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CASE STUDY OF THE TECHNICAL, SOCIO-ECONOMIC AND ENVIRONMENTAL CONDITIONS OF SMALL-SCALE FISHERIES IN THE ESTUARY OF PATOS LAGOON, BRAZIL

A methodology for assessment

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***Cover photograph*:** Navigating the waters of Patos Lagoon estuary, Rio Grande, Brazil; except where indicated, all photographs courtesy of Daniela Kalikoski and Marcelo Vasconcellos.

CASE STUDY OF THE TECHNICAL, SOCIO-ECONOMIC AND ENVIRONMENTAL CONDITIONS OF SMALL-SCALE FISHERIES IN THE ESTUARY OF PATOS LAGOON, BRAZIL

A methodology for assessment

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PREPARATION OF THIS DOCUMENT

Small-scale fisheries in coastal lagoons provide livelihoods for many thousands of people worldwide. These fisheries are recognized globally by their data-poor condition. The paucity of data makes it difficult to identify and evaluate the types of management interventions needed to sustain resources and protect fishing livelihoods. This study, developed under a Letter of Agreement with the Federal University of Rio Grande, Brazil, was carried out in response to a proposal made by the Fishing Operations and Technology Service of the Fisheries and Aquaculture Resources Use and Conservation Division of the Fisheries and Aquaculture Department of the Food and Agriculture Organization of the United Nations (FAO) to elaborate a methodology that could be employed to assess the condition of artisanal fisheries in coastal lagoons. Challenged by this task, and motivated by the necessity for improving the knowledge base of small-scale fisheries in the Patos Lagoon estuary, Brazil, the authors devised a methodological approach to assess the technical, environmental and socio-economic conditions of local small-scale fisheries, to evaluate their vulnerabilities, and to recommend and discuss strategies to enhance livelihood security and sustainable use of resources. The same methodological procedure could be applied to other small-scale lagoon fisheries worldwide, with a view to evaluate their status, to establish benchmarks to monitor their trends, and to provide the needed improvement in the knowledge base to guide a better governance of these fisheries.

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ABSTRACT

This document presents an assessment of small-scale fisheries of the Patos Lagoon estuary, Brazil, using a custom-designed fisheries census methodology. Complementary information was sourced from a literature review, secondary data and in-depth semi-structured interviews. The assessment provides a complete picture of the technical, environmental and socio-economic conditions of these fisheries, including information on the number of fishery-dependent people, fishing effort, technologies and practices, trends in production and resource abundance, income and market, livelihood strategies, community-based organizations, formal institutions established by co-management, and the access to public policies. Results obtained in this study contribute to an improved understanding of the current status and vulnerabilities of local small-scale fisheries. Based on these results, the document discusses and recommends strategies to enhance livelihood security and sustainable use of resources. Lessons learned using the study methodology is presented foreseeing its application and adaptation to assess small-scale lagoon fisheries in other locations.

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ABBREVIATIONS AND ACRONYMS

APA	areas of permanent preservation
APESMI	Association of Fishers of São Miguel Village (Associação dos Pescadores da Vila São Miguel)
BANCEN	Central Bank of Brazil
CECOV	Community Centre of Fishers and Farmers of Várzea Village (*Centro Comunitário de Pescadores e de Agricultores da Localidade da Várzea*)
CEPERG	Center of Fisheries Research and Management of Estuarine and Lagoon Fisheries
CONAB	Federal Government Agency of Food Supply
COOPANORTE	Cooperative of Fishers of São José do Norte (*Cooperativa dos Pescadores de São José do Norte)*
COOPESCA	Cooperative of Artisanal Fishers of the Pérola da Lagoa (*Cooperativa de Pescadores Artesanais Pérola da Lagoa)*
CPUE	catch per unit effort
DPA	Department of Fisheries and Aquaculture
ELETROBRAS	Federal Electric Company
EMATER	Organization for Technical Assistance and Rural Extension
ENSO	El Niño Southern Oscillation
FAO	Food and Agriculture Organization of the United Nations
FEAPER	State Fund to Support the Development of Small Rural Enterprises
FURG	Federal University of Rio Grande
GDP	gross domestic product
GERCO	National Programme for Coastal Management
IBAMA	Brazilian Institute of Environment and Renewable Natural Resources
INSS	National Institute of Social Security
nm	nautical mile
MMA	Ministry of Environment
MPA	Ministry of Fisheries and Aquaculture
NP/TE	net profit/total earnings
PAA	Food Acquisition Program
PRONAF	National Program to Strengthen Family-based Agriculture
RDS	sustainable development reserve
RESEX	marine extractive reserve
RGP	Registry of Professional Fisher
ROI	return on investment
RS	State of Rio Grande do Sul
RS Rural	RS State Programme for Strengthening Family-based Agriculture
SEAP	Special Secretariat of Aquaculture and Fisheries
SUDEPE	Federal Sub-Secretary for Fisheries Development
Z1	Fishers' Colony of the municipality of Rio Grande
Z2	Fishers' Colony of the municipality of São José do Norte
Z3	Fishers Syndicate of the municipality of Pelotas
Z8	Fishers' Colony of the municipality of São Lourenço do Sul

