5. ENVIRONMENTAL ASPECTS AND FISHERIES GOVERNANCE

Institutions that mediate the use of fisheries resources and ecosystem

The institution with the highest authority for coastal zone management in Brazil is the Ministry of the Environment. The National Programme for Coastal Management (GERCO) is administered by this Ministry. The conditions set forth in the programme have to be implemented by each coastal state and municipality. The programme defines the legal aspects for the management of the Brazilian coastal zone and establishes the basis for the development of regional and local policies, programmes and management plans. Estuarine areas, such as the estuary of the Patos Lagoon, were defined as areas of high management priority by GERCO because of their high level of environment risk and actual impacts (MMA, 1996). Although fisheries are important coastal resources, GERCO has no mandate over them.

The management of fisheries in Brazil is mainly the responsibility of the federal government, which is responsible for assessing the status of the stocks and for setting and enforcing regulations on the use of aquatic living resources. However, governmental institutional arrangements for regulating fisheries activities have been evolving over the years. The role of the federal government in marine fisheries management became particularly influential in the mid-1960s with the creation of SUDEPE, an agency of the Ministry of Agriculture with sole responsibility for the development and management of fisheries. Later, in 1989, fisheries became one of the agendas of IBAMA, a subsidiary of the Ministry of Environment. The shift of management responsibilities from SUDEPE to IBAMA was not favourable to artisanal fisheries. Because IBAMA focuses its attention mostly on environmental issues, legislation and law enforcement, there has been little attention given to the sustained development of artisanal fishing communities. In 1998, the government shifted a large part of the responsibilities of the fisheries sector from IBAMA back to the Ministry of Agriculture, thereby constituting the Department of Fisheries and Aquaculture (DPA). The main responsibility of DPA was to promote and execute programmes and projects to support the development of the industrial fisheries. The DPA's main objective then was to promote the development of this sector and to manage unexploited fisheries resources. On the other hand, IBAMA was responsible for executing the national policies to protect the environment, and particularly for managing endangered and overexploited species, and encouraging the sharing and decentralization of decisions through co-management and community-based management initiatives.

The development policies put forth by these two agencies were not only diverse but opposite and conflictive in their approach to resource management. According to Dias Neto (1999), such a change represented "one of the most anarchical moments in fisheries management in Brazilian history". Dias Neto and Marrul-Filho (2003) highlighted the three main institutional conflicts created with the division of responsibilities between IBAMA and DPA. The first one was of legal nature, related to the division of competencies in fisheries management, and in the organization and maintenance of the national system of control and licensing of fishing activities. The second one was conceptual, because stocks are intrinsically linked in the marine environment through ecological and/or technological interactions, and in multispecific fisheries the same fishing activity often targets stocks with different exploitation levels. Besides, a stock that is considered unexploited at a given moment could eventually be overfished, and hence, the same species could be under the responsibility of two different agencies at different moments in time. As stated by Dias Neto and Marrul-Filho (2003) "IBAMA and DPA were trying to divide the indivisible". The third conflict was related to the transfer of responsibility from IBAMA to DPA for the management and control of foreign fleets fishing under joint-venture arrangements and the consequent changes in the rules and norms.

In 2003, a new fisheries agency was created at ministerial level: the Special Secretariat for Aquaculture and Fisheries (SEAP). SEAP had a broader authority than the previous agencies. Its priority is the development of the aquaculture sector, particularly of shrimp cultivation for

export, freshwater aquaculture and industrial fisheries. In spite of official speeches, the artisanal sector is not a top priority for this new agency.

With the enactment of Law 11.958 of June 2009, SEAP was transformed into the Ministry of Fisheries and Aquaculture. The same law put an end to the division of responsibilities in the management of fish stocks stated above, making mandatory the joint work of the Ministry of Fisheries and Aquaculture and IBAMA/Ministry of Environment in the design of regulations and of governance for sustainable use of resources. This work is to be carried out under the general coordination of the Ministry of Fisheries and Aquaculture. However, this new institutional arrangement has not yet contributed to the implementation of policies and measures to revert the critical situation of the main fish stocks.

In terms of property rights, according to the Brazilian Constitution, the fisheries resources in the coastal zone and in the exclusive economic zone are considered open access under a State property regime (Dias Neto and Marrul-Filho, 2003). The Constitution also asserts that state and society should construct the means to collaborate and participate in the process of decision-making for the sustainable use of environmental resources and in the formulation of norms and rules to that effect (Dias Neto and Marrul-Filho, 2003), which leaves ample scope for the sharing of responsibilities between government and society in the management of fisheries.

The weakening role of the state in fostering the development of artisanal fisheries during the last two decades, mainly after the termination of SUDEPE, contributed to the general lack of organization of the sector. On the other hand, the institutional void favoured action to social movements and non-governmental organizations in developing projects and management initiatives for the sustainable management of fisheries. Many of these initiatives were born out of a crisis that required solutions and from a process of increasing participation of fishers as new protagonists in decision-making. The initiatives were developed around five main processes that are currently legitimized, some of which are promoted by the government (all of them could be placed within a spectrum of co-management).

1. Within the National System of Conservation Units (regulated by Law 9985/2000):

    - Areas of permanent preservation (APA) – defined as “large areas with a certain degree of human occupation and characterized by physical, biological, aesthetical or cultural elements of crucial importance for the quality of life and well-being of human populations, having as main goals to protect the biological diversity, to regulate the process of human occupation and to ensure the sustainable use of natural resources”. APAs are managed by a council constituted by representatives of governmental bodies, non-governmental organizations, community organizations, and the local population through specific management plans. Example in fisheries: “APA dos Corais”, Pernambuco, northeastern Brazil.

    - Marine extractive reserve (RESEX): defined as “an area used by traditional extractive activity populations, whose livelihood is based on extractive activities but also complemented by subsistence agriculture and animal production, having as its main goals the protection the livelihoods and culture of these populations and to ensure the sustainable use of natural resources”. RESEXs are managed by a deliberative council of organizations and community representatives through specific management plans. At the time of writing this paper, there were 19 RESEXs operational or in the process of becoming operational along the Brazilian coast (Kalikoski and Vasconcellos, 2011).

    - Sustainable development reserves (RDSs): defined as “areas used by traditional populations, whose existence is based on systems of sustainable exploitation of natural resources, developed through generations and adapted to the local

ecological conditions, and that have played a key role in nature conservation and in the maintenance of biological diversity". The objectives of the RDSs are "to preserve nature and at the same time to ensure the necessary conditions and means to sustain and improve the living conditions and the use of natural resources by traditional populations, as well as to appreciate and conserve the traditional knowledge-practice systems of environmental management of these populations". RDSs are also managed by a deliberative council of organizations and representatives of communities, which is responsible for developing and implementing a management plan that defines, *inter alia*, no-take protected areas, buffer zones and corridors, and areas for sustainable use. The Mamirauá RDSs in the Amazon region are the first and most well-known example.

2. Other processes

- Fishing accords: regulated by Decree No. 29/03 of IBAMA, this instrument aims to define and legitimize access rules and norms elaborated by the fishing community to regulate the use of fisheries resources in a given region. This type of instrument does not involve the expropriation of land (as the conservation units above), but only some aspects for regulating the exploitation of resources. There are examples of fishing accords in fisheries in the Amazon floodplain.

- Fishing forums: this is an instrument that is not regulated by the government; it is rather an instrument that has been created as a result of communities' initiatives in order to organize themselves, and to discuss their problems and seek solutions in partnership with governmental and non-governmental organizations. Because it is not regulated, this instrument can be developed in different ways, with various types of arrangements involving individual stakeholders and institutions. Some examples are the Forum of Patos Lagoon in southern Brazil, the Forum Agenda 21 in Ibiraquera, Santa Catarina, and the Forum Terramar in Ceará, among others.

Given the failure of the above institutional arrangements to sustain artisanal fisheries over time, and benefiting from the policy of mainstreaming co-management initiated in the 1990s, an alternative institutional arrangement was formed to co-manage the local resources in the Patos Lagoon estuary (Kalikoski, Vasconcellos and Lavkulich, 2002; Kalikoski and Satterfield, 2004). The local co-management arrangement referred to as the Forum of Patos Lagoon was set up to: (i) organize the artisanal fisheries sector in relation to fisheries administration policies; (ii) prompt partnerships within the sector in order to implement action plans to rebuild the productive capacity of the fisheries resources in the Patos Lagoon; (iii) establish criteria that control fishing effort as one mechanism for rebuilding fisheries resources; and (iv) encourage the collective organization for the support of local sustainable artisanal fishing communities (Forum of Patos Lagoon Mission Statement, 1998). Since the establishment of the Forum in 1998, fisheries regulation has been debated, redefining rules and rights to local resource use in the estuary of Patos Lagoon. Measures such as fishing effort limit, minimum mesh size, closed season, among others, have been exhaustively discussed and agreed as a first initiative of this co-management arrangement (Decree MMA/SEAP No. 03/2004; Table 26).

Table 26 presents a summary of the laws and decrees that control the use of local resources in the different aquatic environments and their location. It describes the established rules regarding how much, when and what different resources can be harvested, involving management functions such as licensing, timing, location, and vessel or gear restriction to prevent overexploitation, as well as rules to protect critical habitats and water quality from damage to preserve health of the resource. From Table 26, one concludes that access to the majority of artisanal fisheries resources is being limited by licence control in all areas. The exceptions are the semi-industrial fisheries based on gillnets and industrial purse seine fisheries, which are still open access fisheries. The most common rules on paper are those determining fishing seasons,

size limits and the characteristics of fishing gear. The regions differ, however, in the number of restricting rules – the fisheries in the estuary of Patos Lagoon present the largest number of rules controlling fishing seasons and gear characteristics. Another notable feature shown in Table 26 is the absence of management quotas in practically all regions (the exception is a bycatch quota established for deep-water species caught by foreign trawlers) and the absence of fisheries management rules defining marine habitat protection. Habitat protection rules for terrestrial ecosystems that are relevant for fisheries are defined by state and federal environmental agencies. They set the standards for water quality, rules to prevent water pollution, and regulate the types of use in estuarine and freshwater systems for protecting critical habitats such as marshes and riparian ecosystems. There are no similar rules for habitat protection in inshore and offshore marine areas.

Table 26: Summary of norms controlling the use of fisheries in different areas of the Patos Lagoon estuary and surrounding environment

	Freshwater	Estuary Decree 03/2004	Inshore	Offshore
Limited areas	• In the convergence of river and lagoons	None	• Industrial purse seining around the mouth of the lagoon • Trawling inside 3 miles (4.8 km) • Fishing blue crabs 6 km around the mouth of Patos Lagoon • Fishing bluefish inside 3 miles (4.8 km)	• Trawling by foreign fleets inside the 200 m isobaths
Limited access	• Fishing in the Mirim Lagoon to fishers who live in the area	• Licences restricted to full-time fishers who live around the estuary	• Licence control for demersal fish trawling • Licence control for shrimp trawling	
Seasonal limits restrictions	• During spawning migrations (only allowed with hook-and-line fisheries)	• Pink shrimp: 1/6–31/1 • Mullet: 1/6–30/9 • Croaker: 1/3–30/9 • Catfish: 1/6–30/9 and 1/12–30/3 • Fishing closure 1/6–30/9	• Shrimps: 1/3–31/5 • Bluefish: 1/11–31/3 (or 1/12–31/3 for vessels <10 m inside 10 nm) • Catfish: 1/1–31/3	
Size limit	• Pink shrimp (90 mm); mullet (35 cm); croaker (25 cm); catfish (40 cm); silverside (20 cm); flatfish (35 cm); blue crab (12 cm)		• Pink shrimp (90 mm); bluefish (40 cm); Argentine croaker (25 cm); croaker (25 cm); flatfish (30 cm); black drum (50 cm); silverside (20 cm); royal weakfish (25 cm); weakfish (30 cm); mullet (35 cm); catfish (30 cm)	
Fishing gear restrictions	• Bottom gillnet • Trawling, seine nets and electric fishing • Minimum mesh sizes (50–70 mm) • Maximum 1 830 m of nets per fisher in the Mirim Lagoon	• Trawling of any kind • Maximum of 10 shrimp nets/fisher • Maximum length (1 830 m) and height (100 meshes) of gillnets/fisher • Minimum mesh size (mm opposite knots): shrimp 24, gillnet 100, catfish 140, silverside 40 • Maximum length shrimp nets (15 m)	• Minimum mesh size pink shrimp trawl (30 mm) • Minimum mesh size marine shrimp trawl (24 mm) and maximum length of nets (12 m)	• Minimum mesh size fish trawl (90 mm) • Use of Turtle Excluder Device (TED) in shrimp trawlers >11 m
Quota	None	None	None	• Maximum 5% incidental catch of rockfish in foreign trawlers
Habitat protection	• Protection of creeks and lakes; standards for water quality/use • Protection of riparian habitats	• Protection of estuarine shoals; standards for water quality/use • Protection of salt marshes	• Federal laws to prevent pollution by oil spills and other contaminants (MMA, 1998)	• Federal laws to prevent pollution by oil spills and other contaminants (MMA, 1998)

Modified from Kalikoski, Vasconcellos and Lavkulich, 2002.

