. The higher the productivity of fishing effort, the less time families must spend fishing to meet basic needs, freeing up more time for other productive activities, as suggested in the Chayanovian curve for subsistence oriented fishers. In this way, a highly productive fishery constitutes what Hecht et al. ( ) refer to as "nature's subsidy", enabling families to diversity economic activities and increase household income.

In discussing the impact of fishing agreements, it is useful to distinguish between two overlapping management approaches, the intercommunity fishing agreements that are part of the formal co-management system implemented over the last decade and the more localized community management initiatives which combine management and collective marketing so as to capture the collective benefits generated by the management system. Almeida (2004) in a study comparing managed and unmanaged community fisheries, found little difference between the two groups in terms of fishing practices. Despite significant differences in fishing practices, fishing productivity was 40-60% higher in the managed than in unmanaged community lakes, which Almeida attributes to the exclusion of outside commercial fishers. In these cases, the management regime apparently has no significant impact on household fishing strategies because it is designed primarily to exclude abusive practices and protect local norms.

In the second situation the impact of the fishing agreement can be more onerous as more stringent rules are applied. For example, one common measure involves prohibiting the use of gill nets, often seen as responsible for the depletion of local fisheries. The prohibition of gillnets causes a drastic decrease in the productivity of fishing effort and consequently in household

fishing income. For example, based on data from a study of household fishing activity in mamnaged and unmanaged lakes (McGrath et al. 1994), the prohibition of gillnets and shift to the use of the second most productive type of gear, the cast net could reduce the productivity of fishing effort by over 30%. To compensate, families must either significantly increase the amount of time spent fishing or invest in other activities such as farming in order to maintain total income at the level it was prior to implementation of the agreement. The problem is that there are good reasons for the primacy of fishing over crop production in these communities that has to do with labor productivity and the distribution of labor and income over the course of the year.

Figure : Management Transition. (Hypothetical income of R$950)

Households face a management transition in which implementation of the agreement leads to a dramatic cut in the productivity of fishing effort and consequently in fishing income (McGrath et al. (1993). By drastically reducing pressure on the fishery, this management strategy seeks to insure the fairly rapid recovery of local populations. The productivity of fishing effort recovers gradually, eventually exceeding that of gillnets at the time the agreement was implemented. This transition is shown in figure XX where fishing productivity decreases from about $0.90/hr with gillnets to $0.70/hr when gillnets are prohibited and then gradually increases to about $1,20/hr as the fishery recovers, exceeding the original productivity even without gill nets. In this final phase households have more diversified economies made possible in part by the subsidy provided by the higher productivity fishery. This initial drop in fishing productivity and income constitutes a major barrier to the development of more intensive management regimes (McGrath et al. 1993). The success of these initiatives depends on the capacity of management organizations to enforce rules and control free-riding so that members have confidence that others are complying and that there is a reasonable likelihood that short-term sacrifices will be compensated for in the medium term.

B. Cattle Ranching and Collective Agreements:

Cattle ranching has been a part of floodplain land use since quite early in the history of Brazilian/Portuguese settlement in the region, taking advantage of extensive natural grasslands exposed during the low water season. Floodplain ranching has grown considerably over the last few decades as a result of innovations in transport technology and subsidized loans for pasture development in upland areas adjacent to the floodplain. While in the past cattle were maintained on raised platforms, called marombas, and fed cut grass through the flood season, they are now moved between floodplain grasslands in the low water period and upland pastures during the 4 months of peak flooding. This strategy has also been adopted by many smallholders who have either acquired land in smallholder settlements adjacent to the floodplain or rent pasture for their cattle during the flood season. The seasonal movement of cattle between floodplain and uplands eliminates the major bottleneck to the growth of floodplain ranching, the need to maintain cattle in raised platforms, and permits ranchers to put much larger numbers of cattle on floodplain grasslands during the low water season than could be maintain in marombas during the flood season.