Please note that all amounts expressed in this document are in Brazilian reais (R$1): R$1 is equal to US$0.64 (2010).

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1. INTRODUCTION

Coastal lagoons are among some of the most productive ecosystems in the world and occupy 13 percent of coastal areas worldwide (Kjerfve, 1994). They function as important nursery, feeding and reproduction areas for both native and migratory species. At the same time, they are highly stressed by anthropogenic inputs and human activities, including fisheries. Artisanal fisheries in coastal lagoons provide livelihoods for many thousands of people worldwide, including in North and South America, Africa, Asia and the Pacific (Berkes *et al.*, 2001; Garcia *et al.*, 2008; Pomeroy and Andrew, 2011).

In these fisheries, there is often a lack of basic information about their technical, socio-economic and environmental conditions, including the number of fishers, livelihoods, fishing capacity and technologies, access rights, fisheries market and status of resources. The paucity of data makes it difficult to identify and evaluate the types of management interventions needed to sustain resources and protect livelihoods. Considering the importance of lagoons to livelihoods and ecosystem health and the limited financial resources to evaluate them, a low-cost, rapid assessment is required in order to provide a basis for assessing small-scale fisheries in lagoons.

The objective of this study was to design a methodology through which small-scale lagoon fisheries could be assessed to provide a complete picture of their technical, environmental and socio-economic conditions. The methodology was applied to study the small-scale fisheries of the estuary of Patos Lagoon, Brazil, with a view to understand their present condition and vulnerabilities and to recommend and discuss strategies to enhance livelihood security and sustainable use of resources.

Following the overview of the case study, which is in this chapter and presented below, Chapter 2 introduces the methodology used, and Chapters 3, 4 and 5 present the main results of the study. Finally, Chapter 6 discusses the lessons learned on the study methodology, the key findings of the case study and its recommendations for the future governance of small-scale fisheries in the estuary of Patos Lagoon.

General overview of the Patos Lagoon estuary

The estuarine region of the Patos Lagoon is located in the southern Brazilian coastal zone (State of Rio Grande do Sul), an area of the Biosphere Reserve (United Nations Educational, Scientific and Cultural Organization – UNESCO). With an area of approximately 10 000 km^2, the Patos Lagoon is recognized as the world's largest choked lagoon, stretching from 30º30'S to 32º12'S near the city of Rio Grande, where the lagoon connects to the Atlantic Ocean (Figure 1).

Diverse and abundant flora and fauna abound in the estuary. The abundant food resources and protection against predation provided by estuarine shoals make this region an ideal nursery ground for several commercially important fish species. The estuary is characterized by a shallow body of water (mean depth of 7 m) with variable temperature and salinity depending on local climatic and hydrological conditions (Castello, 1985). The dynamics of estuarine waters are mainly conditioned by the wind and rain regimes with only a minor influence by tides. In general, from September to April, the dominant winds are from the northeast, north-northeast and east-northeast, while in the winter period from June to August, the winds are from the east, south, southeast and southwest and are more frequent. While the former favour the discharge of freshwater into the ocean and create a low salinity regime in the estuary, the latter force the penetration of saltwater through the estuarine channel and create conditions for a marine regime in the estuary (Möller, Paim and Soares, 1991). The total mean annual precipitation (1 200–1 500 mm) varies strongly from year to year and is mainly related to the path and passage of cold fronts. Mean monthly rainfall is highest during the winter and spring (June to

October), but a second peak may occur in the summer. Interannual variations in precipitation with either a high amount of rainfall or dry periods seem to be a consequence of the effect on the El Niño Southern Oscillation (ENSO) cycle on the regional climate (Seeliger, Odebrecht and Castello, 1997). As a general rule, years of strong El Niño events cause flooding regimes in southern Brazil. This phenomenon directly influences the amount of continental freshwater runoff and the bio-geochemical processes in the estuary and coastal ecosystem (Ciotti *et al.,* 1995).