Fishers' perception about the legislation

Fishers' perception about the legislation was evaluated based on the level of agreement with some of the rules controlling artisanal fisheries in the estuary (Table 27). The following general consensus was found among fishers from different municipalities:

- the majority disagree with the current rule of a fixed date for the opening of the shrimp season;
- the majority agree with the prohibition of otter trawling in shallow waters of the estuary;
- the majority agree with the prohibition of the operation of boats larger than 12 m in the estuary;
- the majority agree that access to the estuary should be forbidden to fishers from outside the region; and
- the majority agree with the receipt of unemployment benefit during the fishing closure.

These consensual perceptions among fishers reflect a common understanding about some key points for the sustainability of estuarine fisheries. Closing access and limiting fishing capacity of individual boats are two important standing blocks for fisheries sustainability generally supported by fishers.

The control of destructive fishing practices, such as trawling in shallow waters, is also perceived as a necessity because of the role of shallow waters as nursery areas for shrimp and fish resources.

The adoption of an adaptable calendar for shrimp is also supported by fishers because of the variability in environmental conditions that control shrimp recruitment and growth in the estuary. Such strategy has been successfully applied in other coastal lagoons (Almudi and Kalikoski, 2010), where the opening of the fishing season is based on the monitoring of shrimp size. The fixed date rule currently in use was established considering the month of peak historical production of shrimp in the estuary (D'Incao, 1985). It is based on the assumption that the opening in February will allow the escapement of some individuals to recruit back to the adult stock in the sea. In addition, this rule is easier and less costly to enforce and monitor. However, the current regulation brings also problems for the sustainability of the fishery. For instance, in years when conditions are unfavourable for growth, the season opens when shrimp are too small, resulting in a situation of growth overfishing and loss of yield. On the other hand, in years when shrimp are ready before the official opening, there is an intensification of illegal trawling because trawlers, unlike the fixed fyke nets, are less likely to be caught by enforcement officers.

Finally, another perceived general agreement is the receipt of government aid through the unemployment benefit during the months of fishing closure. As demonstrated in this study, the benefit is a necessity for maintaining fishing livelihoods given the low income and high vulnerability of fishers in the region.

On the other hand, there was no general agreement with the following rules:

- *Limit of 10 fyke nets per fisher.* While fishers of Camaquã, Pelotas, Rio Grande and São Lourenço do Sul agree with the rule, fishers from Arambaré and São José do Norte disagree. There was no consensus about this rule in the other municipalities.

- *Limit of 1 000 fathoms (1 829 m) of gillnets per boat.* Fishers from Tapes disagreed with the rule and there was no consensus in Camaquã and São Lourenço. Fisheries in the remaining municipalities agreed with the rule.

- *Prohibition of trawling fisheries.* While there was a general agreement about the rule of banning trawling in shallow waters, fishers from Camaquã and São Lourenço do Sul believed that trawling should be allowed in channel waters of the estuary.

- *Prohibition of beach seines.* Fishers from Rio Grande and São Lourenço do Sul generally disagree with the prohibition of beach seines. In the remaining municipalities, there was a general agreement with the prohibition, with the exception of Tapes where there was no consensus.

- *Prohibition of berimbau.* Fishers from Arambaré and São Lourenço do Sul disagree with the prohibition. There was no consensus in Tapes and an agreement with the rule in all other municipalities.

The consensus found at municipality level for some of these rules hides sometimes disagreement between localities of the same municipalities. For instance, on the limit of 10 fyke nets per fisher, there was a disagreement between fishers from Pontal da Barra (mainly against the limit) and those from Z3 (mainly in favour) in the municipality of Pelotas. The same divergence was found in São José do Norte, where fishers from 5ª Secção da Barra and Povoação da Barra were generally in favour of the limit while fishers in the remaining communities were against it.

One of the most controversial issues is the prohibition of otter trawling in channel waters. In the municipality of Pelotas, fishers from Balsa and Pontal da Barra were generally against the prohibition and those from Z3 were in favour. In Rio Grande, the majority of fishers from Barra and Mangueira (two localities known to operate otter trawling fisheries, see Chapter 3) were against the prohibition, while the majority of fishers in the remaining communities favoured the banning of trawling. In São José do Norte, the community of Povoação da Barra was against the ban. And, finally, in São Lourenço do Sul, there was no consensus among fishers from the community of Barrinha.

Regarding the ban of beach seines, there was disagreement among communities of Rio Grande (Barra, Bosque, Marinheiros, São Miguel and Torotama against the ban) and of São José do Norte (Passinho and Povoação da Barra against the ban). On the banning of *berimbau*, there was disagreement in Pelotas (Balsa against the ban), Rio Grande (Barra and Bosque against) and São José do Norte (Povoação da Barra against).

Table 27: Responses to questions of how fishers agree with the rules defined for artisanal fisheries in the estuary and other proposed rules

Rules	Pelotas (n = 495)		Rio Grande (n = 846)		S. J. do Norte (n = 708)		S. L. do Sul (n = 134)		Camaquã (n = 12)		Arambaré (n = 16)		Tapes (n = 53)		Tavares (n = 81)		Mostardas (n = 16)	
	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Fishing closure (June–September)	82	18	66	34	89	11	64	36	100	0	56	44	47	53	88	12	77	23
Fixed date shrimp season	15	85	19	81	14	86	33	67	25	75	33	67	39	61	11	89	10	90
Max. 10 fyke nets	57	43	65	35	45	55	70	30	80	20	31	69	46	54	48	52	50	50
Max. 1 000 fathoms (1 829 m)	75	25	77	23	67	33	47	53	46	54	63	38	39	61	74	26	57	43
Allow trawling in channel	42	58	34	66	23	77	63	37	58	42	33	67	40	60	4	96	27	73
Allow trawling in shallow water	25	75	11	89	10	90	44	56	25	75	36	64	40	60	4	96	0	100
Allow beach seines	41	59	61	39	38	62	73	27	36	64	44	56	52	48	4	96	15	85
Allow *berimbau*	44	56	36	64	35	65	76	24	13	88	67	33	48	52	10	90	20	80
Allow boats >12m	13	87	14	86	5	95	2	98	0	100	0	100	20	80	15	85	36	64
Open access to lagoon	30	70	23	77	11	89	13	87	0	100	19	81	33	67	27	73	14	86
Receive unemployment benefit	98	2	97	3	97	3	91	9	92	8	94	6	96	4	96	4	100	0

Note: Numbers presented as percentage of total number of responses (n). Y = yes; N = No. Boxes in green are where the majority of the respondents agree with the proposed rule; in red where the majority disagree; and in grey where there is no consensus (difference between yes and no less than 10 percent).

Figures 100 to 103 show the results of the question in which fishers were asked to define for themselves the period they think would be more appropriate for fishing each of the resources. For mullet, the majority believes that the fishing season should encompass the months from January to May, with the highest number of respondents indicating the period from April to May. This is the period when, according to fishers, the largest schools of mullet leave the estuary to reproduce; therefore, it is the most important period for the fishery. The responses differ markedly with the current mullet calendar, defined from October to May (Decree MMA/SEAP No. 03/2004). It is important to note that the mullet calendar was originally from February to May (Decree No. 171 of 1998) and was later revised in response to fishers' complaints that it was impossible to have different calendars for mullet and croaker because both resources are fished with similar gear and are present in the estuary during the same period. Fishers' requests were taken into account in the first revision of the rules for artisanal fisheries in the estuary (Decree No. 144 of 2001) and were later incorporated in the current legislation. Therefore, while a shorter season (February to May) would have obvious conservation benefits, it has proven unpractical to enforce it because of the technological interactions between the croaker and mullet fisheries.

As for the croaker fishing season, there is an apparent disagreement between the opinion of the majority of fishers who believe the season should last from October to January and the current legislation that defines the calendar from October to February. In fact, the original calendar in Decree No. 171 of 1998 was from October to January and was later revised in Decree No. 144 of 2001 based on requests made especially by fishers from the communities of Z3 in Pelotas and São Lourenço do Sul (Kalikoski, Vasconcellos and Lavkulich, 2002). According to the authors, while many fishers from Rio Grande and São José do Norte defend the possibility of ending the croaker season as early as December, practically all fishers from Pelotas and São Lourenço do Sul agree on a calendar extending to February, and some defend also the possibility of leaving the fishery open all year round. These differences reflect distinct fishing strategies of artisanal fishers, and to accommodate these differences the legislation became less restrictive. As for the mullet fishery, it can also be argued here that the fishing calendar for croaker, as currently defined in the legislation, has little conservation value and rather serves to minimize conflicts between fishers.

The calendar for catfish has some peculiarities compared with the other finfish resources. First, there is a general agreement that the fishing seasons should be short, as can be seen from the placement of responses in the diagonal axis of Figure 102. On the other hand, there is no agreement on a single period for the catfish season. While a group of fishers indicated the summer months from January to March, another group of fishers considered the winter months from June to August as ideal seasons for the catfish calendar. The current calendar in the legislation misses both periods. In fact, in contrast to the rules defined for mullet and croaker, the calendar for catfish is largely opposed by fishers in all communities (Kalikoski, 2002). The revision of the catfish calendar is currently on demand by fishers, especially fishers from communities in the upper estuary (such as São Lourenço do Sul) who fish catfish during the winter months of the fishing closure in the estuary. The fishing season for catfish has shown some marked changes since the fishery collapsed in the 1980s (before the collapse, most catches occurred during spring months), which are presently being investigated to support the revision of the legislation.

As for the shrimp calendar, in spite of the general agreement between fishers' knowledge about the season and the current legislation (February to May), as demonstrated in Table 26, the majority of fishers agree that the shrimp calendar should be adapted each year according to the resource conditions, which is in contrast to Decree MMA/SEAP No. 03/2004 that fixes the opening of the season annually on 1 February.

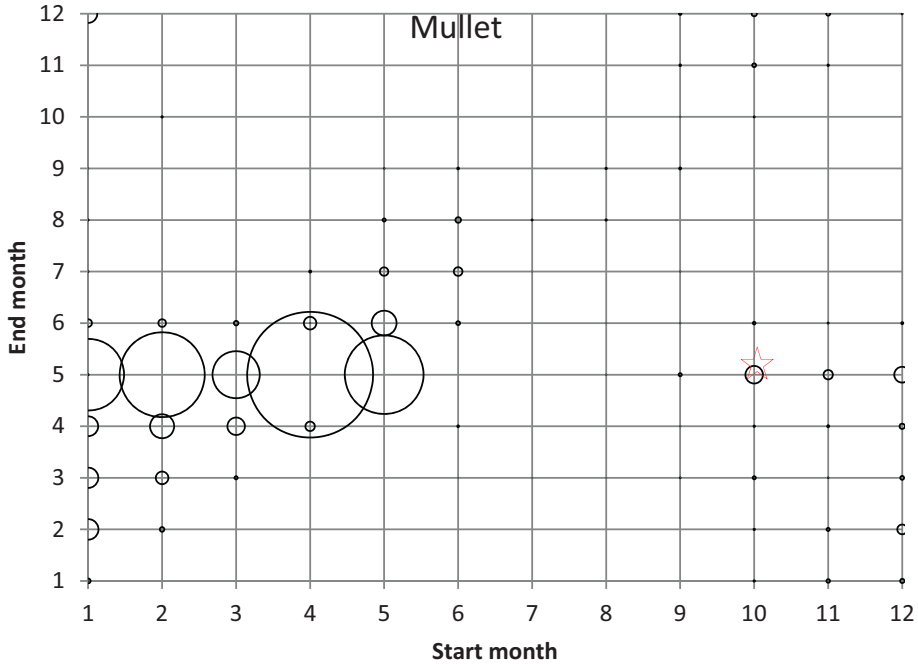

Figure 100: Fishers' perception about the length of the fishing season for mullet

The size of the circles is proportional to the number of respondents (smaller circle [n = 1]; larger circle [n = 360]). The red star indicates the length of the fishing calendar according to Decree MMA/SEAP No. 03/2004.

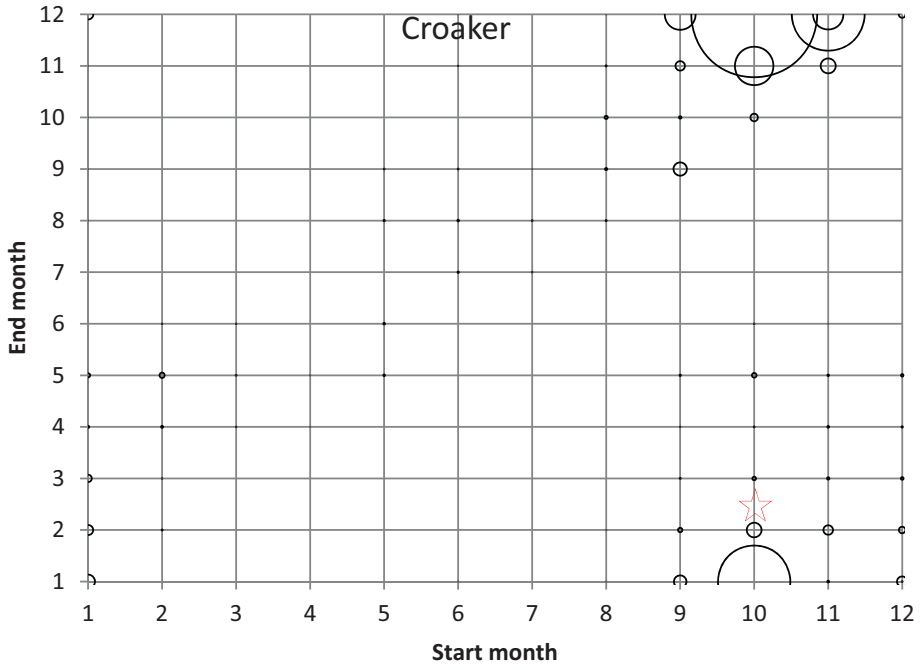

Figure 101: Fishers' perception about the length of the fishing season for croaker

The size of the circles is proportional to the number of respondents (smaller circle [n = 1]; larger circle [n = 464]). The red star indicates the length of the fishing calendar according to Decree MMA/SEAP No. 03/2004.

