

SMALL-SCALE FISHERIES IN LATIN AMERICA: Management Models and Challenges

Alpina Begossi

Fisheries and Food Institute (FIFO) & Capesca (LEPAC-PREAC) & CMU, (UNICAMP),
Brazil

alpinab@uol.com.br

Abstract The theme of the MARE 2009 Conference, 'Living with Uncertainty and Adapting to Change', is well suited to Latin American reality when thinking of the uncertainties of fisheries and the economically poor livelihoods of people in riverine and coastal areas. Currently, there are multiple pressures on those livelihoods, many of which come from imposed conservation restrictions by governmental environmental agencies or by industrial fishing. Artisanal fishing in Latin America is economically important, since it contributes to about a half of national catches for most countries, and it guarantees the subsistence and protein intake of riverine and coastal livelihoods. In order to manage aquatic resources in Latin America, attention to its particularities is needed, including an understanding of the: 1) local level of communities; 2) their geographic dispersion; 3) pre-existing local rules regarding the use of resources; 4) lack of data on aquatic resources; 5) significant body of available local ecological knowledge; and, 6) current levels of poverty and social needs. Moreover, this study addresses the absence of data on natural resources in most Latin American countries, and as a consequence, the problem of detecting overfishing which has been one obstacle in the management of natural resources. Considering those aspects, different approaches to co-management are highlighted in this study, since they are useful for the understanding of the different contexts where co-management is developed. Historical accounts by fishermen are much needed in fisheries that lack a baseline: such relevance increases the importance of participatory approaches in management and the necessity to rely on the use of local knowledge. Cooperatives and Reserves are illustrated, covering marine and freshwater systems. A Brazilian case comparing ecological-historical management processes in the Atlantic Forest coast to Amazonian reserve movements serves to illustrate the need for a temporal understanding of management systems. One of these reserves, the 'Sustainable Development Reserve' in Brazil, is illustrated as a form to include livelihoods in the management process. Finally, the challenges that the management fishery resources in Latin America are faced are analyzed in this study, including the importance of turning attractive management for the poor, taking into consideration the subtractability of managed resources, and the questionable legitimacy of some institutions.

Introduction

In this study, illustrative cases of co-management are given for a set of Latin American fisheries, ranging from ones based on local rules to ones in South and Central America undergoing changes in institutions towards co-management. Emphasis is placed on fisheries in the Amazon and in the Atlantic Coast in Brazil. Special attention is given to historical contexts, where local demands have key roles in initiatives towards conservation. Case studies illustrate and cover: a) co-management processes; b) cooperatives; c) movements towards reserves or fishing agreements (*'Acordos de Pesca'*) with riverine Amazonian fishers; and d) methods used to access local knowledge and local demands of coastal fishers of the Atlantic Forest coast. The methods are applied toward understanding the use of fishery resources and marine space, fisher behavior, and local ecological knowledge (LEK).

Models of management within fisheries have often been applied without taking into account the differences between tropical and temperate systems. One of the key differences lies in the multiple types of fishing gear employed in tropical fisheries, including harpoons, gillnets, and a variety of different hooks, thereby allowing multiple species to be targeted. Local fisheries in tropical areas are dispersed and formed by small local villages, most of which follow local rules regarding the use of the natural environment and aquatic space. Kin ties at both the household and community levels are important to understanding of local rules that apply to fishing activities.

In this paper, models of co-management, local knowledge, and protected areas are analyzed through case studies. Special attention is given to co-management techniques that take into account local rules and methods that include a dialogue between fishers and researchers. An analysis of the background of management in Latin America and current practices of co-management is important in order to understand the particularities of the small-scale Amazonian riverine fisheries and of the coastal Atlantic Forest fisheries. Diverse models of co-management exist to address concerns about overfishing and the sustainability of small-scale fisheries, which are often pressured by large-boat industrial fisheries and governmental restrictions on fishing activities due to adjacent protected areas.

The context of selected co-management models in Latin America is provided, focusing on protected areas but also including the applications of local knowledge and adaptive management towards local management. Those incorporate both: 1) how dialogue between fishers and researchers, on the one hand, and between local and scientific knowledge, on the other hand, can improve co-management procedures and help local fishers when dealing with government agencies; and 2) how historical contexts contribute to differences in the legitimacy of local organizations and in co-management processes.

Efforts to determine the human-ecological, cultural and economic contexts of the fisheries, with examples from riverine and coastal fisheries, are given according to four methodological objectives: 1) gaining knowledge on the use of aquatic and terrestrial natural resources (including fish, plants and terrestrial animals) from local families within the fishery; 2) gaining knowledge on the use of the aquatic space, accessing information about kin ties and existing rules;

3) increasing knowledge about the behavioral dynamics of fishers including their main targets and decision-making processes; and 4) gathering information that exists as local knowledge on the fishery's species and their reproductive habits, and diet, among others. The gains in knowledge and understanding are needed in order to comprehend the multiple tasks and scales associated with local historical contexts that management must tackle in Latin America.

Small Scale Fisheries and Fishery Production in Latin America

The majority of fish production concerning continental catches is concentrated in a few countries in Latin America. On the continent, about five hundred thousands of tons/year are taken (COPESCAL/FAO 2008), ninety per cent of which is taken in six countries: Brazil (fourty-five per cent), Mexico (eighteen per cent), Venezuela (nine per cent), Peru (seven per cent), Argentina (six per cent), and Colombia (six per cent). When marine catches are considered, Peru and Chile emerge as leaders: in 2007, Peru accounted for more than nine thousand tons, and Chile four thousand tons. Marine catches have a high relative importance (in proportion to continental catches within these countries) in countries like Guatemala (sixty per cent), Brazil (thirty-two per cent), and Colombia (twenty-four per cent). Fish consumption is extremely important in many Latin American sites; in the Amazon Basin it can reach almost about 300 kilograms per year for certain rural populations (COPESCAL/FAO 2008). Shrimp includes both extraction and farming (Lopes 2008). Considering global figures, fifty-three per cent of world catches come from marine fisheries (160 mi/tons in 2006, World Bank, 2008). Fish consumption from marine sources is still high (around sixty per cent in some areas) in rural coastal population of the Atlantic Forest coast, in spite of some tendency of reduction (Hanazaki and Begossi 2004; MacCord and Begossi 2006).

Artisanal fishing takes on a special value in Latin America. In Brazil it represents about fifty-three per cent of production (SEAP 2007; Vasconcellos *et al.* 2007), but in the northern parts of the country, it may be responsible for about seventy per cent of fish landings (Cordell 2006). In Venezuela, artisanal fishing comprises sixty-five per cent of fish production (Rojas 2009).

Small scale fisheries in Latin America are responsible for a great deal of fish production, but they are especially important in guaranteeing protein for most rural people living on river banks or coastal sites. Salas *et al.* (2007) reported the figure of two million tons of fish per year for all Latin American and Caribbean fisheries. Beyond fish production, small-scale fisheries in Latin America are part of the livelihood of rural populations, which rely on the use of a rich environment characterized by high biodiversity. Environmental uses include the harvesting of aquatic animals, medicinal plants, and game, among others. Small-scale fisheries in Latin America also target subsistence and commercial species; most are commercial, at least in the sense that extra production is sold after consumption needs are met. As currently almost, or virtually all, small-scale fisheries sell some part of their catch, even in hidden parts of the Amazon region, the possibility of taking part in petty commercialization is widespread.