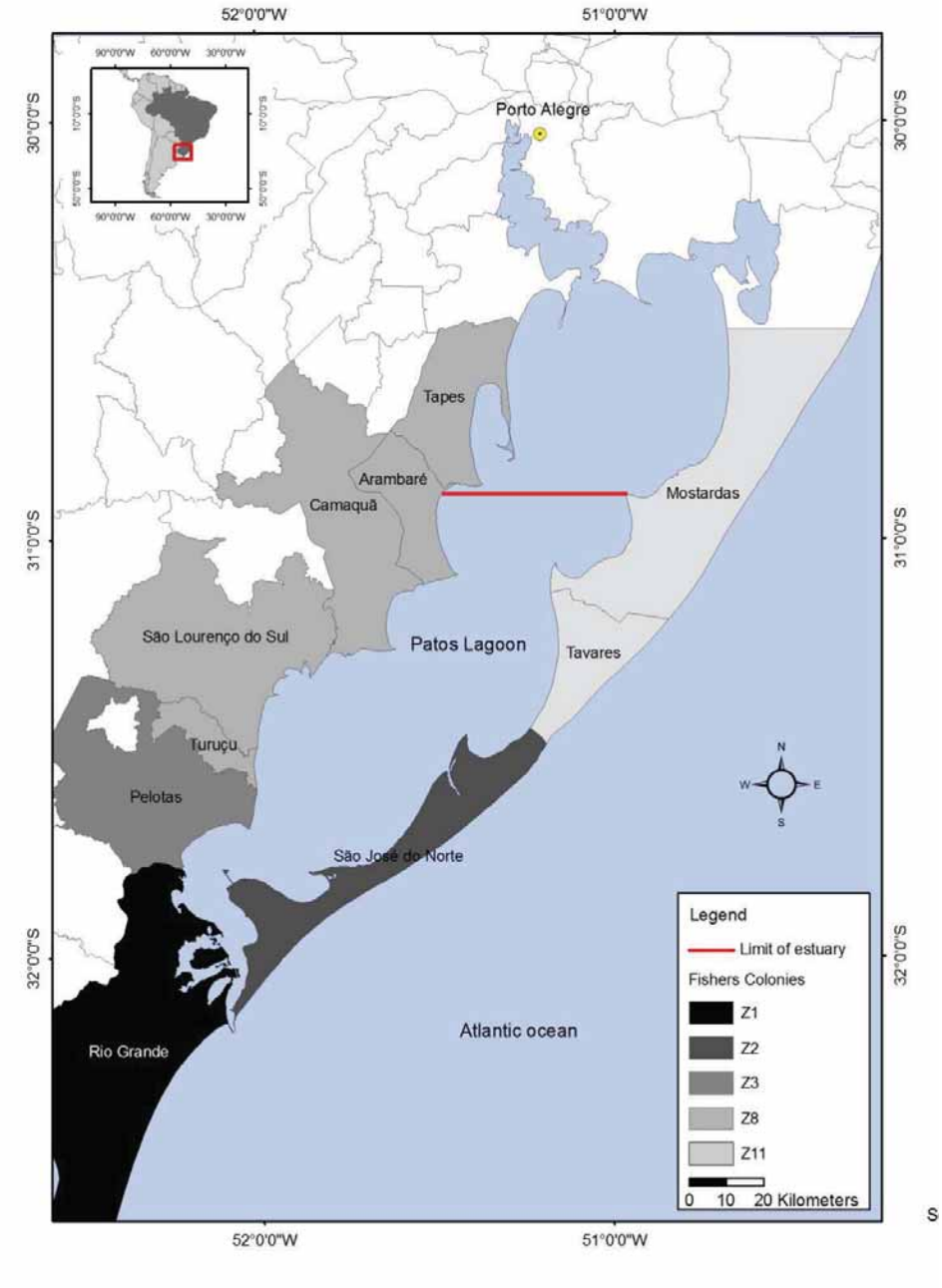

Figure 1: Map of the estuary of Patos Lagoon with the municipalities and fishers' colonies
Note: Fishers' colonies are professional organizations of fishers of a given municipality, which are legitimized by the Federal Constitution as one form of a working union.