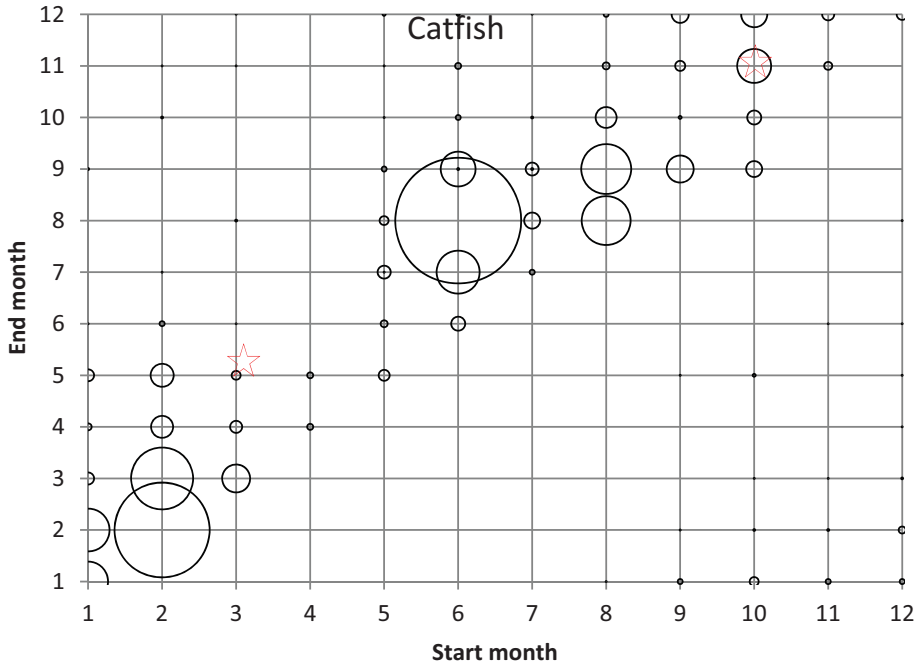

Figure 102: Fishers' perception about the length of the fishing season for catfish

The size of the circles is proportional to the number of respondents (smaller circle [n= 1]; larger circle [n = 126]). The red stars indicate the length of the fishing calendar according to Decree MMA/SEAP No. 03/2004.

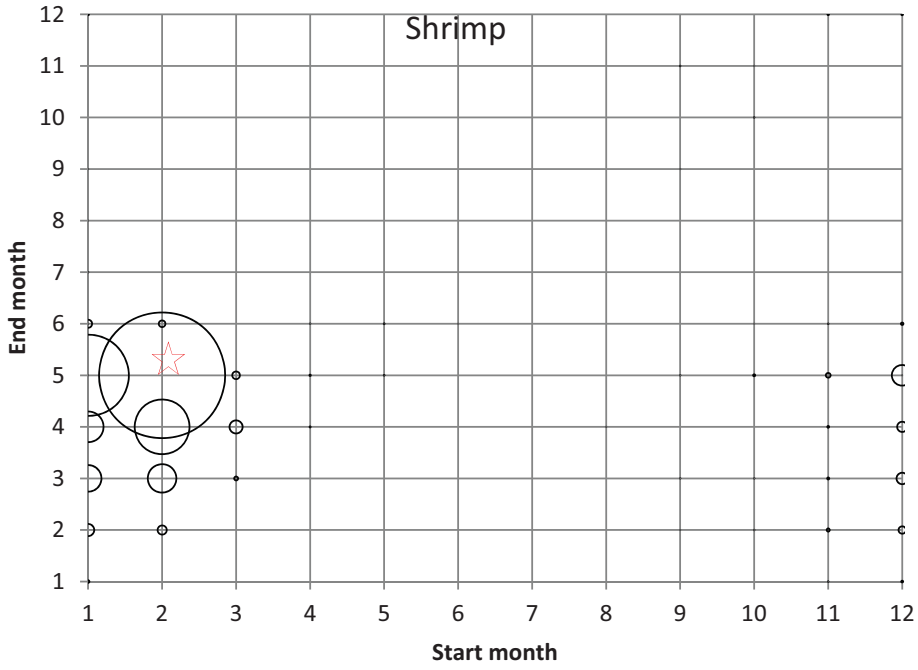

Figure 103: Fishers' perception about the length of the fishing season for shrimp

The size of the circles is proportional to the number of respondents (smaller circle [n = 1]; larger circle [n = 606]). The red star indicates the length of the fishing calendar according to Decree MMA/SEAP No. 03/2004.

The congruence between management rules and resource sustainability

This section describes some mismatches that were identified in the management of fisheries that can potentially affect resources sustainability in the Patos Lagoon estuary.

Harvest technologies and environmental characteristics

Fishing impacts ecosystems in many different ways; for example, by exploiting resources beyond their carrying capacity, by damaging habitats that are important for nursery and production, and by capturing species that are not the main target of the fishery (bycatch) (Hall, 1999). Bycatch is an important issue in the management of shrimp fisheries and as such it has evoked rules that restrict the use of certain fishing methods. In the Patos Lagoon estuary, the gear allowed to catch shrimp (fyke nets and stow nets) are considered adequate by the legislation because they produce relatively low bycatch rates per net compared with what is known about other types of gear such as trawling. Vieira *et al*. (1996) estimated that on average only 6 percent of the total catch in fyke nets is composed of juvenile fish (mostly croaker and catfish), which are discarded. However, the total amount of juvenile fish discarded at the end of shrimp season can be significantly high, in the order of 600 tonnes (Vieira *et al.*, 1996), because of the high number of nets used (see Chapter 3). The reality is, therefore, that the shrimp fishery with fixed nets can produce harmful levels of bycatch. The decision-making process that by law established this as the technology to be used was narrowly defined because it considered only the characteristics of the fishing gear and failed to account for the difficult problem of limiting the right of entry and use of resources. The opening of access and the lack of monitoring and enforcement contributed to increase the pressure on the resource over the years.

The bycatch produced by trawling, which is still used by many fishers, can also be high, although no formal evaluation has been conducted since it was prohibited in the estuary of Patos Lagoon in the 1970s. Bycatch is not only an issue in artisanal shrimp fisheries. It is particularly important in industrial trawling fisheries that operate along the coast. Haimovici (1997) estimated that the total discarded bycatch of pair trawlers and otter trawlers fishing in the region during the early 1980s summed up to 46 percent of the total catch in weight, most of it composed of juvenile weakfish, royal weakfish and *castanha*. The discarded bycatch in double-rig trawlers is about 50 percent of the total catch and is composed of small sharks and fish. A rule limiting the minimum mesh size of fish trawling nets to 90 mm was later adopted to remedy the bycatch of juvenile fish (Vooren, 1983) (Table 26).

Therefore, both artisanal and industrial fisheries use harvest technologies that can affect resource sustainability. The shrimp fishery with fyke nets provides an example of incongruence between rules and the local characteristics of the ecosystems. The case of artisanal trawling in estuarine waters is an example of a rule that is apparently congruent with the resource conditions; however, trawling is still done. A combination of factors seems responsible for the lack of compliance with the trawling ban (Kalikoski, 2002). First, because fishers believe that trawling in the channel waters is less damaging than fishing with fixed nets in shallow waters. Second, because the shallow waters are already occupied by thousands of fixed nets; therefore, for many fishers, there is no other available way to catch shrimp. The third is due to the poor level of involvement of fishers in policy and regulation formulation. Finally, fishers seem to be trapped in the rationale that "if I don't do it, others will do it", which, when combined with the lack of enforcement, leads to non-compliance with the rules. Industrial trawling provides an example of a fishing technology that is incongruent with the sustainability of resources. Rules have been devised to alleviate the damaging effects of this fishery, such as the three-mile exclusion zone and the mesh size limits (Table 26), but in fact there has been little compliance with these rules and low level of enforcement.

Fishing calendars

One of the most widely used rules to control fisheries in the Patos Lagoon estuary is the fishing calendars, which define the timing of fisheries for each of the main resources (Table 26). The shrimp fishery calendar is tied to a fixed opening that occurs every year on 1 February, even though fishers, scientists and managers acknowledge the fact that the cycle of shrimp growth and production varies between years and areas. Although the fishery occurs mostly after February, in reality some fishers follow their own traditional calendar and start catching shrimp earlier in the year depending on environmental and/or resource conditions. The lack of feedback mechanisms to adapt rules to the characteristics of the resource and to the climatic conditions often generates conflicts between fishers and officials. Fishers ask for annual revisions of the rules and for distinct openings by areas, as shrimp production varies along the estuarine shallows and is closely related to the hydrological conditions (Forum of Patos Lagoon minutes). Changing the status quo to an adaptive calendar would require a more complex system of monitoring, which is viewed as unfeasible by the official agency (Forum of Patos Lagoon minutes). On the other hand, attempts to adapt rules to resource conditions have failed because of fierce discussions between scientists and fishers about when the stock would achieve the adequate fishing size (Reis and D'Incao, 2000). There is still a perceived institutional barrier to be broken to allow the sharing of responsibilities between officials and resource users in the monitoring of shrimp stocks and in the management of the activity (Forum of Patos Lagoon minutes).

Another identified incongruence in the law relates to the calendar for catfish. The established rule is that the fishing season is restricted to the period from October to November and from March to May. The fishery traditionally started in August and lasted until December, the period when the species enters the estuary to mature and reproduce (Reis, 1986). Fishers consider the

current calendar inadequate because it makes them catch catfish in a critical period in the species life cycle, when adults are incubating the young in their mouths. After spawning in estuarine and coastal waters in late spring, male catfish incubate the eggs and the fry for up to two months in their buccal cavity (Reis, 1986). The incongruence in the catfish calendar is particularly threatening to the maintenance of this long-lived resource, which suffered from intense overfishing in the last decades and requires strong conservation measures to recover (Reis and D'Incao, 2000).

Limiting excessive exploitation of resources

Most of the fisheries resources traditionally targeted by artisanal fisheries are currently classified as either fully exploited, overexploited or collapsed (D'Incao, 1991; IBAMA, 1995; Haimovici, 1997; Vasconcellos, Diegues and Sales, 2007). The abundance of croaker has been decreasing steadily in the last two decades and current exploitation rates are considered unsustainable (Vasconcellos and Haimovici, 2006). Resources such as black drum and catfish were overexploited in the 1970s, and the fishery in the estuary of Patos Lagoon collapsed in the early 1980s (Reis, Vieira and Duarte, 1994). The stock of pink shrimp also shows signs of overfishing. Despite the high natural variability in catches, the average landings have declined since the 1970s (Reis and D'Incao 2000). Individual fishers catch rates have been also declining in the last three decades (Chapter 3) confirming concerns of resource overfishing. Not much is known about the status of the mullet stock in southern Brazil; landings are highly variable but show a clear declining trend since the peak in reported landings in 1975 (Figure 90). Catch volumes in good seasons during the last two decades have remained relatively constant, as demonstrated by official statistics and fishers' knowledge (see Chapter 3). The species is, however, considered threatened with overfishing owing to the high fishing intensity from artisanal and industrial fishing fleets operating in southern Brazil (Vasconcellos, Diegues and Sales, 2007).

Recognizing the need to recover the productivity of estuarine fisheries, the Decree MMA/SEAP No. 03/2004 defined measures to control the excess resource exploitation in the estuary (e.g. licence control, effort control, closed seasons; Table 26). The expected effect of these rules in alleviating the excess exploitation and allowing the recovery of depleted stocks is highly uncertain. At best, the rules in place are expected to maintain the status quo conditions, which are worrisome for their potential impact on some resources such as catfish and black drum. There is no action plan defined with specific strategies to recover the depleted resources. More importantly is the fact that all species exploited by the artisanal fishery in the estuary migrate to shelf waters of southern and southeastern Brazil (some to Uruguayan and Argentine waters), where they are also exploited and subjected to other less-restrictive management rules (Table 26). A complicating factor to the effectiveness of management rules is the overall limited enforcement.

Deficient monitoring and enforcement

Institutional behaviour is not only defined by its intentions, political rhetoric and the policies that it enacts, but it is also largely defined by the extent to which these policies are implemented and monitored. Monitoring constitutes a vital source of feedback in the management process. Many contend that Brazil has one of the most advanced bodies of environmental laws in the world, yet implementation and enforcement of these laws are exceptionally weak and ineffective (Domask, 1997). As it can be observed in Table 26, a number of rules exist for regulating fisheries activities in southern Brazil, but enforcing these rules has been ineffective.