Besides the typical small-scale fisheries, which include fishing for consumption and sale, the capture of ornamental fish is an extractive activity of huge importance in the Amazon. Ornamental fisheries in the Amazon include about 150 species, but demand focuses on a few species; overfishing has already been observed, as for the cardinal tetra (*Paracheirodon axelrodi*) and the discus (*Symphysodon* spp.) (Crampton 1999). The cardinal tetra comprises eighty per cent of ornamental fish commercial capture in the Negro River, Amazon (Chao *et al.* 2001).

In spite of the economic importance of artisanal fisheries, and of the existence of important commercial species that are currently considered 'endangered' (such as grouper, Begossi and Silvano 2008), the management of coastal and riverine fisheries in Latin America lacks systematic information on catches, and participatory management occurs just for certain cases, such as Belizean cooperatives and some Amazonian reserves (Begossi and Brown 2003). Management processes have been often top-down, following international or national programs, as the Marine Extractive Reserves developed in the last ten years in Brazil, and carried out by the Brazilian Governmental Agency, the IBAMA. Such trends have reduced the credibility of the government for fishers and have shaken the legitimacy of the initiatives.

Co-Management Processes in Latin America

A variety of initiatives exist in Latin America for the co-management of fisheries. Ranging from informal rules to pre-established systems of co-management, there is a tendency towards top-down approaches in Latin America, where the State has outlined the major rules for the processes to be followed (Begossi and Brown 2003). Considering that co-management has different meanings in different settings, a useful definition follows:

Co-management is a collaborative and participatory process of regulatory decision-making between representatives of user-groups, government agencies, research institutions, and other stakeholders. Power sharing and partnership are an essential part of this definition (Jentoft 2003:3).

As such, co-management is part of a Local Management Systems (LMS), defined by de Castro (2002:2) as 'mosaics of prescriptions created throughout the history of the users according to a range of incentives and goals'.

Following both definitions, we can examine co-management in local contexts (Berkes *et al.* 2000), employing livelihood and historical processes as well as ecological and economic characteristics. In those regards, the perspective on co-management follows an interesting observation by Jentoft (2006), that sometimes the problems in a fishery's co-management do not result from fisheries management itself, but from representation of a deeper socio-political and institutional problem emerging from the society by which it is surrounded.

A variety of processes affecting co-management in Latin America fisheries are shown in Table 1. These involve different temporal stages and economic perspectives, including: cooperatives; incipient developments towards co-management practices; and cases with government support. As Table 1 shows, co-management is increasing in Latin America, firstly through as cooperatives in Central America and secondly through other co-management processes in all areas, where power is shared to differing degrees. Such processes can increase the chances of successful management, as they include the participation of users and parties interested in the resource, which are especially the case in the small-scale communities that rely on coastal, estuarine or riverine resources for their livelihoods.

Table 1. Selected examples of local rules and of co-management processes in Latin America²

Reference	Areas	Fishery	Control of resources	Environment
Begossi (2001, 2004, 2006)	Coastal fishing communities in the Atlantic Forest coast, Brazil	High species richness that are caught for consumption and sale (fish and shrimp)	Informal division of fishing spots	Coastal shores, Atlantic Forest coast
Seixas and Troutt (2004), Seixas (2004)	Santa Catarina, Ibiraquera Lake, Brazil	Shrimp fishery	Local demands for management and laws, local <i>forum</i>	Coastal
Leveil and Orlove (1990), Orlove (1991)	Fishing communities at Lake Titicaca, Puno, Peru .	<i>Orestias</i> sp. (Cyprinodont) represents 67% of the annual catch. Gillnets are used for fishing. About 2/3 of the catch is commercialized.	Fishing territories are communally controlled. Totora yields derived from exclusive use rights.	Large and high altitude lake
Cordell (2006) and Castilla and Fernandez, (1998)	Coastal areas of Chile (MEA)	Especially benthic resources, <i>Venus anti-gua</i> clam and <i>Concholepas concholepas</i> gastropod ['loco'].	MEABR (Management and Exploitation Areas for Benthic Resources), territorial use rights to artisanal fisher unions. <ul style="list-style-type: none"> - 547 MEABR, 301 with management plan on benthic resources. - 1989-1992: total closure - 1993: (TAC: Total Allowable Catch) 	Coastal shores
Seixas (2006), Seixas <i>et al.</i> (2008)	Arraial do Cabo Marine Extractive Reserve, Rio de Janeiro State, Brazil	Hook and line, beach seines, pelagic and other fish	MER	Coastal shores

Reference	Areas	Fishery	Control of resources	Environment
Pinedo e Soria (2008), [Editors] Duque <i>et al.</i> (2008); Fernandes and Berkes (2008)	Peru, Bolivia, Colombia, Guiana Central Examples from diverse fisheries	Fish, multi-gear, multi-specific	From local or informal rules (River Pichis, Peru) to co-management processes (lagos Yahuaraca in Colombia and management of Arapaima in Guiana Central)	Rivers and Lakes
Almeida and Menezes (1994), Begossi (1998), Begossi <i>et al.</i> (1999)	Extractive Reserve of Upper Juruá, Acre State, Brazil (1990). Demanded by local population represented by CNS ³ , legalized by IBAMA in 1990 (Decree 98.897)	Fish and other fauna. Fishing is permitted for local consumption (subsistence). There are about 6,000 inhabitants in a areas of 5,062 Km ²	The management plan was approved in 1994 by IBAMA. Management include local participation, through meetings in assemblies with <i>ribeirinhos</i> and with researchers.	Rivers Juruá and Tejo
McDaniel, 1997	Reserva Comunal Tamishiyacu-Tahuayo (RCTT), Tahuayo River, Chino, Peruvian Amazon . (1991)	<ul style="list-style-type: none"> - Fish using nylon mesh nets (<i>trampas</i>), -Long-lines (<i>espineles</i>) - Spears (<i>flechas</i>) - commercial fishing is a supplemental activity, importance of the fishery for subsistence - sales at market of Iquitos. 	<ul style="list-style-type: none"> - Communal management in 1984. - RCTT established in 1991 - community elects a inspector of the fishery, vigilance system - fishery is more sustainable than in 1980. 	Lakes, river
Queiroz (2005), Castello (2004), http://www.mamirauá.org.br	First EEM (Ecological Station) in 1990, and secondly (1996) as RDS (Sustainable Development Reserve, approved by Amazonas State), Amazonas State, Brazil .	About 60 riverine communities in the Reserve. Pirarucu (<i>Arapaima gigas</i>) and Tambaqui are important commercial fish.	Management is decided with local participation in Assemblies and there is a Deliberative Council. NGOs and researches participate in monitoring. There is a local radio (<i>Ligado em Mamirauá</i> – ‘Linked in Mamirauá’).	Rivers Solimões and Japurá, Amazon <i>várzea</i> .
De Castro (2002, 2004), de Castro and MacGrath (2001), MacGrath <i>et al.</i> (1993), MacGrath (2000), Macgrath <i>et al.</i> (2008), Ruffino (2008) (<i>in</i> Pinedo and Soria, 2008)	‘Fishing accords or agreements’, Amazon lakes, Brazil .	Multi gear and multi-species fisheries. Gillnet fishing for migratory fish (catfishes). Other catches are tambaqui (<i>Colossoma macropomum</i>) and pirarucu (<i>Arapaima gigas</i>).	Community control is based on ownership of lake shorefront property by community members. Is a system of collective ownership based on property held by individual members of the community.	Lakes, lower Amazon River, Amazon <i>várzea</i> . Seasonal flood variations.