As with the fishery two distinct ranching strategies can be distinguished, that of larger scale land owners who specialize in raising cattle and water buffalo and maintain sufficiently large herds to generate a regular income from ranching and smallholders who are part time

ranchers, have too few animals to generate an income so that ranching serves primarily as a way of storing savings for family emergencies. As noted earlier, 45-50% of smallholder households raise cattle and the average herd is around 20 head, although. This figure is somewhat skewed upward by the 8% of cattle owners with more than 100 head and, in fact, more than half of those with cattle have less than 17 head. In many if not most cases, returns from smallholder cattle raising are very low and possibly even negative, however, the cultural value of raising cattle combined with its role as a mechanism for forced savings or insurance seem to provide sufficient motivation.

The role of cattle as a savings and accumulation strategy is reinforced by two institutions, the cattle partnership or society and more or less open access to floodplain grasslands. Cattle societies are partnerships in which one person lends a number of cows and one or more bulls to a second person to raise for a specified number of years. During this period the person receiving the cattle is responsible for caring for the animals and at the end of the contract the calves produced are divided equally between the two and the original complement of cattle is returned intact to the owner or the contract can be renewed for another few years. These partnerships are widespread among large and small-scale ranchers throughout the Amazon and some 85% of cattle owners in a survey of the smallholder household economy were currently involved in a cattle partnership (Almeida 2004). These arrangements are especially important as a strategy for families interested in starting up their own herd. In a survey conducted by Merry et al. (2005) 53% of respondents stated that they had started their herds through a partnership. The importance of these partnerships is in large part due to the fact that families have had largely unregulated access to community grasslands enabling them to form societies and care for far more cattle than their own properties could support (Sheikh et al. 2006; Merry et al. 2005).

The result is a classic tragedy of the commons in which individuals pursuing their own short-term economic interests contribute inevitably to the overexploitation of community grasslands (Hardin 1968). In fact, cattle densities tend to be significantly higher in community territories than in adjacent ranches. Camara and McGrath (1978), for example, found that on average smallholder herds were several times larger than the estimated carrying capacity of their properties. The system was viable because cattle owners were able to exploit the grasslands of those without cattle.

As cattle herds have grown, so has the number of complaints and conflicts resulting from cattle damaging crops and also fishing gear as they feed on floating vegetation in lake shallows (Sheikh et al. 2006)[3]. In response communities sought the assistance of government agencies and local Ngo's to help resolve the problem. The solution was to adapt the approach taken for managing fisheries to the problem of managing cattle grazing on community grasslands. Collective agreements were prepared in negotiations between cattle owners and communities to regulate the raising of cattle on the floodplain. Known as Terms for Adjustment of Conduct or TACs, these collective agreements are legally binding for all who sign them, and are monitored and enforced by the Public Ministry together with other local institutions (Sheikh et al. 2006).

Typically, these agreements include rules for separating areas for grazing and farming, define procedures for compensating damages to crops and gear caused by cattle and establish dates for the removal of cattle from the floodplain as waters rise and for their return as floodwaters recede. This measure was identified by Sheikh et al (2006) in a study of floodplain

[3] For a longtime, ranchers were able to impose the view that farmers should fence their fields to protect them from cattle. Only recently have farmers, pointing out that it is the cow that attacks the corn and not vice versa, been able to shift the onus for fencing to those who own cattle.

cattle and water buffalo ranching as a simple and effective measure for reducing the frequency of conflicts between ranchers and farmers and fishers. Though simple the measure does marginally raise costs for smallholders. Most families with cattle seek to maintain their herd on the floodplain as much of the year as possible, because few have upland pastures to maintain their cattle during the flood season and even those that do rarely have sufficient pasture for all their animals. Owners without their own upland pasture must rent pasture paying a monthly rate per head. Given the costs associated with maintaining cattle on upland pastures, rules limiting the amount of time cattle can spend on the floodplain will increase their costs.