Considering the technological characterization of artisanal fisheries described in Chapter 3, it can be concluded that compliance can be low for some rules, such as: the rules limiting the maximum number of fyke nets per fisher (average number in use is 15 per fisher while the rule is 10 nets per fisher); the use of trawling gear (at least 170 fishers declared using otter trawls);

and the use of forbidden gear for blue crab (254 fishers declared using fyke nets and 49 otter trawls). Another set of rules with low compliance is the rules establishing fishing closures and calendars for the main resources. As demonstrated in previous sections, in some localities of the estuary, it is common for fishers to continue fishing controlled species during the closure as a means of guaranteeing some cash income. Likewise, the fishers' disagreements with established calendars for catfish (Figure 102) and also with the fixed calendar for shrimp (Table 26) are indicative of poor compliance with these rules.

Another way of evaluating the level of compliance is to investigate the number of fishers that have been caught or received sanctions for not following rules. Data presented in Figure 104 indicate that 17 percent of artisanal fishers in the estuary have been caught at least once. The highest rate of sanctions was in Tapes, where 42 percent of fishers declared receiving sanctions at least once. These levels of sanctions should be considered minimal estimates of non-compliance considering the deficient enforcement in the region (Dias Neto and Vasconcellos, 2006; Kalikoski, Vasconcellos and Lavkulich, 2002).

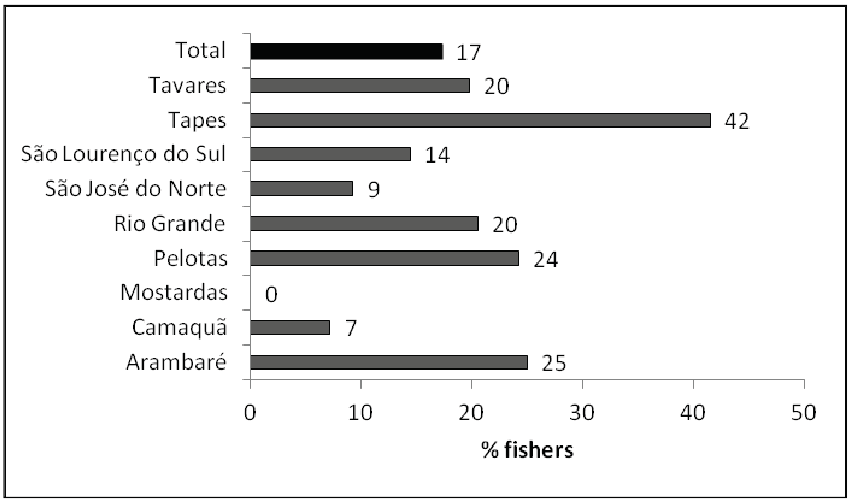

Figure 104: Percentage of fishers who were caught by enforcement officers and/or applied sanctions for not following rules at least once

Many factors contribute to the deficient monitoring of resource conditions and the enforcement of regulations in the estuary of Patos Lagoon and coastal areas. Beginning with the fact that with the centralization of fisheries management both monitoring and enforcement became the responsibility of a single federal agency (SUDEPE and later IBAMA), which has always lacked structure and human resources to carry out the functions effectively. It is known that contravention is usually tolerated by officials, who are often unwilling to enforce rules impartially (Kalikoski, 2002). It has been proposed that the efficiency of this source of feedback (who monitors resource conditions and how) is increased with the inclusiveness and accountability of the resource users (Pinkerton, 1989; Ostrom, 1990). This sharing of responsibilities between government and fishers over enforcement has not been considered yet by the local institutions. On the other hand, efforts to overcome the problem of infrastructure and the monitoring of illegal fishing in estuarine and coastal areas were addressed by concerted action between IBAMA and the Navy and more recently between IBAMA and the Ministry of Fisheries and Aquaculture. The results of these initiatives, which are to be analysed in the future, will serve as an important mechanism to evaluate how these management functions could be better performed over time by the different institutions.

The poor compliance with the established norms should be also evaluated from the perspective of fisheries co-management. The rules in place were exhaustively discussed and agreed in the

Forum of Patos Lagoon as a first step for community-based management. In spite of a consensus reached by the Forum representatives at the time of elaborating these management instruments, few fishers were consulted and gave inputs on the rules launched (Kalikoski, 2002). Measures for fisheries management in place in the estuary seem not to meet fishers' purposes fully; therefore, they are not supported by a large number of Patos Lagoon fishers. This indicates that the Forum does not genuinely represent the interests of the fishers. This challenge illustrates the difficulties in implementing co-management arrangements when only a consultative co-management is in place, i.e. government consults with fishers about decisions but does not share decision-making responsibility with fishers.

Wider environmental impacts

Fisheries management in Brazil is still sectoral, and does not include in its structure the possible interference from other activities and institutions. There are multiple sources of human impacts that can alter the carrying capacity of the estuary of Patos Lagoon and that can potentially impact artisanal fisheries. These include:

- *Destruction of vital habitats:* estuaries provide vital habitats for nursery of aquatic organisms. Seagrass beds, for instance, are a nursery ground in which postlarval stages of many invertebrates and fish species concentrate and develop. Salt marshes are important producers of organic matter that is either transported to the estuary and coastal area or recycled in the marshes by herbivore and detritivore organisms that are important food sources for juvenile fish and birds that rest in the estuary (Costa, 1997). Although legally protected, seagrass and salt marsh habitats (Table 26) have been destroyed by the filling of intertidal and shallow-water flats in the lower estuary for port, residential and industrial development. It is estimated that filling along estuarine margins and around small islands has destroyed as much as 10 percent of the total salt marsh area of the estuary (Seeliger and Costa, 1997). Other important man-induced impacts to salt marshes, which have not yet been quantified, are the large-scale grazing by livestock on marginal marshes. Estuarine habitats are also lost due to sedimentation processes, which could be natural or man-induced, the latter related to the misuse of agricultural land in the watersheds. Over the last two centuries, it is estimated that the water area of the estuary has decreased by about 11 percent owing to the deposition of fine sediments from the Patos Lagoon in shallow estuarine shoals (Seeliger and Costa, 1997).

- *Changes in primary production:* the main primary producers in the estuary of Patos Lagoon are salt marshes, seagrasses, benthic and floating macroalgae, cyanobacteria and microalgae (including phytoplankton). Conservative estimates of net primary production indicate that salt marsh plants, macroalgae and cyanobacteria are responsible for as much as 86 percent of the total addition of carbon to the estuary (Seeliger, Odobrecht and Castello, 1997). There is no direct evidence of changes in primary production in the estuary of Patos Lagoon. On the one hand, a decrease in primary production may have occurred owing to the destruction of salt marshes and seagrass habitats during the last century. On the other hand, excess nutrient loads from domestic and industrial effluents and agricultural runoff are responsible for the eutrophication of the estuary with the development of blooms and changes in phytoplankton composition (Seeliger and Costa, 1997). Eutrophication has as a side effect led to the decline of seagrass biomass in estuarine embayments owing to the attenuation of light penetration, which can also decrease the overall primary productivity (Okey *et al.*, 2004).

- *Pollution and contamination of estuarine waters:* the estuary presents high risks of contamination by chemical substances owing to the large number of petrochemical and fertilizer industries installed on its margins, the trade and transportation of toxic substances in the port of Rio Grande, landfills, and the excessive use of agricultural

pesticides in the farmlands around the lagoon (Seeliger, Odebrecht and Castello, 1997). One of the most recent and important incidents in the port of Rio Grande was the acid spill from the Maltese freighter *MV Bahamas*. The ship entered the port of Rio Grande in August 1998 carrying 22 000 tonnes of sulphuric acid to supply the local fertilizer industries. A hole in the *MV Bahamas* caused water from the estuary to enter the freighter and react with the acid to produce a highly explosive gas. Considering the risks of explosion and the economic costs to take alternative measures, local authorities (port and governmental organizations, Port Authority, municipality and the university) decided to release about 9 000 tonnes of acid in the estuarine environment. The consequences to fisheries activities were extremely grave. Artisanal fisheries activities were prohibited in the estuary, compromising part of the fishing season for croaker and shrimp. The accident revealed the lack of contingency plans in port activities and the absence of care of local authorities for the environment and the population that depend on the resources. Seeliger and Costa (1997) also cite as important pollution sources in port activities the washing of vessel tanks, which release into the estuary different types of toxic hydrocarbon forms. Yet another source of contaminants to the estuary is the landfill of the city of Rio Grande. The municipal district of Rio Grande produces 110 000 tonnes of waste per year, which has been deposited on salt marshes at the margins of the estuary during the last 20 years. There are no prospects of waste treatment in the near future, which poses serious threats for the health of the local people and the environment.

One important environmental stressor to estuarine fisheries relates to the impacts of climate change on the productivity of estuarine resources. Costa, Seelinger and Bemvenuti (2010) demonstrated that the outflow of major tributaries to the Patos Lagoon increased since the first half of the twentieth century mainly in response to an increase in precipitation in the watersheds. Other concurrent processes contributed to the increase in freshwater runoff in the period, such as the decrease in soil permeability resulting from the expansion of urban areas, and the decrease in water infiltration and increase in near-surface runoff caused by deforestation and intensification of agriculture (Castello, in press). The process of turning the estuary into a more limnic state, observed in the last half century, is expected to continue in the next decades. Model projections point to a rise in precipitation and river runoff in the order of 10 percent to 60 percent in the next 50 years associated to an increase in temperature (Costa, Seelinger and Bemvenuti, 2010). According to the authors, the resulting increase in the outflow of the Patos Lagoon could extend the estuarine limits (or the area of brackish water) towards the sea and decrease the productivity of the area currently occupied by the estuary.

The intensification of the lagoon outflow and the decrease in salinity of estuarine waters will have grave consequences to the dynamics of artisanal fisheries resources. The exchange of larvae and juveniles of fish and crustaceans between the coastal waters and the estuary is strongly influenced by the intensity of the outflow currents. Vieira, Garcia and Grimm (2008) showed, for instance, that the increase in precipitation associated to El Niño events reduces the recruitment of juvenile mullet into the estuary and affects the reproductive migration. As a result, there is an inverse relationship between rainfall and mullet catches in the estuary (Vieira, Garcia and Grimm, 2008). Möller, Castello and Vaz (2009) demonstrated the same effect for shrimp, i.e. rainfall anomalies increase the lagoon outflow and negatively affect the passive entry of shrimp postlarvae into estuarine nursery areas, resulting in poor shrimp seasons with low catches. These effects are well known by fishers who frequently associate the success of their fisheries to the prevailing climatic conditions (Kalikoski and Vasconcellos, 2007).

The above examples illustrate the complex reality of the estuary of Patos Lagoon, where artisanal fisheries are subjected to the cascading impacts of other human activities in the watershed and estuarine areas as well as from environmental changes such as those associated to climate.

To be effective, the co-management regime established in the Patos Lagoon has to find ways to protect not only the fish stocks as it has been the issue of concern but also their habitats. There is little point in planning the enhancement of stocks if in the process the community cannot protect its environment and the habitats on which the stocks depend for spawning and nursery (Pinkerton, 1989; Young, 1999). Existing fisheries management institutions pay little attention to this aspect when defining rules for the conservation of fisheries resources (Table 26). On the other hand, efforts for the management and conservation of coastal habitats through their federal and state institutions have narrowly defined goals and indicators that disregard the impacts of coastal activities on the living resources, such as fisheries. This demonstrates the need for an integrated ecosystem-based management plan for fisheries and coastal zones.

6. CONCLUSIONS AND RECOMMENDATIONS

Final considerations on the study methodology

This study was carried out in response to a proposal made by FAO to elaborate a methodology that could be employed to assess the condition of small-scale fisheries in coastal lagoons. Challenged by this task, and motivated by the necessity for improving the knowledge base of artisanal fisheries in the Patos Lagoon estuary, a methodological approach was devised to assess the technical, environmental and socio-economic conditions of local artisanal fisheries.

A preliminary evaluation of the information needs for the governance of local artisanal fisheries, done in consultation with main stakeholders, revealed main deficiencies in basic information, such as the number of fishers, fishing effort and practices, fisheries production, as well as the need to unfold the complexity of livelihoods, vulnerabilities and adaptive capacity of fishers. It became clear that a sample-based approach alone would not suffice to respond to these needs. Therefore, a census methodology was adopted as the main instrument of research. Complementary information was sourced from a literature review, secondary data and in-depth semi-structured interviews.

The authors of this study believe that the census methodology was successful in meeting the demands for improving the knowledge base about local artisanal fisheries. The following strengths and weaknesses of the methodology adopted in the present study can be highlighted:

Strengths:

- The census method provided a complete picture of the fishery in terms of its technical, economic, social and environmental conditions.

- Data obtained can be readily converted into indicators that could be used to monitor these conditions over time and evaluate the performance of fisheries governance against sustainability and human development benchmarks.

- The method provided basic information that is normally lacking to support fisheries governance, such as the number of fishers, fishing effort, socio-economic conditions and access to policies.