Table 1: Summary of the biology and life cycle of main artisanal fisheries resources in the Patos Lagoon estuary

Pink shrimp (*Farfantepenaeus paulensis)*	An estuarine-dependent species. Adults spawn at sea on the continental shelf in waters deeper than 50 m, producing demersal eggs that hatch into planktonic larvae. Once they have entered the estuary, the larvae develop a benthic habit settling in shallow areas where they will grow for a few months until reaching the pre-adult phase, when they migrate to the ocean reinitiating the cycle. Larvae enter with varying success into the estuary all year round but mainly in the spring and summer, depending on the environmental forcing of wind and freshwater outflow. The growing phase in the estuary may last between 4 and 10 months, when they reach about 7 cm in length. The species is considered depleted.
Marine catfish (*Genidens barbus)*	Slow-growing anadromous species with a calculated life span of approximately 23 years, though adults may occasionally attain 36 years of age and a total length of 98 cm. At the end of the winter, the species migrates into the Patos Lagoon estuary. Reproduction takes place in the early spring in the estuary, followed by spawning in the coastal waters in the summer. *G. barba* has low fecundity and, after reproduction, the males incubate the eggs for up to two months in the buccal cavity. Between spawning seasons, adults disperse over the entire shelf. The species is considered collapsed.
Croaker (*Micropogonias furnieri)*	The species depends on the estuary of Patos Lagoon as a nursery and feeding ground. Croakers spawn during spring and summer in coastal waters under the influence of freshwater runoff from the Patos Lagoon. Adults normally migrate into the estuary in September–October and migrate out in December–January. Young and subadult croakers occur throughout the year near the coast and in the estuary of Patos Lagoon. Adults are dispersed over the shelf and migrate from Uruguay to southern Brazil during the fall and winter and towards Uruguay in the summer. The species is considered overfished.
Mullet (mainly represented by *Mugil platanus)*	Mullet occur year round in the Patos Lagoon and adjacent coastal waters. Juveniles are more abundant in the winter and spring in nursery areas of the lagoon. In the fall, adult mullet leave the estuary and initiate their reproductive migration. Spawning occurs in warmer offshore waters at about 27°S between the end of the fall and winter. Eggs and larvae are transported from spawning ground towards the surf zone, followed by long-shore migration to the estuary of Patos Lagoon. The species is considered fully exploited and threatened with overfishing.

Sources: D'Incao, 1991; Reis, 1986; Haimovici, 1997; Vieira and Scalabrin, 1991; Vasconcellos and Haimovici, 2006; Vasconcellos, Diegues and Sales, 2007.

The characteristics of the life cycles of species create a well-defined seasonal variability in the diversity and abundance of resources in the estuary and also in the availability of resources to artisanal fisheries. Fisheries landings also present a marked interannual variability, which is related to the occurrence of strong ENSO events (Figure 2; Möller, Castello and Vaz, 2009). ENSO events have an impact on the amount of rainfall in the region, and these events can directly influence the availability of resources to artisanal fishers in the estuary and thus impact the total landings.

The artisanal fishery operates in estuarine and shallow coastal waters. It is characterized by simple fishing technologies and, consequently, lower fishing effort compared with semi-industrial and industrial fisheries that operate in coastal waters (Haimovici *et al*., 2006). Artisanal fishers normally own their vessels and work together with their kin. The main types of fishing gear used by artisanal fishers are gillnets, stownets and otter trawls.