Interestingly, only a few of the more than fifty agreements already implemented include measures to limit the size of individual herds, despite the fact that this is the underlying cause of the problems generated by cattle ranching. The lack of size limits reflects resistance to measures that might constrain the potential for accumulation via growth of cattle herds. Because, as is the case with fishing agreements, most TACs seek primarily to reduce or eliminate abusive practices, they have little or no direct impact on household ranching strategies or on the role of ranching in the household economy. In the few cases where herd size is limited, rules seek to relate the number of animals a family has with the size of their landholding. However, the wording suggests more a principle to which cattle owners should adhere, and no deadline is given for compliance. Furthermore, the carrying capacity limits proposed are several times higher than those that most specialists would consider appropriate. A large proportion of smallholders have more cattle that their land can support and consequently, widespread implementation of a more realistic upper limit on carrying capacity of floodplain grasslands would have a devastating impact on smallholder cattle raising and its role in the household economy.

IV. Impact of Agreements on Household Fishing and Ranching Strategies.

In the previous section we discussed the impact of management regulations on the fishing and ranching strategies employed by floodplain households. Here we examine how management regimes affect the interaction between economic activities within the household economy. In this regard three points should be highlighted from the previous discussion. First, both fishing and ranching agreements seek to curtail abusive practices and avoid rules that might have a major impact on prevailing patterns of resource use. Second, agreements are as much concerned with insuring equal access to resources as they are with conservation, and include measures to restrict capacity and discourage practices through which individuals could appropriate a disproportionate share of the resource. Third, contrary to the claims of critics (Goulding et al. 1996; Smith 1999), these measures, even where they do not significantly modify normal practices, do seem to improve the productivity of fisheries and reduce some of the negative impacts of cattle ranching. Fourth, there is a temporal dimension as management interventions change the productivity of the fishery and/or constrain ranching activity, forcing households to adapt their economic strategies to evolving conditions in the fishery and in the grasslands. As these adjustments disseminate through the community, they may create new pressures on floodplain resources requiring further collective action in a long-term process of adaptive learning at household and community scales.

Fishing and cattle ranching are the two poles of the household economy, and the relationship between them is at core of household economic strategies. A basic question here is the relative efficiency of the two activities in terms of labor and area. Although there is no

definitive answer to the question, existing studies indicate that fishing is the more economically productive activity in terms of labor and area under most conditions (Junk et al. 2000, Ohly & Hund 2000). This is probably even more the case in the Santarém region due to the dismal quality of the animals and depressed market conditions for floodplain cattle. The presumed higher productivity of floodplain fisheries has led some writers to argue that it makes more sense to cultivate "fish orchards" and manage fish than to raise cattle (Goulding et al. 1996).

The problem with this suggestion is that it ignores differences between fish and cattle with regard to their role in the household economy, the nature of the property rights associated with each and their characteristics as a resource. Fishing and ranching serve different economic functions, one generates income and the other is a medium term investment, so they are not interchangeable at the scale they are practiced. Furthermore, they are subject to different property rights. Cattle are private property and the rights of owners are generally respected, while fish are public/collective property and belong to whoever catches them first. Finally, the two have different characteristics as biological resources. Cattle are terrestrial and can be visually monitored with little difficulty. Fish are aquatic and are very difficult to monitor so there is much greater uncertainty regarding the status local fisheries than there is regarding individual cattle herds.

These other aspects of cattle and fish tend to outweigh questions of their relative economic efficiency. Here the main issues are the security of property rights and confidence in the competence of collective management organizations. In fact, smallholders are operating very much as Popkin (1979) would have predicted, invest in the family for long term security and in the community for short term benefits. Based on this logic, cattle are clearly the better longterm investment, while smallholders seek short term gains from the fishery. Here we will examine how management agreements influence household economic strategies, especially with regard to the roles and relationship between fishing and raising cattle. Later we will investigate the conditions under which smallholders might begin to consider the fishery as a long-term investment.

The first case involves the impact on household economic strategies of co-management agreements. Here, we noted that while there is little difference in fishing practices between managed and unmanaged lake fisheries, fishing in managed lakes is significantly more productive. Earlier, we argued that high productivity fisheries serve as a direct and indirect subsidy for other household economic strategies liberating more labor and also generating money that can be invested in other activities[4]. Given this view, how does the increased productivity of the fishery affect household management strategies? Do households invest the gains in raising more crops or in ranching? To the extent that households invest in farming, increased income from crops might also be invested in cattle, so that one outcome of the increased productivity of the fishery is likely to be a greater number of families with cattle and larger average herd sizes. This tendency is not evident in our data set as the sample of households from managed and unmanaged lakes shows virtually no difference in farming activity. While herd size is on average larger in communities with managed lakes, the difference is not significant, due to the great variability within each sample.