- The design of the survey methodology was participatory and responded to stakeholders' priorities and demands. As a consequence, results of the study are being rapidly appropriated and applied to address governance issues by local institutions (e.g. in the 2010/2011 licensing of artisanal fishers by IBAMA, in the monitoring of fisheries statistics by the Ministry of Fisheries and Aquaculture, and in diligences of the Public Ministry).

- The capture of local knowledge in a systematic way provided information about fisheries dynamics and trends until now inexistent, contributing to the assessment of these data-poor fisheries.

- The method provided information on illegal, unreported and unregulated fisheries.

Weaknesses:

- The census method is time consuming and needs to take into account fishers' time availability, which is seasonal and often does not follow regular working hours. Carrying out fieldwork during fishing closure, on weekends and holidays, and having the help of

fishing community members were strategies used to conduct the study and overcome this problem.

- The high cost of conducting a census in large areas may be a limiting factor in some situations. Obtaining additional in-kind contributions from interested parties, especially for field support, has shown to be a viable option to attenuate this problem.

- Difficulty in finding adequately trained people with technical capacity to carry out fieldwork and data entry. A considerable amount of time was spent on training people to guarantee the quality of the study.

Censuses studies have been historically used in the agriculture sector to monitor the status and trends of food production and living conditions of rural people worldwide (FAO, 1995). Similarly, considering the data-poor status of artisanal fisheries globally, we conclude that censuses have the potential to be used by fishing states to monitor the status and trends in small-scale fisheries and improve the availability of information about these fisheries. The authors of this study believe that the Fisheries and Aquaculture Department of FAO has a strong role to play to this end, providing guidance to apply fisheries censuses globally.

To apply and adapt the method described in the present study to assess small-scale fisheries in other locations, the following general steps and recommendations are considered important:

1. Rapid assessment of data needs and priorities with all key fisheries stakeholders through meetings, interviews and focus groups. This initial step should aim to respond to questions such as those proposed by Garcia *et al*. (2008): Why is an assessment needed? Who asked for it? Who else should be invited to participate? What sort of assessment is needed? What sort of advice is expected? When is the response needed? What is the management context and/or capacity? The results of the study should always lead to further actions that secure livelihoods and sustainability of the fisheries.

2. Draft of the census survey questionnaire based on the data needs and priorities previously identified. When organizations draft the survey instrument, particular consideration should be given as to how the data collected can be merged and analysed in order to draw important conclusions. Do not collect data just to have it, but consider how the data can be triangulated to confirm certain hypotheses. Another important step to be taken at this stage is to evaluate the sensitivity of the information requested based on the cultural context, fishing practices and legislation. Finding ways to deal with the most sensitive information is key to obtaining reliable data. In this study, for instance, sensitive questions that could put respondents at risk were included in a separate anonymous questionnaire.

3. Validation of the census survey questionnaire through key stakeholders meetings. Once the survey instrument is drafted, it is important to check with key stakeholders if the instrument is adequately addressing all the needed information. The instrument should be revised until the questions are considered satisfactory.

4. Pre-test the census survey questionnaire with fishers for both content and language. It is important to pre-test the instrument with fishers' representatives of the whole diversity of fishing livelihoods and cultural backgrounds. The pre-test should be used to revise and prepare the final instrument to be applied in the fieldwork. At this stage, questions are reformulated to be clearer and to avoid ambiguity.

5. Announce the objectives of the study and the procedure to be adopted (including why, how, when, where and who will carry out the survey) before beginning fieldwork. Strategies such as radio interviews and distribution of pamphlets in fishing villages are

useful to make the study widely known. Inception workshops, such as the one conducted in this study, are also useful to discuss survey procedures with a wide range of main stakeholders. In situations where participation is voluntary, this step is particularly important to promote fishers buying into the study.

6. Make sure that all the logistics are in place to run fieldwork and data storage. The success of the study depends not only on the quality of the survey instrument but also on the technical capacity of the team running the project, including coordinators, enumerators and people responsible for data storage and processing. To this end, providing basic training in fisheries census surveys for enumerators is an important preparatory step. Good planning at this stage involves knowing the communities and mapping the fishing villages to be visited beforehand, establishing a calendar of visits per village and checking the best time to conduct the survey, having reliable contact people in the villages, having contingency plans for unexpected situations (e.g. bad weather, transportation problems, changes in team composition, etc.) that will require adaptations in the fieldwork. Customized databases are probably the best option for data storage, but in the lack of them commonly available spreadsheets and databases (Microsoft Excel and Access) can provide the needed tools for storage and analysis. Keep backups of the data.

7. Existing censuses and surveys from other non-fisheries authorities should be analysed to identify synergies and data gaps, and thereby providing important data for fisheries' managers. In this context, fisheries' managers and authorities should insist on the inclusion of fisheries pertinent data in national censuses and surveys for future use. Data such as the World Bank "Living Standards Measurement Study" can provide important sources of information to enrich the studies on fisheries. The World Bank database can be accessed at http://microdata.worldbank.org/lsms/index.php/catalog, and then can be searched for the country of interest.

Final considerations on the status and trends of artisanal fisheries in the Patos Lagoon estuary

This study has provided important contributions for the understanding of the current status and the challenges for the future of artisanal fisheries in the estuary of Patos Lagoon. Some of the key findings of the study, summarized below, can serve as benchmarks for guiding and evaluating future governance strategies to secure fishing livelihood and for sustainable use of resources.

- The number of artisanal fishers dependent on fishing as main livelihood in the Patos Lagoon estuary is smaller than expected from previously available information. It should be noted, however, that the number of people exploiting fisheries resources in the area is probably higher if occasional fishers are taken into account. In the future, a specific study will be required to adequately evaluate the magnitude and impact on the resources by occasional fishers.

- A better system of registration and documentation of artisanal fishers is a necessity to control access into the fishery and to guarantee participation in formulation of governmental policies by those who have fisheries as their main livelihood. The findings that a significant number of fishers are not fully documented and that a large contingent of non-fishers have been accessing governmental benefits are symptomatic of the failures of the current system. The institutions regulating the fisheries of the estuary should take into consideration the following aspects when revising the regulations and documentation required for the registration and licensing: differences between occasional and professional fishers, sale, transfer, rental and expiration of licences and registration, new

fishers, licence of boat and/or fisher, crews and owners, inheritance, invoices, and history in the fishery.

- The artisanal fishery has diverse technological characteristics, expressed in terms of differences in boat sizes, engines, equipment and fishing gear, affecting distinct levels of fishing capacity, territories and both fishing and non-fishing livelihood strategies.

- The shrimp fishery is an important source of income for the majority of the fishing localities, but not in all. There are many instances where other fisheries play a more important economic role, such as the mullet and croaker fisheries. Other species such as blue crab and silverside represent an important auxiliary source of income, especially in fishing seasons where there is a failure in abundance of the main resources.

- Shrimp catch volumes estimated in this study matched reasonably well the official statistics of production in recent good seasons. The same finding was not verified for the other main resources, which appear to be grossly underestimated by official statistics. The reasons for discrepancies need to be better evaluated in future studies. Declining trends in catches and CPUE of shrimp and croaker, inferred on the basis of fishers' knowledge, corroborate scientific assessments of the overexploited status of these resources. On the other hand, there is no clear indication of decline in mullet catches that would characterize overfishing. Instead, individual catches in good seasons seem to have changed little in the last two decades; a finding that is consistent with the official statistics. Further analysis of the changes in artisanal fishing effort and the changes in the frequency of occurrence of good seasons (another indicator of resource overfishing), as well as of other biological indicators, should be made in the future to better evaluate the status of this important resource for artisanal fishers.

- Artisanal fisheries make a significant contribution to local economies, as inferred from the first sale value of production. It is estimated that between R$23 million and R$46 million worth of fisheries resources enter the local economies in good seasons. Fisheries can account for up to 25 percent of the agriculture GDP of municipalities in the estuary of Patos Lagoon. This represents an underestimate of the real economic importance of the sector if other use and non-use values of fisheries are considered.

- Artisanal fisheries are characterized by minimal infrastructure for fish landing and conservation. Although this situation is well suited to the dominant type of commercialization, it is an important impediment to the development of alternative market strategies, which would increase economic returns for fishers and allow them to break away from the economic dependence on intermediaries and processors.

- The bulk of fisheries production is marketed fresh. Fishers sell their catches to a different array of buyers, including intermediaries, local processors, associations and/or cooperatives and directly to consumers. Selling to local buyers and/or intermediaries is the dominant way of commercialization in the main fishing localities. The highest prices are fetched when selling directly to consumers, while little variation in prices was found among the other identified buyers. In recent years, efforts have been made to stimulate the organization of fishers' associations and cooperatives as a way of promoting better and fairer options for fish commercialization. Although this mode of commercialization has a potential role to play in the future, it was found to have a minor importance at the moment in the region.

- Improving the role of fishers associations and cooperatives in the region will require strengthening community leaderships, building technical capacity, improving and strengthening formal credit policies for local community-based organizations,

strengthening alternative markets for artisanal fisheries production (e.g. institutional markets and fish fairs), and finding ways to regulate the dominant mode of commercialization in the region centred on the intermediaries.

- The income level of fishers is generally low in good seasons and can drop below the poverty line in bad seasons. Given the deteriorating status of resources and the unfavourable climatic conditions that prevailed in the last decades, it can be concluded that artisanal fishers' livelihoods are currently in a vulnerable situation.

- Fishing livelihoods in the Patos Lagoon estuary are diverse and generally not exclusively dependent on capture fisheries activities. Fishers often rely on other sources of income in addition to fishing as a strategy for subsistence, including both fisheries and non-fisheries- related activities. Gear maintenance, fish processing, agriculture in rural areas and occasional jobs in urban areas are common alternatives of cash income for fishers. This situation is both a reflection of traditional practices and an adaptation strategy to current poor economic returns from fishing.

- Fishers also employ distinct fishing strategies to cope with failed seasons, such as directing effort to alternative species – blue crab and mullet are important alternatives in communities of the lower estuary and freshwater species in the upper estuary.

- Government aid in the form of an unemployment benefit paid during the fishing closure is one of the main sources of fishers' income at the moment. This policy, which was shown to reach 80 percent of fishers interviewed, has an important role to livelihood maintenance because it guarantees a minimal level of income to households in the face of the current poor economic returns from fishing. If on the one hand it provides an important social "safety net" that precludes fishers from entering in a situation of poverty, on the other hand it is unclear the effect that high dependence on this policy will have on the adaptive capacity of communities to cope with such situations of crisis and to secure their livelihoods in a changing environment.

- Qualitative and quantitative data indicate that a large number of artisanal fishers of the estuary of Patos Lagoon receive a significant part of their livelihood from sources other than capture fishing. Numerous factors have contributed to this situation, including failures in fisheries governance and environmental changes, which led to a series of adaptation strategies at the community and government levels for securing fishing livelihoods. These findings have serious policy implications, if it is considered that the current view of artisanal fishers adopted by government institutions that artisanal fishers work exclusively on fishing. As demonstrated here, with some exceptions, this is no longer a reality in the region, where fishers were forced to find income sources in addition to fishing to maintain their fishing livelihood.

- Fish is an important source of animal protein to artisanal fishers and plays a crucial role for their food security. The estimated average fish consumption per capita (52.8 kg/person per year) in artisanal fishing communities of the estuary of Patos Lagoon is among the highest in the country.

- Fish capture activities are mostly developed by men, while women participate more intensively in fish processing activities. In addition, in some communities, the income obtained by women in activities outside the fishery plays an important role in the maintenance of fishers' households. The importance of this source of family income becomes particularly important during failed fishing seasons.

- There are very few young fishers engaged in artisanal fisheries (12.8 percent are less than 30 years old). The low recruitment of individuals to the fishery, associated with the overexploitation of resources, represents a threat to the continuity of the activity in the estuary of Patos Lagoon in the medium-long term.

- The illiteracy rate among fishers is high (10.9 percent) and well above the state (3.1 percent) average. Still, about 75 percent of fishers may be considered functionally illiterate for not having completed elementary school.

- With few exceptions, the access of households to basic infrastructure and social services, including access to potable water, sewage systems, collection of domestic waste, health, school and transport, are reasonably good compared with other areas in Brazil.

- Both formal and informal credit mechanisms play a role in the financing of artisanal fisheries activities at the moment. While federal and state programmes of rural credit have been instrumental to the acquisition of means of production by fishers, informal credit options, sourced for instance from intermediaries, have been providing the needed cash flow to run individual fishing units. The absence of formal credit options to cover the latter aspect, contributes to maintaining the relationship of dependence of fishers on intermediaries – a dependence that permeates the whole fishery system from production to commercialization. Governmental policies of rural credit have enabled artisanal fishers to access financial resources previously inaccessible, and therefore created the conditions for the independence of fishers who lacked the means of production. However, concerns exist that without appropriate criteria for accessing credit, these policies will have the unintended effect of exacerbating the pernicious cycle of increase in fishing capacity, intensification of resource overfishing and worsening of the economic situation of fishers.