The available data on artisanal fisheries landings indicate that total production increased from close to 10 000 tonnes in 1945, reached a peak of 43 640 tonnes in 1972, and steadily declined since then (Figure 2). Total landings in 2008, the last year of available data, were 6 592 tonnes. Landings of the main resources followed more or less the same pattern of decline after the mid-1970s, mainly as a result of overfishing. Today, the main artisanal resources are fully

exploited, overexploited or depleted, and catches are close to subsistence levels, with the exception of mullet and shrimps, which provide sporadic good economic returns during ideal environmental conditions (IBAMA, 1995; Reis and D'Incao, 2000). Trends are more difficult to interpret for silverside and blue crabs, which have been poorly monitored. The blue crab fishery has a much more recent history than the other fisheries.

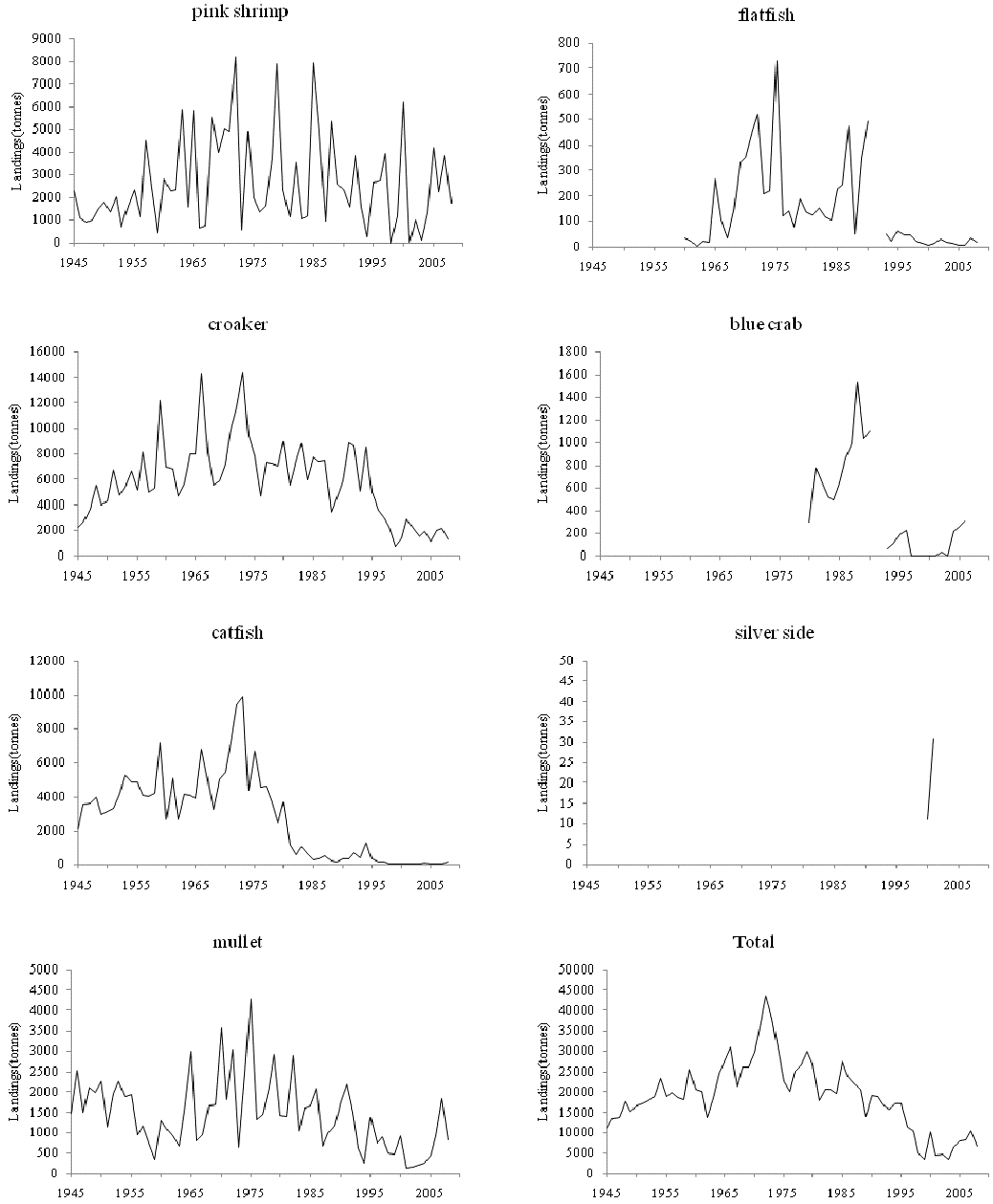

Figure 2: Artisanal fisheries landings, by resource and total, in the Patos Lagoon estuary (*Source*: CEPERG/IBAMA)