The situation is somewhat different in the case where management rules are more stringent and gill nets are prohibited. Here the relative roles of cattle and fishing may change considerably as the management system evolves through the management transition. In the first

[4] Depending on how stringent management regulations are, families have the option of investing to increase fishing effort.

phase immediately after the management system is imposed and gill nets are prohibited, the productivity of fishing effort falls significantly. Families must invest in other activities such as crop production to compensate for lost income. Here not only is investment in increasing herds likely to dry up, but households may be forced to sell animals to support themselves until other income sources can be developed. The stagnation or even decline in the community herd may reduce pressure on habitat and aid recovery of the fishery. However, as the productivity of the fishery recovers, investment in ranching could increase once again leading to renewed pressure on grasslands and forests and degradation of the productive capacity of floodplain fisheries. Here, as in the first case, the benefits gained from managing one common pool resource simply contribute to the more intensive exploitation of the other, once the productivity of the former has recovered.

The third case involves the collective regulation of ranching activities. It may not be a coincidence that implementation of the regional co-management system was followed shortly by community efforts to bring ranching under control as well. As noted earlier, most cattle agreements seek to mitigate the problems generated by extensive cattle ranching, and very few include measures to limit the number of cattle families can graze on community grasslands. One measure that is aimed not just at reducing damages to fishing gear, but also seeks to protect fish habitat, is the rule requiring cattle to be removed from the floodplain as waters rise and stipulating conditions for the return of cattle as water levels fall. This measure seeks to protect aquatic macrophyte communities from predation and permit growth of "floating meadows" that are the main nursery habitat for many floodplain fish species and other aquatic and semi-aquatic vertebrates (Junk et al. 2000). It is one of the very few measures that favors the fishery over ranching. This kind of management regime seeks to make ranching more compatible with other economic activities by reducing more visible sources of conflict with ranching.

The fourth case involves those situations in which communities have imposed restrictions on the number of cattle households can maintain on the floodplain. As noted earlier, most agreements do not limit cattle and even those that do give maximum stocking rates well above sustainable levels and so have little impact on individual herds. While none of the agreements implemented to date requires realistic stocking rates, it is interesting to investigate what the impact of such a regulation might be. Approximately 50% of smallholders with cattle have less than 17 head. If a rule of one head per hectare were applied the average property of 20 hectares (one hundred meters of frontage versus two thousand meters long) could maintain at most 20 head. However, since a large part of the 2000 meter length of the property is underwater much of the year, the effective area for pasture is much smaller, perhaps only 1000 meters or 10 hectares. Since many properties are even smaller, the effect would be too drastically reduce the potential for smallholders to use ranching as a longterm investment strategy, athough its function as accident insurance would remain viable for most families. This kind of measure would also reduce the frequency of cattle societies, especially for those who already have some cattle.

A significant reduction in the potential for expansion of herds could affect household economic strategies in a number of ways. Before investigating these interactions, it should be noted that the value of cattle ranching as a savings strategy is being undercut by the integration of smallholders into the formal economy, including access to formal savings accounts, as well as greater access to government social benefits, including retirement pensions and unemployment benefits during the closed season. Given the dubious economics of smallholder ranching under prevailing conditions, herd size restrictions could lead to a greater than expected reduction in the number of families raising cattle and in average herd size.

These changes could benefit the fishery, since cattle ranching has been the major cause of habitat degradation on the floodplain over the last two decades (Sheikh et al. 2006). As ranching becomes less attractive as an investment strategy, households might be more inclined to invest in the management of the fishery and also in implementing rules that seek to conserve floodplain habitats. This possibility is also supported by the fact that the successful implementation of collective agreements for fisheries and cattle reinforces confidence in the efficacy of local management organizations and thereby reduces insecurities with regard to the risks involved in making longterm investments in managing the fishery. In this way, the barriers to investment in community management identified may be overcome.