- An important institutional change that influenced positively the governance of artisanal fisheries in the Patos Lagoon estuary was the creation of the Forum of Patos Lagoon, a multi-institutional co-management arrangement. Through the Forum, a venue exists where institutions and fishers can discuss and take actions on different issues affecting the artisanal fishery. One of the merits of the Forum was the establishment of norms for resource exploitation based on a participatory process. An evaluation of fishers' perception about the norms in place revealed, however, incongruence and lack of consensus about the control of fishing gear and fishing calendars of some species. It has also shown that compliance with the norms is generally low. Other factors contributing to this situation are the diversified fishing livelihoods in the estuary, the lack of community organization and leadership able to influence decisions and improve governance, and the condition of open access to fisheries outside the estuarine limits. This situation encourages competition that leads to overexploitation of resources instead of cooperation for sustainable use.

- Artisanal fisheries in the Patos Lagoon estuary are inserted in a coastal ecosystem with multiple activities, which can alter the carrying capacity and resilience of the estuary. The information available also indicates that the estuarine ecosystem is shifting to a more limnic condition in response to environmental changes and may become less productive and consequently less favourable to artisanal fisheries in the next decades. This scenario points to a continuous increase in the vulnerability of fishers. The need for an ecosystem-based fisheries management is certain under this scenario to improve the adaptive capacity of institutions and communities to find optimal solutions, within and outside the sector, to deal with these threats.

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ANNEX 1

SURVEY QUESTIONNAIRES USED IN THE CENSUS OF ARTISANAL FISHERIES IN THE PATOS LAGOON ESTUARY

Interviewer: _____ Date: __/__/__

BASIC QUESTIONNAIRE		
1-Name:_____Nickname:_____ Gender: ( ) M ( ) F Date of birth: ___/___/___ CPF:_____ Street:_____ #_____ City:_____ District/area _____		
2-Marital status: ( ) Single ( ) Married ( )Separated ( )Live-in ( ) Widower	3-Children? ( ) yes How many? _____ ( ) no	
4- Other family members in the community? ( ) yes ( ) no	5- Were you born and raised in the community? ( ) yes ( ) no Where?_____	
6- How long have you live in the current house? _____years	7- How long have you lived in the community? ____years	
8- Home situation: ( ) own ( ) rented ( ) family ( ) squatted ( ) other		
PHYSICAL CONDITIONS OF HOME		
9-Type of construction material: ( ) Brick, with plaster covering ( ) Brick, with partial or no plaster covering ( ) Wood ( ) Mixed	10-Bathroom? ( ) yes, within the house ( ) yes, outside ( ) no	11-Type of flooring: ( ) covered ( ) concrete base ( ) dirt ( ) mixed(covered/concrete base) ( ) other_____
12-Which of the following appliances do you own? ( )TV ( ) DVD ( )Radio ( )Fridge ( ) Stove ( )Freezer ( )Telephone ( )Mobile phone ( )Computer ( )Other(s):_____		
VULNERABILITY OF HOME		
13- Has your home ever been affected by floods? ( ) often ( ) a few times ( ) once ( ) never		
14- Is your home located at an unstable area (affected by erosion)? ( ) yes ( ) no		
15- Is your home near any of the following: ( ) industrial area ( ) open sewer ( ) waste disposal area ( ) fish processing disposal area ( ) another unhealthy place_____ ( ) no		
HUMAN SERVICES AVAILABLE		
16-Do you have electric power supply at home? ( )yes ( )no	17- How is the water supply to your home? ( ) pipe ( ) pipe within lot ( ) cistern ( ) ground well ( ) artesian well, with pump ( ) none	
18- Where does your home's sewer drain to? ( )tank ( )tank with overflow pipe ( )septic tank ( )public sewage system ( )directly to lagoon ( )open ( )other		
19- Your solid waste is: ( )collected ( )collected and separated ( ) recycled ( )burnt ( )burried ( ) thrown into lagoon ( )others		
20- Is there public transportation in the community? ( ) no ( ) yes, access less than 2 km from home	21- Is there a community health center available in the community? ( ) yes ( ) no	22- Is there a public school available in the community? ( ) yes ( ) no
23- Who do you look to during a medical emergency in the family? ( ) no one, go directly to the local health center or hospital ( ) family members ( ) friends ( ) colony/union ( ) middleman ( ) association ( ) cooperative ( ) politicians		

FISHERY ACTIVITIES AND TRADITION	
24- How old were you when you started fishing? ____ years old	**26- How old were you when you started fishing with your own nets and boat?** ____years old
27- If you had a choice, would you have chosen the profession of fisherman? ( ) yes ( ) no Which one?__-	**28- If you could have the same income at another occupation, would you change activity?** ( )yes ( )no
29- If you have underage children or grandchildren, would you like them to keep fishing?( ) yes, children ( )yes, children( )no	
30- How many people in your home work at fishing?	
Self	
Schooling: ( )1-illiterate ( ) 2- Incomplete Elementary ( ) 3- Complete Elementary ( ) 4- Incomplete High School ( ) 5- Complete High School ( ) 6- Incomplete College ( ) 7- Complete College	
Fishery-related activities : ( ) 1-fishing ( ) 2-direct sale to consumer ( ) 3-direct sale to middleman ( ) 4-direct sale to associations/cooperatives ( ) 5-processing ( ) 6-equipment maintenance and cleaning ( ) 7-other:__________	Do you also perform those activities outside your household? ( ) yes ( ) no ( ) yes ( ) no ( ) yes ( ) no ( ) yes ( ) no ( ) yes ( ) no ( ) yes ( ) no ( ) yes ( ) no
Name:	**CPF:**
Kinship:	**Gender:** ( )M ( ) F
Schooling: ( )1-illiterate ( ) 2- Incomplete Elementary ( ) 3- Complete Elementary ( ) 4- Incomplete High School ( ) 5- Complete High School ( ) 6- Incomplete College ( ) 7- Complete College	
Fishery-related activities: (1) (2) (3) (4) (5) (6) (7)	Which one is also performed outside the family (home)? ______
Name:	**CPF:**
Kinship:	**Gender:** ( )M ( ) F
Schooling: ( )1-illiterate ( ) 2- Incomplete Elementary ( ) 3- Complete Elementary ( ) 4- Incomplete High School ( ) 5- Complete High School ( ) 6- Incomplete College ( ) 7- Complete College	
Fishery-related activities: (1) (2) (3) (4) (5) (6) (7)	Which one is also performed outside the family (home)? ______
Name:	**CPF:**
Kinship:	**Gender:** ( )M ( ) F
Schooling: ( )1-illiterate ( ) 2- Incomplete Elementary ( ) 3- Complete Elementary ( ) 4- Incomplete High School ( ) 5- Complete High School ( ) 6- Incomplete College ( ) 7- Complete College	
Fishery-related activities: (1) (2) (3) (4) (5) (6) (7)	Which one is also performed outside the family (home)? ______

ORGANIZATIONS AND REPRESENTATION	
31-Are you affiliated to any fishermen's colony/union?( )Z1( )Z2 ( )Z3( )Z8( )other __( )no	32- Are you affiliated to any fishermen's association or cooperative? ( ) no ( ) yes, which one?_____
33- Have you taken any course or training for associativism or cooperativism? ( )yes, which one?_____ ( )no	

DOCUMENTATION AND BENEFITS			
34- Among the people in your home who work at fishing, who has the fishermen's registry card (SEAP)?			
Self:		Kinship:	
Type:	Do not have NFR. Reasons:	Type:	Do not have NFR. Reasons:
( ) professional artisanal ( ) professional industrial ( ) does not have	( ) never applied ( ) applied, but never received ( ) lack of documentation ( ) other _____	( ) professional artisanal ( ) professional industrial ( ) does not have	( ) never applied ( ) applied, but never received ( ) lack of documentation ( ) other _____
Kinship:		Kinship:	
Type:	Do not have NFR. Reasons:	Type:	Do not have NFR. Reasons:
( ) professional artisanal ( ) professional industrial ( ) does not have	( ) never applied ( ) applied, but never received ( ) lack of documentation ( ) other _____	( ) professional artisanal ( ) professional industrial ( ) does not have	( ) never applied ( ) applied, but never received ( ) lack of documentation ( ) other _____
35- Among the people in your home who work at fishing, who has IBAMA's license permit?			
( ) yes, self:		( ) yes, kinship:	
Does not have permit. reasons:	If asked, but never got, reasons?	Does not have permit. Reasons:	If asked, but never got, reasons?
( ) never applied ( ) applied, but never received (has protocol)	( ) IBAMA's limit reached ( ) applied after deadline ( ) lack of documentation Which one? _____ ( ) other (s) _____	( ) never applied ( ) applied, but never received (has protocol)	( ) IBAMA's limit reached ( ) applied after deadline ( ) lack of documentation Which one? _____ ( ) other (s) _____
( ) yes, kinship:		( ) yes, kinship:	
Does not have permit. reasons:	If asked, but never got, reasons?	Does not have permit. Reasons:	If asked, but never got, reasons?
( ) never applied ( ) applied, but never received (has protocol)	( ) IBAMA's limit reached ( ) applied after deadline ( ) lack of documentation Which one? _____ ( ) other (s) _____	( ) never applied ( ) applied, but never received (has protocol)	( ) IBAMA's limit reached ( ) applied after deadline ( ) lack of documentation Which one? _____ ( ) other (s) _____
36- Among the people in your home who work at fishing, who is registered at the Navy Port State Control?			
( ) yes, self:		( ) yes, kinship:	
Not registered. Reasons: ( ) not minimum schooling (4th grade) ( ) cannot swim ( ) does not have NFR ( ) never applied for ( ) has no identification document ( ) course always full ( ) other(s) _____		Not registered. Reasons: ( ) not minimum schooling (4th grade) ( ) cannot swim ( ) does not have NFR ( ) never applied for ( ) has no identification document ( ) course always full ( ) other(s) _____	

( ) yes, kinship:	( ) yes, kinship:
Not registered. Reasons: ( ) not minimum schooling (4th grade) ( ) cannot swim ( ) does not have NFR ( ) never applied for ( ) has no identification document ( ) course always full ( ) other(s) _____	**Not registered. Reasons:** ( ) not minimum schooling (4th grade) ( ) cannot swim ( ) does not have NFR ( ) never applied for ( ) has no identification document ( ) course always full ( ) other(s) _____
37- Do you or anyone else in your household have a producer receipt of invoices?	
Self:	**Kinship:**
( ) yes, self ( ) yes, with someone else ( ) no	( ) yes, self ( ) yes, with someone else ( ) no
Kinship:	
( ) yes, self ( ) yes, with someone else ( ) no	( ) yes, self ( ) yes, with someone else ( ) no

38- If you have the producer receipt of invoices, do you give out the invoice?

Self:	Kinship:	Kinship:
( ) yes, for costumers ( ) yes, for buyers/middlemen ( ) yes, for industries ( ) yes, for association or cooperative ( ) no	( ) yes, for costumers ( ) yes, for buyers/middlemen ( ) yes, for industries ( ) yes, for association or cooperative ( ) no	( ) yes, for costumers ( ) yes, for buyers/middlemen ( ) yes, for industries ( ) yes, for association or cooperative ( ) no

39- Out of the people who work at fishing in your home, which ones own boats?

Self:

Powerless boats.

Name of boat:
Is it registered at the Navy Port State Control? ( ) yes ( ) no
If not registered. Reason: ( ) financial issues ( ) travel to the Navy ( ) didn't know ( ) others ____

Name of boat:
Is it registered at the Navy Port State Control? ( ) yes ( ) no
If not registered. Reason: ( ) financial issues ( ) travel to the Navy ( ) didn't know ( ) others ____

Powered boats.

Name of boat:

Is it registered at the Navy Port State ? ( ) yes ( ) no	If not registered. Reason: ( ) financial issues ( ) travel to the captancy ( ) didn't know ( ) others ____
Year. _____ Size._____ GRT._____ Cabin? ( ) yes ( ) no	Engine: (Hp)_____ ( ) diesel ( ) gas Brand _____ Switchgear ( ) yes ( ) no

Equipment:( )VHF radio ( )mobile phone ( )TV ( )AM/FM radio ( )PX/radio(amateur) ( )sound ( )sonar ( )GPS ( )other___

Name of boat:

Is it registered at the Navy Port State? ( ) yes ( ) no	If not registered. Reason: ( ) financial issues ( ) travel to the captancy ( ) didn't know ( ) others ____
Year. _____ Size._____ GRT._____ Cabin? ( ) yes ( ) no	Engine: (Hp)_____ ( ) diesel ( ) gas Brand _____ Switchgear ( ) yes ( ) no

Equipment:( )VHF radio ( )mobile phone ( )TV ( )AM/FM radio ( )PX/radio(amateur) ( )sound ( )sonar ( )GPS ( )other___

Kinship:

Powerless boats.

Name of boat:
Is it registered at the Navy Port State Control? ( ) yes ( ) no
If not registered. Reason: ( ) financial issues ( ) travel to the captancy ( ) didn't know () others ____

Powered boats.

Name of boat:

Is it registered at the Navy Port State? ( ) yes ( ) no	If not registered. Reason: ( ) financial issues ( ) travel to the captancy ( ) didn't know ( ) others ____
Year. ________ Size.________ GRT.________ Cabin? ( ) yes ( ) no	Engine: (Hp)_______ ( ) diesel ( ) gas Brand _____________ Switchgear ( ) yes ( ) no

Equipment:( )VHF radio ()mobile phone ( )TV ()AM/FM radio ()PXradio(amateur) ( )sound ( )sonar ()GPS ()other____

40- If takes part in capture fishing but has no boat, what function?