Table 2 shows the distribution of the main fisheries resources exploited by artisanal fisheries. According to data from the Center of Fisheries Research and Management of Estuarine and Lagoon Fisheries (CEPERG) and the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), these species compose over 90 percent of total artisanal catches in southern Brazil. The shaded boxes in the table represent the aquatic zones where these resources occur (Vasconcellos *et al.*, 2005; Haimovici *et al.*, 2006). The table also shows that of the

31 most important species only 9 of these spend their entire life cycle in freshwater and another 10 completely in the marine environment. None of the species spend their entire life cycle in the estuarine environment. However, of the 12 species that spend part of their life cycle in the estuary, 11 of these migrate between marine waters and estuarine and 1 migrates between fresh and estuarine water.

Species, such as croaker, weakfish, Argentine croaker and bluefish, which are primarily marine species, migrate across international borders. In these areas, resources are also exploited by other types of fisheries using distinct technologies (Haimovici *et al.*, 2006).

Table 2: Distribution of the main fisheries resources exploited by artisanal fisheries (these species compose over 90 percent of total artisanal catches according to data from CEPERG/IBAMA)

Species	Local names (Portuguese, **English**)	Environment		
Fish		**Freshwater**	**Estuarine**	**Marine**
Brevoortia pectinata	Savelha, **menhaden**			
Cynoscion guatucupa	Pescada olhuda, **weakfish**			
Hoplias malabaricus	Traíra			
Hypostomus spp.	Cascudo, **catfish**			
Leporinus obtusidens	Piava			
Loricariichthys spp.	Viola, **catfish**			
Luciopimelodus pati	Pati, **catfish**			
Macrodon ancylodon	Pescadinha, **weakfish**			
Menticirrhus spp.	Papa-terra**, king croaker**			
Micropogonias furnieri	Corvina, **croaker**			
Mugil platanus	Tainha, **mullet**			
Genidens barbus	Bagre, **marine catfish**			
Odontesthes bonariensis	Peixe-rei, **silverside**			
Odontesthes argentinensis	Peixe-rei, **silverside**			
Oligosarcus spp.	Tambica			
Paralichthys orbignyana	Linguado, **flatfish**			
Pimelodus maculatus	Pintado, **catfish**			
Pogonias cromis	Miragaia, **black drum**			
Pomatomus saltatrix	Anchova, **bluefish**			
Prochilodus lineatus	Grumatá, **streaked prochilod**			
Pseudocurimta gilberti	Biru			
Rhamdia spp.	Jundiá, **catfish**			
Rinobathos horkellii	Viola,			
Salminus orbignyanus	Dourado			
Sorubim lima	Surubim, **duckbill catfish**			
Squatina spp.	Cação anjo, **angel shark**			
Umbrina canosai	Castanha, **croaker**			
Urophycis brasiliensis	Abrótea, **codling**			
Crustaceans		**Freshwater**	**Estuarine**	**Marine**
Callinectes sapidus	Siri, **blue crab**			
Farfantepenaeus	Camarão-rosa, **pink shrimp**			
Xiphopenaeus kroyeri	Camarão-sete-barbas, **seabob**			

Source: Vasconcellos *et al.*, 2005; Haimovici *et al.*, 2006.

Fisheries resources also suffer from the impacts of human activities on the coast, such as pollution, contamination, dredging, and loss of nursery habitats (Seeliger, Odebrecht and

Castello, 1997). In the estuarine area of the Patos Lagoon, contamination by organic matter and metals in the water and the estuarine sediments is due to urban and industrial drainage, activities linked to the fishing terminals and to port activity. Alterations in the natural hydrological patterns and a series of impacts on the salt marshes caused by several human sources have also been reported (Seeliger, Odebrecht and Castello, 1997).