Reference	Areas	Fishery	Control of resources	Environment
King (1997)	Caye Caulkner, Belizean Coast -cooperatives in the sixties, Belize	Lobster <i>Panulirus argus</i> /traps and dive	— 1960: northern fishermen cooperative society (NFCS)	Coastal sites
Pollnac (1977)	153 small-scale fishers from six communities from the Pacific Ocean and one (Colon) in the Caribbean Sea: Panama .	Traps and nets, hook and lines.	Cooperatives Cooperative members are more optimistic about attaining the best possible that non-members.	Pacific Ocean, Panama.
Sutinem and Pollnac, (1981)	Golf of Nicoya, Guanacaste, Pacific Ocean, Costa Rica . Data from 187 fishers from 4 communities.	Croakers (Sciaenidae), Snappers (Lutjanidae), Snooks (Centropomidae), and catfish (Ariidae) are common. Market for fishing, importance of middlemen.	Cooperatives. There is high variation in the perception of benefits in participating in cooperatives	Golf of Nicoya, Pacific Ocean.

Overall, Table 1 gives illustrative examples of local and co-management institutions in Latin America. Incipient forms of co-management are illustrated considering informal division of areas in Brazil and in the fishing rules of Lake Titicaca. Other developed forms of co-management include: co-management systems as MERS (Marine Extractive Reserves) or RDS (Development Sustainable Reserves in Brazil), and MEABR (Marine Exploitation Areas for Benthic Resources) in Chile, along with other Communal-Based management systems in Peru, among other areas. Gradients between different scales and levels of local rules have been observed for many of the world's fisheries (Berkes 1985), and are also present in Latin America. The scales and ranges include cases from incipient management forms to co-management processes, those illustrated by territorial rights at different scales, such as groups, clans, villages.

Although Table 1 provides an overview of processes and factors that impact co-management of fisheries, the information is not complete. In order to tackle the Latin American reality concerning resources and people, co-management should take into consideration the following:

1. The local level context of the small scale fishing communities as resource users;
2. Their geographic dispersion;
3. Their local rules regarding the use and sharing of resources, such as territories and taboos;
4. The scarce available data on the aquatic resources;
5. The significant body of available local ecological knowledge; and
6. The current levels of poverty and social needs.

Those are important variables to include in assessing Latin American co-management processes. Nevertheless, there is no evidence in the studies taken from Table 1 that they are all addressed. Some of those variables are included in the different co-management processes shown, but in an uneven fashion. Three of those aspects: 1) local context of the fisheries; 2) geographic dispersion, and 3) scarce data available on resources, are probably common to all thirteen cases mentioned in Table 1.⁴ Other variables, such as the use of local rules, and the available local knowledge are shown, at least partially or incipiently, in cases cited for Peru (Levieil and Orlove 1990; Orlove 1991; McDaniel 1997), in riverine fisheries in South America (Pinedo and Soria 2008), and in extractive reserves and sustainable reserves in Brazil. It may be that the preoccupation and awareness associated with the importance of local knowledge towards management, has reached Latin America only in the last decade, thereby having still many opponents among academics and governmental executors, in spite of being a practice in Oceania and in other fisheries of the world since the eighties (Johannes 1980). In other words, for the cases mentioned, there is only a marginal or incipient process that embodies local rules or local knowledge in the development that leads towards co-management of the fisheries.

The last variable, 'current social and economic levels', is taken into account in any intentional co-management (or management) process in Latin America, but there is no evidence of results associated with the development of the co-management process, concerning the life quality of the local people involved. There is also no sufficient time lag for diachronic comparisons in Latin America. Salas *et al.* (2007) suggests that some weakness are relevant in the management of small scale fisheries in Latin America, such as a lack of control of fishing effort, weak institutional structures, lack of a framework integrating social, bio-ecological, and economic aspects, unresolved conflicts with other fleets, among others.

One exception to the observation by Salas *et al.* (2007)⁵ might be the Sustainable Reserves in Brazil, such as Mamirauá (Table 1), where social and economic developments were part of the management ordering since the process of its creation. It is an illustrative example of an integrated co-management process that embodies many of the recommended features. I had the opportunity to visit Mamirauá Sustainable in 2003, and to follow some of the publications on the development of the reserve, including its fisheries and co-management processes. Mamirauá not only includes the participation of local fishermen in management processes, including the Pirarucu (*Arapaima gigas*) (Castello 2004), but it also includes a livelihood concept that incorporates a variety of incremental features, such as solar energy panels, water filtering, health care, among others, thus linking the management system with people's lives (Website Mamirauá).

Central America seems to have an historical focus on Cooperatives (Table 1). For example, Belize's fishermen's cooperatives emerged in the sixties and have achieved political independence, turning into an interesting example of co-management (Begossi and Brown 2003). There is no single recipe for a successful co-management process, but a local process integrated into its ecological, cultural, social, historical and economic context, with local participation and power sharing, allows for the creation of a much stronger co-management plan.

Institutional arrangements for the co-management of small-scale fisheries vary in Latin America. Some of these are simple institutional arrangements, where fisher's engagement is based upon and rooted within historical local movements, such as the 'Fishing Accords or Agreements' in the Amazon (a kind of collective contract). Others lie under federal government domains (such as MERS – Maritime Extractive Reserves in Brazil).

For Latin America, some additional features should be taken into account, although they fall beyond the fishery itself, which are their historical, economical and cultural pedigrees. In countries with a history of authoritative governments and institutions, even if democratic changes have occurred in recent times, authoritative institutions are often still found, carrying on top-down patterns of behavior. This observation applies to many institutions in Brazil, including the country's environmental agencies (Begossi and Brown 2003). The history of the 'Colônias de Pescadores' in Brazil is also an illustrative example (Breton *et al.* 1996), along with examples of attempts to impose extractive reserves (MERS) (Begossi 2006) and of institutions created by environmental agencies to 'represent' fishers (the AREMAC in MER of Arraial do Cabo, Seixas *et al.* 2009). Other top-down practices include areas that were closed to fishing (artisanal fishers) by government environmental agencies, as occurred in islands of Ilha Grande Bay in Brazil (Begossi *et al.* 2010), and as well conflicts observed in southern coastal Brazil (Kalikovsky and Satterfield 2004). For more information, a comparative analysis on extractive reserves and sustainable development reserves in Brazil is available in Lopes *et al.* (2008).

Corruption and bribery also disrupt any process of development, governance and management. An illustrative case is presented in a study of community-based management in Venezuela (Zannetell and Knutt 2002), which can be generalized to Latin America, and includes the difficulties in dealing with regulatory credibility due to corruption at higher levels of the institutions. The question of legitimacy emerges: how can real co-management develop without legitimate institutions and processes? Pinkerton and John (2008) analyze how a legitimate system can be developed, giving examples at different stages of the process and taking into account historical, institutional, and political features at the local level, not just the characteristics of the fisheries themselves. Unfortunately, a few cases in Latin America could be considered as the outcome of legitimate processes; the main reason for that is not strictly tied to fisheries, but to the general behavior found within institutions, especially governmental institutions that still carry within past autocratic behaviors.