Kinship	Function	Owner name	Fish on land?
	() crew () skipper		( ) yes () no
	() crew () skipper		( ) yes () no
	() crew () skipper		( ) yes () no
	() crew () skipper		( ) yes () no
	() crew () skipper		( ) yes () no
	() crew () skipper		( ) yes () no

BENEFITS

41- Do you or anyone in your home receive or have received any of the following benefits?

Self:

Unemployment benefit	Others	Retirement
( )Yes ( )Yes, but no longer gets ( )No ( )Tried, but didn't get	( )School grant ( )Maternity bonus ( )Family grant ( )Illness bonus, work accident ( )Death pension ( )Reclusion bonus ( )Gas bonus ( )Tried, but didn't get. Which one____________	( )Tried, but didn't get ( )Yes Type: ( )Disability ( )Age ( )Time in fishery

Kinship:

Unemployment benefit	Others	Retirement
( )Yes ( )Yes, but no longer gets ( )No ( )Tried, but couldn't	( )School grant ( )Maternity bonus ( )Family grant ( )Illness bonus, work accident ( )Death pension ( )Reclusion bonus ( )Gas bonus ( )Tried, but didn't get. Which one____________	( )Tried, but didn't get ( )Yes Type: ( )Disability ( )Age ( )Time in fishery

Kinship:

Unemployment benefit	Others	Retirement
( )Yes ( )Yes, but no longer gets ( )No ( )Tried, but couldn't	( )School grant ( )Maternity bonus ( )Family grant ( )Illness bonus, work accident ( )Death pension ( )Reclusion bonus ( )Gas bonus ( )Tried, but didn't get. Which one____________	( )Tried, but didn't get ( )Yes Type: ( )Disability ( )Age ( )Time in fishery

Kinship:

Unemployment benefit	Others	Retirement
( )Yes ( )Yes, but no longer gets ( )No ( )Tried, but couldn't	( )School grant ( )Maternity bonus ( )Family grant ( )Illness bonus, work accident ( )Death pension ( )Reclusion bonus ( )Gas bonus ( )Tried, but didn't get. Which one____________	( )Tried, but didn't get ( )Yes Type: ( )Disability ( )Age ( )Time in fishery

42- How do you make your retirement payments (INSS)?		
Self:		
How? ( )Own producer receipt of invoices ( )Husband's/wife's producer receipt of invoices ( )Social security payment ( )No payment	How long? ( ) Less than 1 year ( ) 1-5 years ( ) 5-10 years ( ) 10-20 years ( ) More than 20 years	Still paying? ( )Yes ( )No
Kinship:		
How? ( )Own producer receipt of invoices ( )Husband's/wife's producer receipt of invoices ( )Social security payment ( )No payment	How long? ( ) Less than 1 year ( ) 1-5 years ( ) 5-10 years ( ) 10-20 years ( ) More than 20 years	Still paying? ( )Yes ( )No
Kinship:		
How? ( )Own producer receipt of invoices ( )Husband's/wife's producer receipt of invoices ( )Social security payment ( )No payment	How long? ( ) Less than 1 year ( ) 1-5 years ( ) 5-10 years ( ) 10-20 years ( ) More than 20 years	Still paying? ( )Yes ( )No
Kinship:		
How? ( )Own producer receipt of invoices ( )Husband's/wife's producer receipt of invoices ( )Social security payment ( )No payment	How long? ( ) Less than 1 year ( ) 1-5 years ( ) 5-10 years ( ) 10-20 years ( ) More than 20 years	Still paying? ( )Yes ( )No
43- Have you or anyone from your household ever accessed a fishery financing program?		
Self:		
Financing and debt situation		
( )PRONAF: ( ) still paying ( ) paid for ( ) stopped paying ( )PRONAFINHO: ( ) still paying ( ) paid for ( ) stopped paying ( )RS/RURAL/PESCA: ( ) still paying ( ) paid for ( ) stopped paying ( )Bank loan ( ) still paying ( ) paid for ( ) stopped paying		
Kinship:		
Financing and debt situation		
( )PRONAF: ( ) still paying ( ) paid for ( ) stopped paying ( )PRONAFINHO: ( ) still paying ( ) paid for ( ) stopped paying ( )RS/RURAL/PESCA: ( ) still paying ( ) paid for ( ) stopped paying ( )Bank loan ( ) still paying ( ) paid for ( ) stopped paying		
Kinship:		
Financing and debt situation		
( )PRONAF: ( ) still paying ( ) paid for ( ) stopped paying ( )PRONAFINHO: ( ) still paying ( ) paid for ( ) stopped paying ( )RS/RURAL/PESCA: ( ) still paying ( ) paid for ( ) stopped paying ( )Bank loan ( ) still paying ( ) paid for ( ) stopped paying		
44- What is the average monthly fish consumption in your household?		
( ) Everyday ( ) At least 5 days a week ( ) At least 3 days a week ( ) At least 1 day a week ( ) Occasional, at least 1 day a month ( ) None		

Interviewer:_____ Date: _/_/__

1- Gender: ( ) M ( ) F 2- Year of birth: _____

3- City:_____ 4- District/area:_____

5- How old were you when you started fishing? _____ With whom?_____

6- How old were you when you started fishing with your own gear? _____

7- Do you own fishing gear/nets? ( ) yes ( ) no **MOVE TO PART B**

8- Are the fishing nets you use your own, or are they leased (borrowed)?
( ) own
( ) leased (borrowed)

9- Do you fish or just own gear? ( ) yes, I do ( ) I don't fish **MOVE TO THE TABLE**

10- If you own gear but do not fish, answer the following table and move to part B.

Gear types	Size	How many
Fyke net		
Stow net		
Otter trawl		
Gillnet		
Troina		
Beninbau		
Beach seine		
Other		

PART A: EFFORT AND FISHING SEASONS YOU FISH

Select the species you catch and specify the fishing gear and effort used for each one. Indicate how many nets you own (o) in each case.

11- ( ) Pink shrimp

Currently

Gear	Size (fathom)	How many	Mesh (mm)	Engine power (Hp)	Where? (see map)	Yield in a good day
Fyke net						
Stow net						
Otter trawl						
Beach seine						
Palm trawl						
Beninbau						
Other:						

When you started fishing

Gear	Size (fathom)	How many	Mesh (mm)	Engine power (Hp)	Where? (see map)	Gear
Fyke net						
Stow net						
Otter trawl						
Beach seine						
Palm trawl						
Beninbau						
Other:						

12- How much do you catch, on average, in a good shrimp season?

When you started fishing _____ kg

Currently _____kg

13- ( ) Croaker

Currently

Gear	Size (fathom)	Height (mesh)	How many	Mesh (mm)	Where (see map)	Yield in a good day
Drift gillnet						
Drift gillnet in the ocean						
Fixed gillnet'						
Surround gillnet						
Tróina						
Caracol (arrastão)						
Other:						

When you started fishing

Gear	Size (fathom)	Height (mesh)	How many	Mesh (mm)	Where (see map)	Yield in a good day
Drift gillnet						
Drift gillnet in the ocean						
Fixed gillnet'						
Surround gillnet						
Tróina						
Caracol (arrastão)						
Other:						

14- How much do you catch, on average, in a good croaker season?

When you started fishing _____ kg

Currently _____kg

15- ( ) Mullet

Currently

Gear	Size (fathom)	Height (mesh)	How many	Mesh (mm)	Where (see map)	Yield in a good day
Drift gillnet						
Drift gillnet in the ocean						
Fixed gillnet'						
Surround gillnet						
Tróina						
Caracol (arrastão)						
Other:						

When you started fishing

Gear	Size (fathom)	Height (mesh)	How many	Mesh (mm)	Where (see map)	Yield in a good day
Drift gillnet						
Drift gillnet in the ocean						
Fixed gillnet'						
Surround gillnet						
Trolina						
Caracol (arrastão)						
Other:						

16- How much do you catch, on average, in a good mullet fseason?

When you started fishing _____ kg

Currently _____kg

17- ( ) Catfish

Currently

Gear	Size (fathom)	Height (mesh)	How many	Mesh (mm)	Where (see map)	Yield in a good day
Drift gillnet						
Drift gillnet in the ocean						
Fixed gillnet'						
Surround gillnet						
Trolina						
Caracol (arrastão)						
Other:						

When you started fishing

Gear	Size (fathom)	Height (mesh)	How many	Mesh (mm)	Where (see map)	Yield in a good day
Drift gillnet						
Drift gillnet in the ocean						
Fixed gillnet'						
Surround gillnet						
Trolina						
Caracol (arrastão)						
Other:						

18- How much do you catch, on average, in a good catfish season?

When you started fishing _____ kg

Currently _____kg

19- ( ) Silverside

Currently

Gear	Size (fatho m)	Height (mesh)	How many	Mesh (mm)	Where (see map)	Yield in a good day
Drift gillnet						
Fixed gillnet						
Fixed gillnet'						
Surround gillnet						
Trolina						
Caracol (arrastão)						
Other:						

When you started fishing

Gear	Size (fatho m)	Height (mesh)	How many	Mesh (mm)	Where (see map)	Yield in a good day
Drift gillnet						
Fixed gillnet						
Fixed gillnet'						
Surround gillnet						
Trolina						
Caracol (arrastão)						
Other:						

20- How much do you catch, on average, in a good silverside season?

When you started fishing _____ kg

Currently _____kg

21- ( ) Flatfish

Currently

Gear	Size (fatho m)	Height (mesh)	How many	Mesh (mm)	Where (see map)	Yield in a good day
Drift gillnet						
Fixed gillnet						
Fixed gillnet'						
Surround gillnet						
Trolina						
Caracol (arrastão)						
Other:						

When you started fishing						
Gear	Size (fathom)	Height (mesh)	Number	Mesh (mm)	Where (see map)	Yield in a good day
Drift gillnet						
Fixed gillnet						
Fixed gillnet'						
Surround gillnet						
Trolina						
Caracol (arrastão)						
Other:						

22- How much do you catch, on average, in a good flatfish season?

When you started fishing _____ kg

Currently _____kg

23- ( ) Blue crab

Currently					
Gear	Size (fathom)	Number	Mesh (mm)	Where (see map)	Yield in a good day
Fyke net					
Longline					
Otter trawl					
Beach seine					
Argola					
Gerere					
Other:					

When you started fishing					
Gear	Size (fathom)	Number	Mesh (mm)	Where (see map)	Yield in a good day
Fyke net					
Longline					
Otter trawl					
Beach seine					
Argola					
Gerere					
Other:					

24- How much do you catch, on average, in a good blue season?

When you started fishing _____ kg

Currently _____kg

25- What other species are important for your fishery?

Species	Before	Now	Species	Before	Now	Species	Before	Now
Codling			"Garoupa"			"Piava"		
Bluefish			"Dourado"			Catfish "pintado"		
Argentine croaker			Streaked prochilod			"Tambica"		
Catfish "guri"			Catfish "jundia"			"Tainha"		
Catfish "boca-larga"			Flatfish			Menhaden		
"Biru"			Black drum			Catfish "viola "		
Angel shark			King croaker			Other(s)		
Guitarfish			Catfish "pati"					
Other sharks			Fresh water silverside					
Seabob shrimp			Weakfish					
Catfish "cascudo"			Royal weakfish					

PART B

26- When applying for your IBAMA license permit, what do you inform as your "andaina" location?
( ) Place:_____

27- Do you fish here?
( ) yes, during the whole season
( ) yes, during part of the season
( ) no, I don't usually fish at a fixed place

28- Do you think fishermen should always fish with their "andainas" at the same spot?
( )yes ( )no

30- If you fish at another fisherman's registered spot, what happens when he arrives?
( )I take my gears away
( )I go on fishing
( )we share the space between both andainas
( )I wait to leave when he calls enforcement
( )other____

29- Do you think the andaina's location should be registered?
( )yes ( )no

INCOME AND CONSUMPTION

31- What are your means of subsistence?

( ) work at fishing throughout year
( ) only fish shrimp
( ) fish aboard the industrial fleet in the ocean
( ) boat owner
( ) buyer or middleman
( ) net fixing
( ) processing (e.g., peeling shrimp, fish filleting)
( ) agriculture
( ) work in the city (formal job)
( ) occasional jobs
( ) unemployment benefit
( ) retirement pay
( ) other:_____

32- Activity you perform during the winter:
( ) keep fishing in the estuary (mullet, shrimp, croaker or catfish)
( ) keep fishing in the estuary (other species)
( ) fish in other areas in Patos Lagoon (outside the closed area)
( ) fish in other lagoons ( ) Mirim ( ) Mangueira ( ) Canal São Gonçalo
( ) fish outside the channel's mouth
( ) fish aboard the industrial fleet in the ocean
( ) net fixing
( ) processing (e.g. fish filleting)
( ) agriculture
( ) sell fish
( ) work in the city (formal job)
( ) occasional jobs
( ) don't work
( ) others____

33- Does anyone in your house work with pay?
No ( ) Yes ( )

Kinship	Activity in fishery. Which?	Activity outside fishery. Which?