The challenge is how to turn a fish into a cow from the perspective of smallholder investment strategies. An example of how this might work can be found in community initiatives to adaptively manage local pirarucu fisheries. Here groups of fishers with the support of a local ngo are developing adaptive management systems based on a participatory census methodology developed by Castello (2000) at the Mamirauá Sustainable Development Reserve. The pirarucu, *Arapaima gigas*, has several features that make it a very promising species for management in floodplain lakes. It is one of the largest fish species in the Amazon, has great commercial and cultural value, and is a sedentary, lake dwelling species that gulps air on a regular basis and forms couples to care for young during the first 4-6 months after spawning. A participatory census technique, based on wildlife census methods, has been developed in which teams of experienced fishers are trained to count the number of times fish rise to the surface in order to estimate the number of adult and juvenile pirarucu in the lake being surveyed. By combining this information with information on the number and distribution of breeding couples, and statistics on the local pirarucu catch, fishers gain a very concrete understanding of local pirarucu population dynamics. With this information fishers can develop management plans establishing annual quotas. An important fearure of this kind of management system is its linkage to a collective marketing strategy. Many communities harvest the annual quota collectively, for example. Income from the sale of the catch is then distributed among participants according to their contribution to the management system over the course of the previous year, with a proportion of the total going to a community fund. This approach reinforces confidence in the collective management system in several ways. First, the methodology for monitoring fish populations reduces one of the main problems with managing fish, the fact that they are largely invisible so there is no feasible way of determining the status of stocks. Second, the management system generates a highly visible and concrete benefit that is distributed according to each individual's contribution while a portion contributes to a collective fund, thereby reinforcing the collective value of the fishery resource. Finally, the tightly organized management system provides guarantees that free-riding will be discouraged and that benefits will be consistent with individual investments (McGrath et al. 2005).

As these kinds of management systems develop and proliferate in the region, they are likely to further change smallholder propensity for investing in the management of common pool resources. In fact, this seems to be happening in one community, instigated in part by the observations of pirarucu management teams that lakes without a significant cover of aquatic macrophytes and no breeding couples of pirarucu. Fishers attribute the lack of floating vegetation to excessive pressure on grasslands during the low water season. The community is now beginning the process of negotiating rules to reduce pressure and protect what is considered the most productive and longest managed pirarucu fishery in the Lower Amazon.

V. Discussion/Conclusion

The above investigation of the interaction between household economic strategies and collective management regimes illustrates the complex and dynamic nature of this interaction, how ecological and household responses to a management regime lead to new interactions and may generate new problems that require new collective agreements or the modification of existing agreements. Implementation of fishing agreements lead to increased productivity of the fishery, which led to greater investment in cattle. As herds grew, conflicts proliferated and pressure increased requiring progressively more stringent rules for floodplain ranching that could eventually drastically reduce its importance for floodplain smallholders.

A key issue here is the extent to which increasingly productive and well managed fisheries based on robust local collective organizations can generate sufficient confidence in smallholder families that they will come to see management of local fisheries as a long-term investment comparable to the role that cattle ranching now plays. Here a critical factor, or set of factors alluded to earlier, are the regional market and macroeconomic and social trends that are reducing the market value of cattle, their importance as a savings strategy and more generally its reliability and economic efficiency as a long-term accumulation strategy. Smallholders increasingly have bank accounts and receive various kinds of government payments. These trends reinforce those in the development of effective and reliable management systems for local fisheries and other resources. Through this longterm adaptive learning process some communities seem to be moving slowly and carefully in the direction of more integrated approaches to the management of floodplain resources, more consistent with the basic dynamic of the floodplain ecosystem (Junk et al. 1989; Junk et al. 2000), that seeks to optimize global production from a number of different sources rather than specializing in one or another activity.