The cost of changing institutions, or creating emergency institutions, should also be considered (de Castro 2002). This prompts a general consideration of transaction costs, such as the cost of information, bargains, enforcing rules, collective action, and more, all of which should be considered (Hanna 2003). Differences in legitimacy, both in the process of emerging institutions and in the process of the practice of co-management, can lead to differences in transaction costs, as shown by Begossi (2006) in Brazil. For example, failing to consider pre-existing local rules in a fishery can increase transaction costs and reduce legitimacy.

Discussion

Tackling fishery management has some peculiarities that should be taken into account in countries where there are no baselines and no temporal data available, which applies for most Latin American countries. Those peculiarities are how to detect overfishing, the lack of historical data and the lack of information on tropical species. Other aspect to be considered here is how to analyze Latin America cases in direct comparison with the current models of co-management, specifically adaptive management, ecosystem approach, local knowledge, and protected areas (following Ruddle and Hickey 2000).

Problems Associated with Management: The Problem in Detecting Overfishing

The difficulties in detecting overfishing or even a decrease in catch production are complex, especially in places where there are no historical data, or an absence of data collection at regular intervals, preventing temporal comparisons. If in other fisheries there are 'shifting baselines' (Pauly 1995), there are often no baselines at all, or even data that permit comparative analysis of stock levels for small-scale tropical fisheries in Latin America. Information from other sources needs to be considered. Pauly (1995) pointed out the necessity of developing frameworks in order to incorporate earlier knowledge, or historical data on fish production. Johannes *et al.* (2000) observed also that fishers could provide key information concerning environmental clues, as well as the levels of fish production. At a disciplinary level, ethnobiology and human ecology attempt to incorporate local fisher knowledge of a variety of ecological and biological factors pertaining to small-scale fisheries with scientific understandings (Lopes and Begossi 2009; Silvano *et al.* 2009). Such local ecological knowledge (LEK) includes the knowledge fishers have of the ecology of fish in both freshwater and marine systems, as already shown in several studies within Brazilian small-scale fisheries along the Atlantic Forest coast and in riverine areas (Begossi 2008; Begossi and Silvano 2008; Silvano 2004; Silvano *et al.* 2006, 2008; Silvano and Begossi 2002, 2005). Details on the terms linked to 'ecological knowledge' are found in Berkes (2008).

For some fisheries, such as for Amazonian rivers, some data on landed catches have been collected in detail (Bailey and Petrere 1989; Petrere 1989; Barthem and Goulding 1997; MacCord *et al.* 2007; Ruffino 2004), but only scarce information is available for many coastal environments, where many small-scale fisheries are located in Latin America. In addition to local knowledge (LEK) that can be recorded from fishers, other important indicators can be obtained through interviews with fishers, as follows:

- a) Recall of information from older fishers, to produce historical data on fisheries;
- b) Increasing use of marine space, indicating an increased level of effort within a small-scale fishery. Such changes were observed by Berkes *et al.* (2006). As observed by those authors, such an increase in effort level can also occur when a fishery changes from local to export production;
- c) Observations of changes in target species: for example, the 'fishing down the food web' effect (Pauly *et al.* 1998) could be highlighted when a change occurs

in a small-scale fishery that has a carnivorous target (such as groupers or snappers, for example) and moves to a target that is an invertebrate-eater or a species from a lower trophic level (such croakers, or porgies, for example). If such a change in target species is observed in a small-scale fishery, it might indicate overfishing. It is important to note that even artisanal fisheries can impact species with slow maturation (such as groupers); such impacts were observed in six Caribbean islands, among other sites studied (Pinnegar and Engelhard 2007);

- d) Observations on the change of the size of species ('size-at-age'), or on the age of maturation ('size-at-maturation') (Law 2000) can also give clues on the level of stress within a small-scale fishery. For example, after interviewing 413 artisanal, small-scale fishers at the Ilha Grande Bay, in the coast of Rio de Janeiro State, respondents noted the decreased size of important local economic species, such as grouper (Begossi *et al.* 2010; Oliveira 2010); and
- e) Observations on the increased quantity of a lower trophic level species can also be indicative of the changing stock of predators, which are often the target species of small-scale fisheries (very often the expensive, 'first quality species', Begossi and Richerson, 1992). Such observations were also reported by the fishers of Ilha Grande Bay (Begossi *et al.* 2010; Oliveira 2010).

The importance of the local knowledge of fishers cannot be neglected, and it should be incorporated in fishery studies because it serves as an indicator of the healthiness of the fishery at the stock level.

Inserting Latin American Experiences in Current Models of Co-Management

Tropical fisheries, especially small-scale fisheries, differ in a variety of ways from their counterparts in temperate areas. Kurien (2001) compared the 'temperate-minority' world to the 'tropical-majority' world in several aspects, suggesting re-definitions in concepts and analysis, such as on definition of community, on market interactions, on the role of the state, among others. Ruddle (2007) observed that resources and technology, among other variables, interact differently with the ecosystems of the two disparate environments. For tropical small-scale fisheries, the author points out several features, including the limitation of fish to inshore areas, socially-determined fishing areas, the numerous and dispersed nature of fishing communities, the fisheries' biological and technical complexity, the limited employment opportunities, and the presence of local territories, among others. Such features are well observed in Latin America; for example, many examples can be recalled from Brazil, such as fishing territories, the complex extraction of multi-level resources using a variety of gear and techniques, and the geographical dispersion of fisheries (Begossi 2006; Begossi *et al.* 2004; Diegues 2005). How these variables can be associated with the current models of co-management deserves some thought. Models of co-management vary, and the paradigms implemented in known processes have been deeply analyzed by Ruddle and Hickey (2008), suggesting some models and considerations (see also Rojas 2009):

- 1) Adaptive Management: a 'learning-by-doing' approach that takes into account the uncertainties and complexities of the environment, evolving as adaptive

co-management (Berkes 2009). For an analysis of the insertion of adaptive management into co-management processes, see Berkes (2007). According to Ruddle and Hickey (2008), Adaptive Management has been widely applied in the Pacific and is well suited for nearshore fisheries where cooperative management or data-less management is a possible approach. Johannes (2002) gives examples of community-based management in many Pacific islands and areas, which can be seen as a form of adaptive management. For an analysis of integrating co-management processes and Adaptive Management in Latin America, see i) McConney *et al.* (2007) for Barbados coastal pelagic fish and sea urchins; ii) the Grenada beach seine fishery; and iii) Belize protected areas.

- 2) Ecosystem Approach: as noted by Ruddle and Hickey (2008), it was adopted in 2000 by the Convention on Biological Diversity. This approach integrates a variety of other approaches, as it focuses on the biological organization, structure, processes, functions of and interactions among organisms and their environment, including humans and diversity as part of the ecosystem; benefit-sharing and adaptive management are important aspects of this approach. McGrath *et al.* (2008) present a study based on this approach for the Amazon floodplain ('várzea'), where economic activities of the households are integrated within the economical and historical context of the region towards the co-management system of the fishing agreements.
- 3) The Local Knowledge approach: considered to be empirically-based and practically oriented, this approach is not a sufficient management process on its own, but supports the development of indicators, moving towards adaptive management (Ruddle and Hickey 2008). It has been widely applied in the Pacific (Aswani and Hamilton 2004), and the organization of such local knowledge towards management processes can be extremely useful, as shown by several studies of small-scale coastal fisheries in Brazil (Begossi *et al.* 2004, 2006; Silvano *et al.* 2006, 2009, 2009a).
- 4) Protected Areas: according to Ruddle and Hickey (2008), those areas emerged from the Convention on Biological Diversity, the World Summit on Sustainable Development, and the World Parks Congress. Frequently, government environmental agencies in Latin America have based their environmental agendas on creating protected areas through top-down approaches, excluding the local population from either the management process or the areas themselves. Top-down approaches are exemplified by the Marine Reserves in Santa Lucia (Pomeroy 2003) and in Brazil (Begossi and Brown 2003). Diegues (1999) observed in Brazil that top-down models that caused the displacement of traditional populations were additional causes for the impoverishment of local people. Even recently, governmental agencies implemented an old decree (n° 98.864, January 23, 1990) that forbade fishing activities around many islands of Grande Bay, Brazil, even for small-scale, artisanal local fishers, disrupting their ability to obtain resources for consumption and sale (Begossi *et al.* 2010).