34- How much of your home's income comes from fishing?
( ) everything
( ) more than half
( ) half
( ) less than half
( ) almost nothing

35- Which fishery provides you with more money? (list)
( ) pink shrimp
( ) croaker
( ) mullet
( ) catfish
( ) bluemcrab
( ) flatfish
( ) silverside
( ) other_____

36- What do you do when the shrimp season is weak?
( ) fish another species during shrimp season. Which one?_____
( ) fish other species at other times of the year. Which ones?___
( ) fish elsewhere
( ) fish with otter trawl
( ) fish with beach seine
( ) fish with berimbau
( ) find an occasional job. Which one?_____
( ) fish aboard industrial fleet
( ) find agricultural work
( ) fish and shrimp aquaculture
( ) borrow money from middleman
( ) borrow money from friends
( ) borrow money from family
( ) borrow money from bank
( ) shop on credit
( ) other_____

37- Do you usually have money to start the fishing season?
( ) yes, have own resource
( ) no, borrow from middlemen (buyers)
( ) no, borrow from others
( ) no, borrow from bank
( ) do not need (crew)

38- If you have a boat, how did you acquire it?
( ) through financing, already paid for
( ) through financing, still paying for
( ) loan from others, paid for
( ) loan from others, still paying for
( ) acquired with own resource
( ) do not own boat

39- If you own a powered boat, how did you acquire its engine?
( ) through financing, already paid for
( ) through financing, still paying for
( ) loan from others, paid for
( ) loan from others, still paying for
( ) acquired with own resource
( ) do not own powered boat

40- Who do you look to when you need to repair your nets, boat, or engine?
( ) no one, use own resource
( ) financing
( ) buyers (middlemen)
( ) other_____
( ) do not own boat, engine, or nets

INFRA-STRUCTURE AND PROCESSING

41- How do you preserve the catch in the boat?
( ) Ice
( ) In natura (no ice)
( ) other:_____

42- Where dou you land your catch?
( ) local factory
( ) factory in other city
( ) own dock
( ) community dock
( ) dock in other community
( ) beach
( ) buyer boat

43- Do you sell directly upon landing?
( ) yes
( ) no: How do you stock/preserve landed catch?
( ) Ice box
( ) cold room with ice
( ) refrigeration (freezer)
( ) In natura (no ice)

44- Do you perform any kind of processing before selling the catch?

	Shrimp	Croaker	Mullet	Catfish	Crab	Others:___
	( ) no	( ) no	( ) no	( ) no	( ) no	( ) no
	( ) yes	( ) yes	( ) yes	( ) yes	( ) yes	( ) yes
45- If you perform any processing, what do you do with the remains (waste)? ( ) dump in the lagoon ( ) throw away ( ) bury ( ) sell. To whom? _____ ( ) other:_____	What? ( ) headless ( ) shell off ( ) other	What? ( ) gutted ( ) filleted ( ) other	What? ( ) gutted ( ) filleted ( ) other	What? ( )gutted ( ) filleted ( ) other	What? ( ) shell off ( )other	What? ( ) gutted ( ) filleted ( ) other

MARKETING

46- Who do you usually sell the catch to? (May choose more than one, mark 1 for most important).
( ) local factory.
( ) factory in other cities. Which ones?
( ) local buyer (middleman).
( ) buyer (middleman) from other cities/towns. Which ones?
( ) buyer boat.
( ) buyers (middlemen) from Santa Catarina
( ) fisherman's association.
Name:_____
( ) fishermen's cooperative.
Name:_____
( ) fish shop
( ) restaurant
( ) directly to consumers in fairs
( ) directly to consumers at their homes
( ) directly to consumers, at fisherman's home
( ) other(s)_____

47- How much did you sell for, on average, the in natura Kg of the following catch in the latest years?

	Lowest price (R$/kg)	Highest price (R$/kg)
Pink shrimp		
Croaker		
Mullet		
Catfish		
Flatfish		
Silverside		
Crab		
Other(s)		

48- IF YOU PERFORM ANY KIND OF PROCESSING, indicate the lowest and the highest price obtained in the latest years.

	Lowest price (R$/kg)	Highest price (R$/kg)
Pink shrimp ( ) shell off ( ) headless		
Croaker ( ) gutted ( ) fillet ( ) other		
Mullet ( ) gutted ( ) fillet ( ) other		
Catfish ( ) gutted ( ) fillet ( ) other		
Flatfish ( ) gutted ( ) fillet ( ) other		
Silverside ( ) gutted ( ) fillet ( ) other		
Blue crab ( ) shell off ( ) other		
Other(s)		

49- What affects fish price the most?
( ) quantity (good or bad season)
( ) middlemen (buyers)
( ) industry
( ) cooperative/association
( ) catch quality
( ) aquaculture yield
( ) fish size
( ) other_____

50- What affects shrimp price the most?
( ) quantity (good or bad season)
( ) middlemen
( ) industry
( ) cooperative/association
( ) shrimp quality (net kind)
( ) shrimp size
( ) aquaculture shrimp
( ) other_____

BOAT

51- If you own a boat, who usually fishes with you on you boat?
( ) familly members
( ) friends
( ) fishermen from the community
( ) fishermen from other communities
( ) others_____
( ) don't own boat

52- The people who fish with you are listed on your boat roster?
( ) yes
( ) some
( ) no

SAFETY AT SEA	
53- Can you swim? ( ) yes ( ) no	**54-** Can you float? ( ) yes ( ) no
55- Have you ever done any kind of safety training (first aid, survival at sea) to work aboard fishing boats? ( ) yes ( ) no Which one?_____	**56-** Does your boat have any safety equipment? ( ) life vest ( ) fire extinguisher ( ) anchor ( ) circular buoy ( ) none
57- Do you have insurance on your boat (s)? ( ) yes, all of them ( ) yes, some ( ) no	**58-** Have you ever had a serious accident while fishing (bone fracture, burn, fall into sea)? ( ) yes, once ( ) yes, more than once. How many times?____ ( ) no
59- If you have suffered an accident, where were you fishing when it occurred? ( ) within Patos Lagoon ( ) outside the channel's mouth	**60-** Do you know anyone who has suffered a serious accident or died while fishing? ( ) No ( ) Less than 5 ( ) 5-10 ( ) More than 10

LEGISLATION
61- Do you think: The fishing closure should be between june and september? ( ) yes ( ) no Fishermen must use up to 10 fyke nets? ( ) yes ( ) no Fishermen must use up to 1000 fathoms of net? ( ) yes ( ) no Trawling should be allowed in the channel? ( ) yes ( ) no Trawling should be allowed in bays? ( ) yes ( ) no The beavh seine net should be allowed? ( ) yes ( ) no The berimbau net should be allowed? ( ) yes ( ) no Crab should be only fished with the longline ? ( ) yes ( ) no Boats over 12-m long should be allowed to enter the lagoon? ( ) yes ( ) no Fishermen from other areas should be allowed to fish in the lagoon? ( ) yes ( ) no Fishermen should receive unemployment benefit? ( ) yes ( ) no Do you receive unemployment benefit? ( ) yes ( ) no

62- When do you think you should fish:

Mullet

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Croaker

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Catfish

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Shrimp

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Crab

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Flatfish

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Silverside

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

63- Have you ever been consulted by IBAMA or SEAP (Ministry of Fishery and Aquaculture) about the fishery rules in Patos Lagoon?
( ) Yes
( ) No

64- Should the shrimping season start at a fixed date or according to size?

( ) fixed date
( ) according to size

ORGANIZATIONS AND REPRESENTATION

65- Who helps the fisherman the most?
( ) SEAP (Ministry of Fishery and Aquaculture)
( ) IBAMA
( ) Fishermen's colony
( ) EMATER
( ) City Governments
( ) Forum of Patos Lagoon
( ) Pastoral do Pescador
( ) Fishermen's associations/cooperatives
( ) Other:_____

66- If you take part of a fishermen's association of cooperative, do you think there have been changes in catch price since you joined the association or cooperative?

Shrimp	Croaker	Mullet	Catfish	Crab	Other____
( )much better ( ) better ( ) not changed ( ) worse ( ) much worse	( )much better ( ) better ( ) not changed ( ) worse ( ) much worse	( )much better ( ) better ( ) not changed ( ) worse ( ) much worse	( )much better ( ) better ( ) not changed ( ) worse ( ) much worse	( )much better ( ) better ( ) not changed ( ) worse ( ) much worse	( )much better ( ) better ( ) not changed ( ) worse ( ) much worse

67- Do you believe in the work of the association/cooperative?
( )Yes ( )No

68- Do you know or have ever heard about the Forum of Patos Lagoon?
( )Yes ( )No

69- Have you participated of any fishing-related meetings throughtout the year?

	Never	1-5 times	More than 5 times	Once a month
Colony	( )	( )	( )	
Union				
Associations				
Pastoral				
Forum of Patos Lagoon				
Other				

70- If you have participated,how do you consider the practical and/or concrete results of those meetings?

	Good	Medium	Bad	There has been none
Colony				
Union				
Associations				
Pastoral				
Forum of Patos Lagoon				
Other				

RULE ENFORCEMENT

71- Have you ever been **caught** or fined for not following the rules?
( )Never
( )Once
( )Twice
( )More than twice

72- Do you know any fisherman who has been **caught** or fined for not following the rules?
( ) None
( ) One
( ) 1-10
( ) 10-20
( ) More than 20

73- Do you think rule enforcement is needed?
( ) Yes
( ) No

FISHERY IMPACTS

74- What fisheries damage the lagoon's environment the most? (You may choose several options, mark 1 on the most important)
( )Fyke net
( ) Stow net
( ) Trawling
( )Troiha
( )Beach seine
( )Berimbau
( )Gillnet
( ) Other____

75- Have you ever lost nets while fishing?
( ) never
( ) sometimes
( ) often (every season)
( ) very often (more than once every season)

76- Have you ever had nets, boats, or other fishing gear stolen out at sea?
( ) no
( ) yes, once
( ) yes, a few times
( ) yes, often (every year)

77- Have you ever – unwittingly – caught any of the following animals?
( ) sea turtle
( ) seal (sea lion)
( ) sea birds (e.g. cormorants, gallinules)
( ) sea otter
( ) Plata dolphin
( ) dolphin

78- Have you ever suffer any damage to your fishing gear or catch due to seals (sea lions) and/or sea otters?

Seal (sea lion)	Otter
( ) never ( ) sometimes ( ) often (every season) ( ) very often (more than once every season)	( ) never ( ) sometimes ( ) often (every season) ( ) very often (more than once every season)

79- In your opinion, what is the future of fishing?

_____

_____

_____

_____

_____

ANNEX 2

AGENDA AND LIST OF PARTICIPANTS OF THE STUDY INCEPTION WORKSHOP

Inception workshop on the project "A techno-economic study of the small-scale fishing operations of the estuary of Patos Lagoon, Brazil"

Centro de Convivio dos Meninos do Mar (CCMAR-FURG), Rio Grande, 19 October 2009

Agenda

14:00 Workshop opening

Dr Daniela Kalikoski
Dr Marcelo Vasconcellos
Mr Dirceu Lopes, Executive Director, MPA
Mr Joao Carlos Cousin, Rector, FURG
Ms Darlene Torrada, Dean of Extension, FURG
Ms Adriana Senna, Director Institute of Science and Humanities, FURG
Ms Lucia Nobre, Coordinator of NUDESE-FURG

15:00 Signature of Letter of Intention between FURG and MPA

15:30 Coffee break

15:45 Presentation of the project objectives and methodology
Dr Daniela Kalikoski
Dr Marcelo Vasconcellos

16:30 Plenary discussion

17:30: Workshop closure

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ANNEX 3

AGENDA AND LIST OF PARTICIPANTS OF THE FINAL WORKSHOP

Workshop "Status and perspectives for the artisanal fisheries of the estuary of Patos Lagoon: results from the census of artisanal fisheries"

13 April 2011

CIDEC-Sul, FURG, Rio Grande, Brazil

Agenda

9:00	Workshop opening Daniela Kalikoski (ICHI-FURG) Marcelo Vasconcellos (IO-FURG) Joao Carlos Cousin, Rector (FURG) Ernesto Casares Pinto, Vice-Rector (FURG) Adriana Senna, Director (ICHI-FURG) Adriane Lobo Costa (MPA-RS)
9:30 – 10:00	Current status of artisanal fisheries in the estuary of Patos Lagoon: technical aspects Plenary discussion
10:00 – 10:30	
10:30 – 11:00	*Coffee break*
11:00 – 11:30	Current status of artisanal fisheries in the estuary of Patos Lagoon: socio-economic aspects
11:30 – 12:00	Plenary discussion
12:00 – 13:30	*Lunch*
13:30 – 14:00	Current status of artisanal fisheries in the estuary of Patos Lagoon: environmental aspects
14:00 – 14:30	Plenary discussion
14:30 – 15:00	Current status of artisanal fisheries in the estuary of Patos Lagoon: governance aspects
15:00 – 15:30	Plenary discussion
15:30 – 16:00	*Coffee break*
16:00 – 17:00	Plenary discussion
17:00	Workshop closure

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