This paper is largely an exploratory essay that seeks to lay out the main interactions involving households, communities, resources and their respective management regimes as a first step in analyzing case studies to test the model described here. Analyses of existing data sets comparing smallholder economic strategies in managed and unmanaged lake systems reveals little difference between the two. Even where differences are larger, they are not statistically significant. It is clear from these initial investigations that we need to think carefully about how to design a methodology that enables us to get at these interactions with more precision, so we can better understand how households and management systems co-evolve over time. This information will be of great importance not just for better understanding of the dynamics of collective management, but also in designing more effective policies and intervention strategies in support of participatory management systems.

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Figures and Tables:

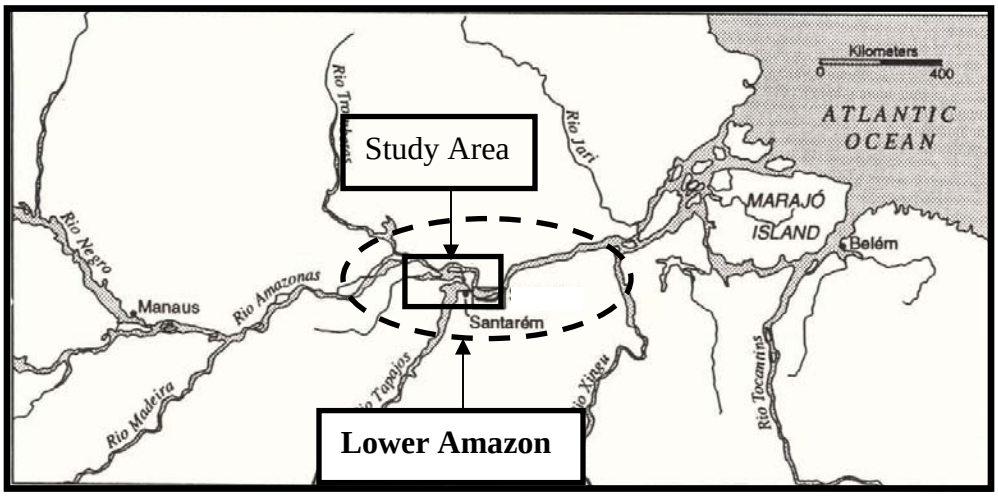

Figure 1: Lower Amazon and Project Study Area.