Concluding Remarks: Methods and Perspectives

In order to deal with the variables that affect local people and the use of resources within artisanal, small-scale fisheries, and to employ those variables as tools for management, we have been using a method that includes four key aspects as a basic template for approaching small-scale communities in both Amazon riverine fisheries and in the coastal communities of the Atlantic Forest (Begossi 2008, Begossi *et al.* 2004, 2009). Four main steps to collect data on small-scale fisheries permits to subsidize knowledge on the variables described earlier in this study (geographic dispersion, local rules, lack of data, local ecological knowledge, and poverty and social needs), as follows (Begossi 2008):

- 1) The use of fishery resources: besides the use of aquatic resources, the use of plants and game, along with the techniques used to obtain resources; preferences and taboos relating to resources, among others (Hanazaki *et al.* 2007; Begossi *et al.* 2004).
- 2) The use of the aquatic space, such as fishing areas (Begossi 2006).
- 3) Fisher behavior, and information regarding their decision-making processes, such as where to fish, what to consume and what to sell. One of the tools for understanding this dynamic is optimal foraging theory (Begossi *et al.* 2009a)
- 4) The knowledge fishers have of local species' biology and ecology, such as the ethnotaxonomy, ethnobiology, and ethnoecology of fish (Begossi and Silvano 2008; Begossi *et al.* 2008).

The four aspects mentioned address the interactions of fishers and resources; we then add information on the community's historical context and livelihood processes, including these in a household dynamics analysis. For the historical context, when we compare the trajectories of inhabitants of the Atlantic Forest coast (the *Caiçaras*) and the inhabitants of the riverine areas of the Amazon (the *Caboclos*), we find some similar and some divergent aspects, leading to different outcomes for co-management processes. The similar contextual aspects include the high biodiversity of terrestrial and aquatic environments (riverine or coastal), their descent from native Indians and Portuguese colonizers, a similar cultural background, a dependence upon artisanal fishing for subsistence and for the regional market trade, using artisanal fishing technologies including dugout or motor canoes and small boats, as well as range of gear types from hooks and lines to set gillnets and a variety of different traps. When there are no restrictions, often from environmental agencies, *Caiçaras* and *Caboclos* still maintain small plots for the cultivation of *Manihot esculenta* (manioc), through swidden cultivation; plants and other terrestrial resources are gathered from the forest, including medicinal plants and game. Currently, both *Caiçaras* and *Caboclos* have been affected by very restrictive circumstances given by environmental agencies, industries, and tourism-related activities, in addition to agricultural pressure from major landowners in the north (Begossi 2004).

Caiçaras and *Caboclos* differ in regard to the historical processes related to their grass-roots movements (Begossi 1998). Along the Atlantic Forest coast no

strong grass-roots movements occurred, and religious influences came from Pentecostal churches. In contrast, among the small-scale fishers in the Amazon, there were the Rubber-tapper's movements, political organizations and, as a religious counterpart, Liberation Theology via the '*Pastoral da Terra*'. Movements concerning the conservation of lakes in the Amazon began during the eighties and were carried out through local, pre-existing institutions of rubber-tappers and fishers, among others; these initial measures paved the way for the development of the Extractive Reserve of Mamirauá, as well as the fishing agreements or accords of the Amazon (Lima 1999; de Castro 2002; de Castro and McGrath 2001).

One Question Remains: How can Conservation be Attractive to the Poor?

Facing the context in which there are several restrictive aspects for the livelihoods of small-scale artisanal fishers, including the coastal *Caiçaras* of the Atlantic Forest and the riverine *Caboclos* of the Amazon, some thoughts can be useful:

- a) Are economic models of optimization and their trade-offs sufficient to detect the costs and benefits of conservation to small-scale fisheries? In that regard, how can we deal with excludability and subtractability of the managed resources in relation to local livelihoods?
- b) Are TACS ('*Termo de Ajuste de Conduta*' – Terms of Adjustment of Conducts)⁶ as applied to small-scale communities (McGrath *et al.* 2008) sufficient to improve living conditions and to be attractive to fishers?

The experience of the Development Sustainable Reserve of Mamirauá (Padoch *et al.* 1999) tells us something about linkages among co-management, livelihood processes and improved living conditions. Further exploration of these connections can be a basis in order to expand conservation processes to include livelihoods and the multi-level activities that occur in the high biodiversity environments that are widespread in Latin America.

In order to make co-management feasible in tropical countries, a higher degree of legitimacy should be obtained, even if it increases the transaction costs of the co-management system. One of the roads towards increasing credibility between co-managers is through a dialogue between those with scientific and local knowledge. This dialogue would not solve the credibility problem between governmental agencies and fishers, but would help improve the local management of the resources.

Finally, for the cases shown in this study, we notice that in spite of a local heterogeneity of data and of local processes, at least three aspects are common to Latin American small-scale artisanal fisheries. These aspects refer to the local level context of the small scale fishing communities as resource users, their geographic dispersion, and the scarce data available on resources. The necessity to embody local fishers into management processes, including their empirical knowledge on the local natural resources (Local Ecological knowledge), is urgent in the management processes in Latin America, as well as the organization of a systematic data collection at landing points, which could be done with the help of local fishers. Such data are important in order to detect temporal and spatial

changes, as well as to monitor the local fisheries. Management is, however, a local process, and local features, such as their ecological, economical, cultural, and historical contexts explain the heterogeneity found in the outcomes within the management of Latin American fisheries.

Notes

- 1 Presented at MARE Conference 2009: Revision: January 05, 2010. I am grateful for the kind invitation from MARE for this keynote, along with their support; UNICAMP for partial support of the trip to Amsterdam; CNPq, Brazil, for a productivity scholarship. I wish to thank P.F. Lopes for sending me some related publications, and Benjamin Blount for a detailed revision and helpful suggestions on earlier drafts.
- 2 After Begossi (2002) and Begossi and Brown (2003). Co-management includes pre-starting systems, such as from local informal rulers to co-management processes.
- 3 CNS (National Council of Rubber Tappers): *Conselho Nacional dos Seringueiros*, ASAREAJ (Association of rubber-tappers and agricultors of the Upper Juruá): *Associação dos Seringueiros e Agricultores da Reserva Extrativista do Alto Juruá*
- 4 Countries were FAO (or other bilateral agreements or institutions) developed data collecting efforts on small-scale fisheries have more available sets of data, but lack of data exist especially for small-scale fisheries; even national enterprises for research and data collection started late in the 20th century (see Aguerro 1991 for Pacific coastal fisheries , and Copescal/Fao 2008 for continental fisheries.)
- 5 In fact, Salas *et al.* (2007) studied coastal fisheries, and the case mentioned, Mamirauá, is a riverine (continental) fishery.
- 6 TACS, or ('Termo de Ajuste de Conduta' – Terms of Adjustment of Conducts) are compensatory mechanisms by which industries or other enterprises that impact the environment may 'compensate' by promoting environmental management. One form of compensation is to give support to local organizations that promote co-management processes.

References

- Aguero, M.
1991. Small-scale fisheries research in Pacific South America. In: R. Durand, J. Lemoalle e J. Weber (eds) *La Recherche Face à la pêche artisanale, Symp. Int.* ORSTOM-IFREMER, Montpellier France, Paris, ORSTOM; 223-241.
- Almeida, M.W.B., A.M. Menezes.
1994 *O Destino da Floresta. Reserva Extrativista do Alto Juruá.* Dumará Distribuidora de Publicações Ltda, Rio de Janeiro:165-225.
- Aswani S., R. Hamilton.
2004 Integrating Indigenous Ecological Knowledge and Customary Sea Tenure with Marine and Social Science for Conservation of Bumphead Parrotfish (*Bolbometopon muricatum*) in the Roviana Lagoon, Solomon Islands. *Environmental Conservation. Rio de Janeiro* 31(1):69-83.
- Barthem R., M. Goulding.
1997 *The catfish connection.* New York: Columbia University Press.
- Bayley P.B., Petrere M.
1989 Amazon fisheries: assessment methods, current status and management options. *Canadian Special Publication on Fisheries and Aquatic Sciences* 106:385–398.

- Begossi, A.
2008 Local Knowledge and Training Towards Management. *Environment, Development and Sustainability* 10:591-603.
- 2006 Temporal Stability in Fishing Spots: Conservation and Co-management in Brazilian Artisanal Coastal Fisheries. *Ecology & Society* 11(1): 5. Available: www.ecologyandsociety.org/vol11/iss1
- 2006a The ethnoecology of Caiçara Metapopulations (Atlantic Forest, Brazil): Ecological Concepts and Questions. *Journal of Ethnobiology and Ethnomedicine*. 2:40. Available: www.ethnobiomed.com/content/2/1/40.
- 2002 Latin America Fisheries, ISEE Tunisia The 7th Biennial Conference of the International Society for Ecological Economics, Sousse, Tunisia, March 6-9, 2002 Available: www.ecoleconeurope.com/ISEETunisia2002.html.
- 2001 Cooperative and Territorial Resources: Brazilian Artisanal Fisheries. In: J. Burger, R. Norgaard, E. Ostrom, D. Policansky, B. Goldstein (Eds.), *Protecting the Commons: a Framework for Resource Management in the Americas*. Island Press, Washington, D.C., USA:109-130.
- 1998 Cultural and Ecological Resilience Among Caiçaras of the Atlantic Forest and Caboclos of the Amazon, Brazil. In: C. Folke, F. Berkes (Eds.), *Linking social and cultural systems for resilience*, (6):129-157. Cambridge U. Press.
- Begossi, A., D. Brown. (Eds.)
2003 Experiences with fisheries co-management in Latin America and the Caribbean, In: D.C. Wilson, J.R. Nielsen, P. Degnbol (Eds.), *The fisheries co-management experience: accomplishments, challenges, and prospects*. Kluwer Academic, Dordrecht, The Netherlands:135-150.
- Begossi, A., P.J. Richerson.
1992 The animal diet of families from Búzios Island: an Optimal Foraging Approach. *Journal of Human Ecology* 3(2): 433-458.
- Begossi, A., R.A.M. Silvano.
2008 Ecology and Ethnoecology of Dusky Grouper (*Epinephelus marginatus* (Lowe, 1834)) Along the Coast of Brazil. *Journal of Ethnobiology and Ethnomedicine* 2008.4:20 doi:10.1186/1746-4269-4-20. Available: www.ethnobiomed.com/content/4/1/20.
- Begossi, A., B. Amaral, R.A.M. Silvano
1999 Uses of Fish and Game by Inhabitants of an Extractive Reserve (Upper Juruá, Acre, Brazil). *Environment, Development and Sustainability* 1:1-21.
- Begossi, A., N. Hanazaki, R. Ramos.
2004 Food chain and the reasons for food taboos in the Amazon and in the Atlantic Forest coast. *Ecological Applications* 14(5):1334-1343.

- Begossi, A., P.F. Lopes, L.E.C. Oliveira, H. Nakano
2010 Ecologia de Pescadores da Baía de Ilha Grande. Editora Rima, in press.
- Begossi, A., A.L. Silva, C.S. Seixas, F. de Castro, J Pezzuti, N Hananaki, N. Peroni, R.A.M. Silvano
2004 Ecologia de Pescadores da Mata Atlântica e da Amazônia. Ed. Hucitec. São Paulo. Available: www.fisheriesandfood.org.
- Begossi, A., M. Clauzet, J.L. Figueiredo, L. Garuana, R.V. Lima, P.F. Lopes, M. Ramires, A.L. Silva, R.A.M. Silvano
2008 Are biological species and high-ranking Categories Real? A Comparison of Fish Folk Taxonomy in the Atlantic Forest and in the Amazon (Brazil). *Current Anthropology* 49:292-306.
- Begossi A., M. Clauzet, N. Hanazaki, P.F. Lopes, M. Ramires, R.A.M Silvano
2009 Fishers' decision-making, optimal foraging, and management, III Seminário de Gestão Socioambiental para o Desenvolvimento Sustentável da Aqüicultura e da Pesca no Brasil – III SEGAP April 2009, Arraial do Cabo, Rio de Janeiro, Brazil.
- Berkes, F.
2009 Evolution of Co-management: Role of Knowledge Generation, Bridging Organizations and Social Learning. *Journal of Environmental Management* 90:1692-1702
- 2008 *Sacred Ecology*. Routledge: New York.
- 1985 Fishermen and the Tragedy of the Commons. *Environmental Conservation* 12:199-206.
- Berkes, F. (Ed.)
2007 Adaptive Co-Management and Complexity: Exploring the Many Faces of Co-Management. In: D. Armitage, N. Doubleday (Eds). *Adaptive Co-Management*, UBC Press, Vancouver:19-37.
- Berkes, F., et al.
2006 Globalization, Roving Bandits, and Marine Resources. *Science* 311:1557-1558.
- Berkes, F., et al.
2000 Managing Small-scale Fisheries: Alternative Directions and Methods. International Research Development Centre, Ottawa, Ontario, Canada (Portuguese Edition organized by D. Kalisoky, FURG).
- Breton Y., et al.
1996 Fisheries Management and the Colonias in Brazil: a Case Study of a Top-Down Producers Organization, Society and Natural Resources 9:307-315.
- Castello, L.
2004 A Method to Count Pirarucu *Arapaima gigas*: Fishers, Assessment, and Management. *North American Journal of Fisheries Management* 24:379-389.