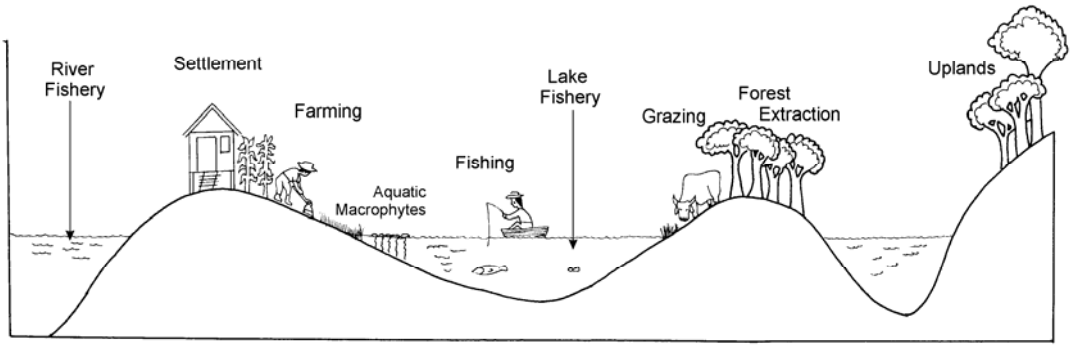

Figure 2: Major Habitats and :and use Activities of Lower Amazon floodplain

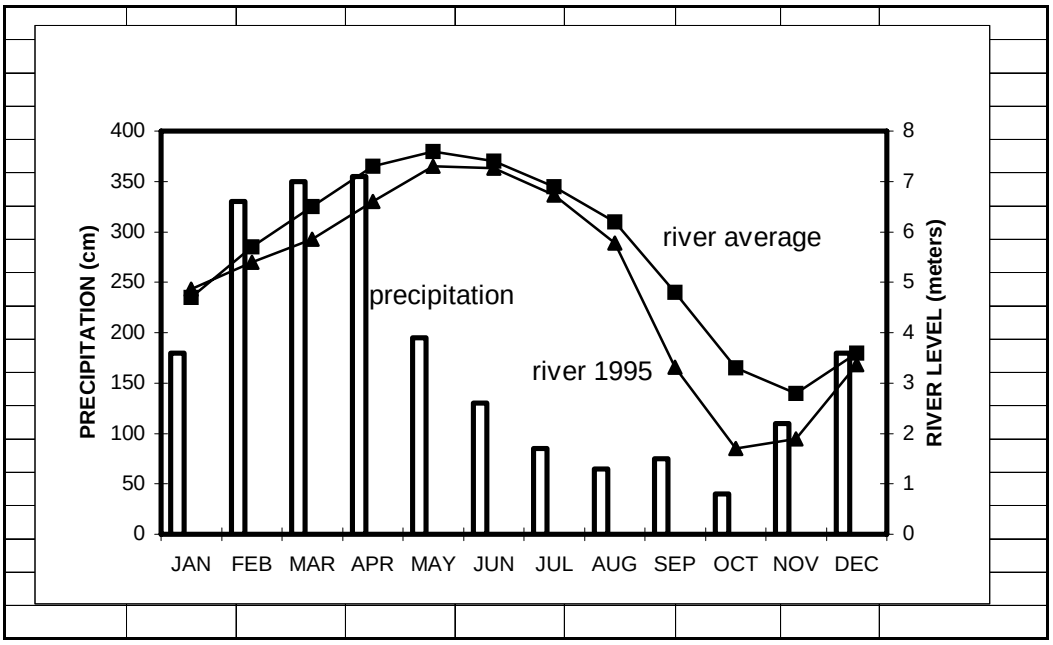

Figure 3: Seasonal Variation On The Varzea

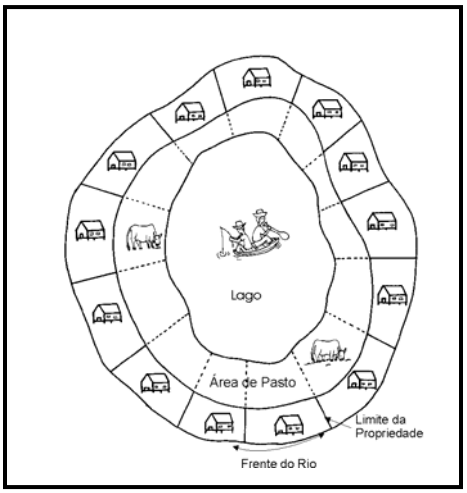

Figure 4: Property Rights Zones on the Floodplain

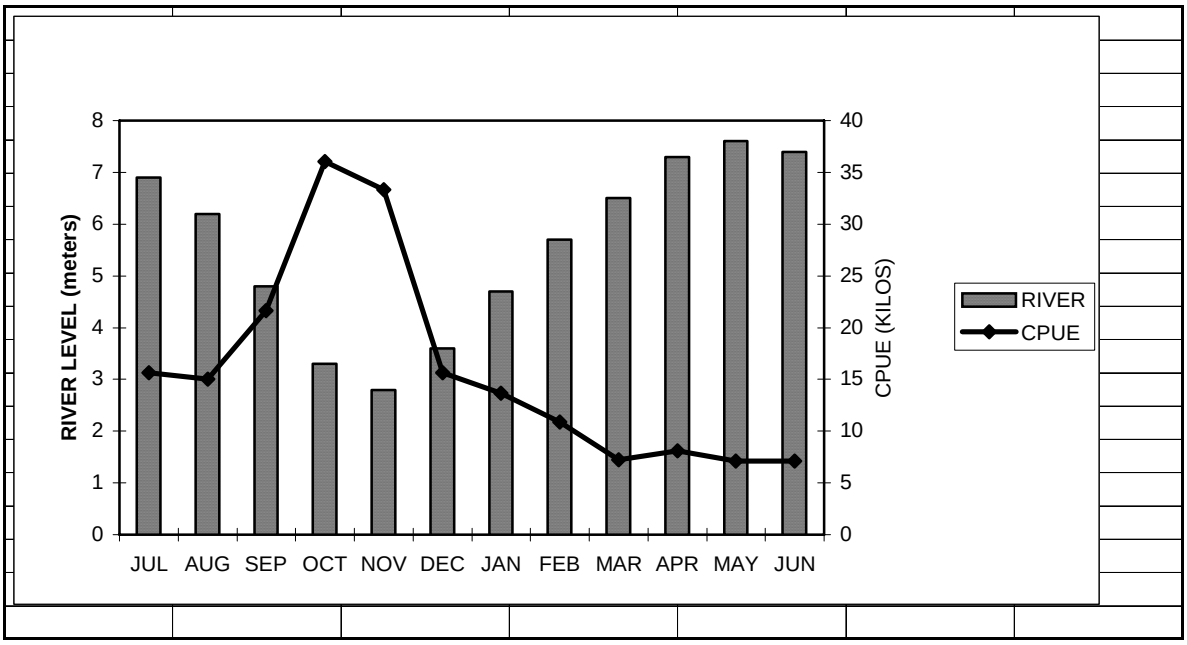

Figure 5: Seasonal Variation In Cpue (Kg/Fisher/Day)

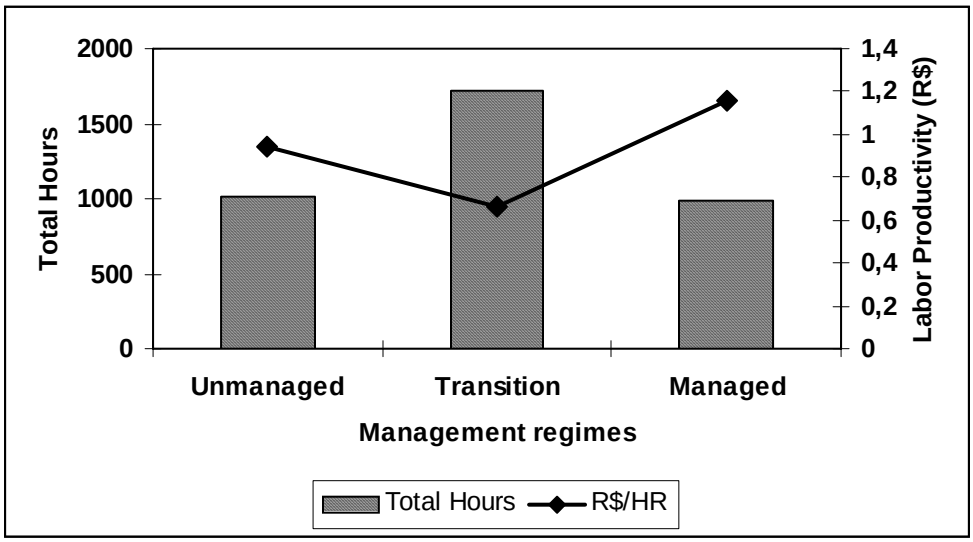

Figure 6: The Management Transition. (Hypothetical income of R$950)

Table 1: Frequency of Income Sources in Sample Household

INCOME SOURCE	FREQUENCY
Fishing	84%
Farming	81%
Small Animal Husbandry	88%
Government Benefits	60%
Cattle ranching	45%
Salaries	16%

Table 2: Total Annual Family Income by activity.

Income Type	Sample	%	Family	Month
Government Benefits	257,949	31%	1,000	83
Salaries	86,532	10%	335	28
Fishing	309,783	38%	1,201	100
Agriculture	144,497	18%	560	47
Cattle	26,748	3%	104	9
TOTAL	**825,509**	**100%**	**3,200**	**267**

Source: (Almeida 2004)

Table 3: Economic Diversity and Average Annual Income by Household

Activity	Count	%	Value Income	SD
One activity	**70**	**30%**		
Two Activities	**100**	**39%**		
Fishing and Agriculture, No Cattle	70	27%	2,361.33	3,785.21
Agriculture and Cattle, No Fishing	12	5%	2,853.69	4,005.95
Fishing and Cattle, No Agriculture	18	7%	3,172.03	5,403.18
Three Activities	**81**	**30%**	**3,796.70**	**6,874.93**