- Castilla, J.C., M. Fernandez.
1998 Small-scale Benthic Fisheries in Chile: on Co-management and Sustainable Use of Benthic Invertebrates. *Ecological Applications* 8(1):S124-S132.
- Castro, F. de
2004 Níveis de Decisão e o Manejo dos Recursos Pesqueiros. In: A. Begossi, (Ed). *Ecologia de Pescadores da Mata Atlântica e da Amazônia*. Editora Hucitec, São Paulo, Brazil. Available: www.fisheriesandfood.org/publications: 255-284
- 2002 From Myths to Rules: The Evolution of Local Management in the Amazonian Floodplain. *Environment and History* 8:197-216.
- Castro, F. de, D. McGrath.
2001 O Manejo Comunitário dos Lagos na Amazônia. In: *Parcerias estratégicas*, Centro de Estudos Estratégicos, Ministério da Ciência e Tecnologia, Brasília, Brazil:112-126
- Castro, F. de, D. McGrath, M. Crossa.
2002 Adaptandose a los Cambios: la Habilidad de Las Comunidades Riberenas en el Manejo de Sistemas de Lagos de la Amazonia Brasileira. In: R.C. Smith, D. Pinedo, (Eds), *El cuidado de los bienes comunes, gobierno y manejo de los lagos y bosques en la Amazonia*, Instituto del Bien Comum. Instituto de Estudios Peruanos, Lima, Peru: 272-303
- Chao, N.L., *et al.*
2001 Conservation and Management of Ornamental Fish Resources of the Rio Negro Basin, Amazonia, Brasil (Projeto Piaba). EDUA, Manaus.
- Cordell, J.
2006 *Scaling up Marine Management: the Role of Protected Areas*. The World Bank, Washington D.C.
- 1989 *A Sea of Small Boats*. Cultural Survival Inc., Cambridge, Massachusetts, USA.
- COPESCAL/FAO.
2008 La Pesca continental en América Latina: su contribución económica y social e instrumentos normativos asociados, Documento Ocasional 11, Roma.
- Crampton, W.G.R.
1999 The impact of the ornamental fish trade on the Discus *Symphysodon aequifasciatus*: a case study from the floodplain forests of Estacao Ecologica Mamirauá. In: C. Padoch, J.M. Ayres, M. Pinedo-Vasquez, A. Henderson (Eds.) *Várzea diversity, development and conservation of Amazonia's whitewater floodplains*. New York Botanical Garden, NY:29-44.
- Diegues, A.C.
2005 *Enciclopédia Caiçara*. Ed. Hucitec: São Paulo.

- 1999 Human Populations and Coastal Wetlands: Conservation and Management in Brazil. *Ocean and Coastal Management* 42:187-210.
- Hanazaki N. and A. Begossi.
2004. Does fish still matter ? Changes in the diet of two Brazilian fishing communities. *Ecology of Food and Nutrition* 42(4-5):279-301.
- Hanazaki N. *et al.*
2007 *Etnobotânica Caiçara no Litoral Paulista*. Editora Rima, São Paulo.
- Hanna, S.
2003 The Economics of Co-management. In: D.C. Wilson, J.R. Nielsen, D. Degnbol (Eds.). *Fisheries Co-Management Experiences*. Kluwer Academic: Dordrecht:51-60.
- Jentoft, S. (Ed).
2003 Co-management the way forward. Pp.. In: D.C. Wilson, J.R. Nielsen, D. Degnbol (Eds.), *Fisheries Co-Management Experiences*. Kluwer Academic, Dordrecht, The Netherlands:1-14
- Jentoft, S.
2007 Limits of Governability: Institutional Implications for Fisheries and Coastal Governance. *Marine Policy* 31:360-370.
2006 Beyond Fisheries Management: The Phronetic Dimension. *Marine Policy* 30:671-680.
- Johannes, R.E.
2002 The Renaissance of Community Based Marine Resource Management in Oceania. *Annual Review of Ecology and Systematics* 33:317-40.
1981 *Words of the lagoon*. University of California Press: Berkeley.
- Johannes, R.E., M.R.M. Freeman, R. Hamilton.
2000 Ignore Fishers Knowledge and Miss the Boat. *Fish and Fisheries* 1:257-271.
- Kalikoski, D.C., T. Satterfield.
2004 On Crafting a Fisheries Co-Management Arrangement in the Estuary of Patos Lagoon (Brazil): Opportunities and Challenges faced through implementation. *Marine Policy* 28:503-522.
- King, T.D.
1997 Folk Management Among Belizean Lobster Fishermen: Success and Resilience or Decline and Depletion? *Human Organization* 56(4):418-426.
- Kurien, J.
2001 *People and the Sea*, The Tropical Marine Lecture Series, MARE. Amsterdam.
- Law, R.
2000 Fishing, Selection, and Phenotypic Evolution. *ICES Journal of Marine Science* 57:659-668.

- Levieil, D., Orlove, B.S.
1990 Local Control of Aquatic Resources: Community and Ecology in Lake Titicaca, Peru. *American Anthropologist* 92(2):362-382.
- Lima, D.M.
1999 Equity, Sustainable Development and Biodiversity Preservation: some questions About Ecological Partnerships in the Brazilian Amazon. In: C. Padoch, J.M. Ayres, M.P. Vasquez, A. Henderson. (Org.). *Varzea: Diversity, Development, and Conservation of Amazonia's Whitewater Floodplains*. New York: The NewYork Botanical Garden Press:247-263.
- Lopes, P.F.M.
2008 Extracted and Farmed Shrimp Fisheries in Brazil: Economic, Environmental and Social Consequences of Exploitation. *Environment, Development and Sustainability* 10:639-655.
- Lopes, P.F., A. Begossi (Eds).
2009 *Current Trends in Human Ecology*. Cambridge Scholars Pub., UK.
- Lopes, et al.
2008 Extractive Reserves and Sustainable Development Reserves in the Amazon and on the coast: resilient alternatives? Paper presented at the XVI International Meeting of the Society for Human Ecology, Bellingham, WA, USA, June 10-13, 2008.
- MacCord P.F., A. Begossi
2006. Dietary changes over time in a Caiçara community from the Brazilian Atlantic Forest. *Ecology & Society* 11(2):38.
- Maccord, P.F., et al.
2007 Dynamics of Artisanal Fisheries in Two Brazilian Amazonian reserves: Implications to Co-management. *Hydrobiologia* [DOI 10.1007/s10750-006-0486-4].
- Mamirauá
www.mamirauá.org.br
- McConney, P., R. Mahon, R. Pomeroy.
2007 Challenges Facing Coastal Resource Co-Management in the Caribbean. In: F. Berkes. *Adaptive Co-Management and Complexity: Exploring the Many Faces of Co-Management*. In: D. Armitage, F. Berkes, N. Doubleday. *Adaptive Co-Management*. UBC Press: Vancouver:105-124.
- McDaniel, J.
1997 Communal Fisheries Management in the Peruvian Amazon. *Human Organization* 56(2):147-152.
- McGrath, D.G.
2000 Avoiding a Tragedy of the Commons: Recent Developments in the Management of Amazonian Fisheries. In: A. Hall (Ed.), *Amazonia at the crossroads*. Institute of Latin American Studies: London.

- McGrath, D., *et al.*
 1999 Community Management of Floodplain Lakes and the Sustainable Development of Amazonian Fisheries. In: C. Padoch, J.M. Ayres, M.P. Vasquez, A. Henderson. (Org.). *Varzea: Diversity, Development, and Conservation of Amazonia's Whitewater Floodplains*. New York: The New York Botanical Garden Press:59-82.
- McGrath, D., *et al.*
 1993 Fisheries and the Evolution of Resource Management on the Lower Amazon Floodplain. *Human Ecology* 21:167-195.
- McGrath, D., *et al.*
 2008 Constructing a Policy and Institutional Framework for an Ecosystem-Based Approach to Managing the Lower Amazon floodplain. *Environment Development, and Sustainability* 10(5):677-695.
- Oliveira, L.E, P.F. Lopes and A Begossi
 2010 A percepção da conservação na Baía da Ilha Grande. In *Ecologia de Pescadores da Baía de Ilha Grande*. Editora Rima, São Carlos. pp 235-292.
- Orlove, B.S.
 1991 Mapping Reeds and Reading Maps: the Politics of Representation in Lake Titicaca. *American Ethnologist* 18(1):3-38.
- Padoch, C., *et al.*
 1999 *Varzea: Diversity, Development, and Conservation of Amazonia's Whitewater Floodplains*. New York: The New York Botanical Garden Press:247-263.
- Pauly, D.
 1995 Anectodes and the Shifting Baseline Syndrome of the Fisheries. *Tree* 10 (10): 430.
- Pauly, D., *et al.*
 1998 Fishing-Down Marine Food Webs. *Science* 279:860.
- Petrere, Jr.
 1989 River Fisheries in Brazil: a Review. *Regulated Rivers and Management* 4:1-16.
- Pinedo, D., C. Soria (Eds).
 2008 El Manejo de lãs Pesquerias em Rios Tropicales de Sudamérica. Bogotá. Available: www.idrc.ca/en/
- Pinnegar, J.K., G.H. Engelhard.
 2007 The 'Shifting Baseline Phenomenon: a global perspective, Rev Fish Biol Fisheries DOI 10.1007/s11160-007-9058-6.
- Pinkerton, E., L. John.
 2008 Creating Local Management Legitimacy. *Marine Policy* 32:680-691.

- Pollnac, R.B. (Ed.)
1977 Panamanian small-scale fishermen: society, culture and change. Marine Technical Report 44. International Center for Marine Resource Development, University of Rhode Island, Kingston.
- Pollnac, R.B., J.J. Poggie.
1991 Psychocultural Adaptation and Development Policy for Small-Scale Fishermen's Cooperatives in Ecuador. *Human Organization* 50(1):43-49.
- Pomeroy C.
2003 Co-Management and Marine Reserves in Fishery Management. In: D.C. Wilson, J.R. Nielsen, P. Degnbol, (Eds.), *The fisheries co-management experience: accomplishments, challenges, and prospects*. Kluwer Academic, Dordrecht, The Netherlands:213-229
- Queiroz H.L.
2005 A Reserva de Desenvolvimento Sustentável Mamirauá. *Estudos Avançados* 19 (54):183-202.
- Rojas, B.L.B.
2009 Contrastes entre o Manejo Pesqueiro na Orinoquia Venezuelana e na Amazônia Brasileira. Doctoral Dissertation, Graduate Course in Zoology, UNESP, Rio Claro.
- Ruddle, K.
2007 Misconceptions outright prejudice. *Samudra Report* 48.
- Ruddle, K., F.R. Hickey.
2008 Accounting for the Mismanagement of Tropical Nearshore Fisheries. *Environment, Development, and Sustainability* 10 (5):565-589.
- Ruffino, M.L. (Ed.)
2004 *A Pesca e os Recursos Pesqueiros na Amazônia*. Pró-Várzea, Manaus.
- Salas, S. Chuenpagdee, R., Seijo, J.C., and Charles, A.
2007. Challenges in the assessment and management of small-scale fisheries in Latin American and the Caribbean. *Fisheries Research* 87:5-16.
- SCM, CNPQ, MCT, IPAAM.
1996 Mamirauá: Plano de Manejo. Brasília, SCM, CNPQ, MCT. RDSM. 2000. Reserva de Desenvolvimento Sustentável Mamirauá. Available: www.pop.tefe.rnp.br/reserva/reserva/htm.
- SEAP
2007 Relatório Integrado: Diagnóstico da Pesca Artesanal no Brasil como Subsídio para o Fortalecimento Institucional da Secretaria Especial de Aquicultura e Pesca. Vasconcelos, M., Diegues, A.C., Sales, R.R. Available: www.seap/conape/planejamento
- Sutinem J.G., R.B. Pollnac (Eds)
1981 *Small-scale fisheries in Central America: acquiring information for decision making*. International Center for Marine Resource Development, University of Rhode Island, Kingston.

- Seixas, C.
2006 Barriers to Local-level Ecosystem Management and Participator Management in Brazil. 'Bridging Scales and Knowledge Systems'. In: W.V. Reid, F. Berkes, T.J. Wildbanks, D., Capistrano (Eds):255-274.
- 2004 Instituições e Manejo Pesqueiro: O caso da Lagoa de Ibiraquera, sc. In: A. Begossi (Org.), A. Leme, C. Seixas, F. de Castro, J. Pezzuti. N. Hanazaki, N. Peroni, R.A.M. Silvano. 2004. Ecologia de Pescadores da Mata Atlântica e da Amazônia, Ed. Hucitec. São Paulo:85-312. Available: www.fisheriesand.food.org/publicações.
- Seixas, C., E. Troutt.
2004 Socio-economic and Ecological Feedbacks in Lagoon Fisheries: Management Principles for a co-evolutionary setting. *Interciência* 29:362-367.
- Seixas, C., P. Chamy, A. Begossi.
2008 Using 'Resilient Lens' to Assess Conservation Efforts: the Case of a Marine Extractive Reserve in Brazil, Paper Presented at the XVI International Conference of the Society for Human Ecology, Bellingham, WA, USA. Unpublished.
- Silvano, R.A.M.
2004 Pesca Artesanal e Ictiologia. In: A. Begossi (Org.), A. Leme, C.S. Seixas, F. de Castro, J. Pezzuti, N. Hanazaki, N. Peronie R.A.M. Silvano. 2004. Ecologia de Pescadores da Mata Atlântica e da Amazônia. Ed. Hucitec. São Paulo. Available: www.fisheriesandfood.org:187-222.
- Silvano, R.A.M., A. Begossi.
2009 Contributions to Human Ecology to Conciliate People and Biodiversity with a Focus on Fishing Communities, Encyclopedia of Life Support Systems (EOLSS), Developed by UNESCO, EOLSS Pub., Oxford, UK. Available: www.eolss.net.
- 2005 Local Knowledge on a Cosmopolitan Fish. Ethnoecology of *Pomatomus saltatrix* (Pomatomidae) in Brazil and Australia. *Fisheries Research* 71:43-59.
- 2002 Ethnoichthyology and Fish Conservation in the Piracicaba River, Brazil. *Journal of Ethnobiology* 22(2):285-306.
- Silvano, R.A.M., P. Maccord, R.V. Lima, A. Begossi.
2006 When Does this Fish Spawn ? Fishermen's Local Knowledge of Migration and Reproduction of Brazilian Coastal Fishes. *Environmental Biology of Fishes* 76:371-386.
- Silvano, R.A.M., M.A. Gasalla, S.P. Souza.
2009 Applications of Fisher's Local Ecological Knowledge to Better Understand and Manage Tropical Fisheries. In: P.F. Lopes, A. Begossi (Eds). *Current Trends in Human Ecology*. Cambridge Scholars Pub, Newcastle.

- Silvano, R.A.M., *et al.*
2008 Contributions of Ethnobiology to the Conservation of Tropical Rivers and Streams. *Aquatic Conservation: Marine and Freshwater ecosystems* 18:241–260.
- World Bank
2008 The Sunken Billions, Economics justification for fisheries reform. Washington, DC.
- Zanetell, B.A., B.A. Knuth.
2002 Bribing Biodiversity: Corruption, Participation, and Community-Based Management in Venezuela. *Southern Rural Sociology* 18(2):130-161.