Despite its high ecological importance as a biosphere reserve, the Patos Lagoon estuary and its surrounding ecosystem are under heavy and constant anthropogenic pressure owing to economic development. The municipalities of Pelotas (about 328 000 inhabitants) and Rio Grande (about 197 000 inhabitants) are the most important urban centres in the region. The port and harbour facilities of the city of Rio Grande are important geopolitically and strategically for international economic market systems, and both state and federal governments have a keen interest to accelerate the economic development in the Patos Lagoon. The opportunities created for rapid and intense industrialization and development impacts negatively on the environment. Concurrent with the present depletion of fishery resources, natural features such as marshes, riparian forests, wetlands, lagoons and coastal beaches, which have an important role in the maintenance of the coastal ecosystems integrity, are being exploited by conflicting activities for short-term economic interests. Historically, socio-economic demand has tended to collide with ecological preservation, and increasing human alterations are jeopardizing the health of the coast and the estuarine region of the Patos Lagoon and thus compromising the quality of life of local communities whose livelihoods depend on coastal resources (Seeliger, Odebrecht and Castello, 1997).

2. METHODOLOGY

This chapter describes the steps that led to the scope and focus of the study and the methods used to conduct the research. The study design was prepared in a manner that allowed linkages between qualitative and quantitative data, iterative workshops, fieldwork and literature reviews (Jick, 1979; Payls, 1992; Creswell, 1994; Maxwell, 1996; Strauss and Corbin, 1997).

Operational definition of small-scale fisheries for this study

Small-scale fisheries or artisanal fisheries are used here interchangeably and generally emphasize relatively simple and easily available technologies used by household or family-based social units as compared with larger-scale and industrial or company-based fisheries. Importantly, small-scale fisheries incorporate both subsistence and commercial fisheries (Garcia *et al.*, 2008). Artisanal fishery is defined in this study as the activity practised by professional fisherfolk directly, independently or in a household system, with their own means of production or under contractual partnership, using small vessels (Law 11.959, 29 June 2009). Small vessels up to 12 m in length are allowed to fish in the Patos Lagoon estuary (Decree MMA/SEAP No. 03/2004).

Fisheries census methodology

The selection of a census methodology as the main survey instrument for studying small-scale fisheries in the Patos Lagoon estuary was decided on after preliminary analysis of information and data gathered from detailed interviews and meetings with representatives of the Ministry of Fisheries and Aquaculture, IBAMA, the Public Ombudsman, the Ministry of Labour and Employment, the Navy, the Forum of Patos Lagoon, Fishers' Colonies, associations and cooperatives, and universities. In addition, supplemental secondary data included reviews of scientific reports, local newspapers, the Forum of Patos Lagoon meeting minutes, as well as databases, laws, decrees and policy statements from the environmental agency (IBAMA), the former Federal Sub-Secretary for Fisheries Development (SUDEPE), the Ministry of Fisheries and Aquaculture, the Ministry of Labour and Employment, and the Bank of Brazil. From this review and the meetings, it became clear that the most basic information, such as the number of fishery-dependent people and fishing livelihoods strategies, were highly uncertain. In all fisheries, good and up-to-date information and data on the technical, socio-economic, resource and environmental aspects are necessary for appropriate management and governance of the fisheries. The preliminary analysis of the information and data available on the Patos Lagoon estuary indicated the need for establishing a benchmark for the technical, economic, social and environmental conditions of small-scale fisheries so as to know the actual status and eventually to measure the different trends within the fishery. The analysis also identified the major information gaps. Once these were identified, a simple, robust and easily replicated standard survey instrument for data collection was developed for the study. The main elements for data gathering to establish the status and trends identified are shown in Table 3.

Table 3: Relevant elements for data gathering to establish status and trends

Technical	Economic	Social	Environmental
• Fishing vessels • Fishing effort and catches • Fishing seasons and areas • Infrastructure and processing • Safety at sea • Documentation	• Main sources of income • Marketing and commercialization • Microfinance • Assets	• Availability of public services in communities • Fishing livelihoods • Fishing as part of family/cultural tradition • Collective formal and informal organizations (status and legitimacy) • Access to public policies/benefits • Fish consumption • Conflicts	• Legitimacy of legal framework • Local ecological knowledge • Historical trends in catch and effort • Fisheries impacts

Census survey instrument

The census survey questionnaire was designed based on the preliminary information gathering process and the gap identification. The design was made to collect the data needed to assess the technical, socio-economic and environmental conditions of small-scale fisheries. The questionnaire was first drafted in August 2009 and, after two meetings with officers representing the Ministry of Fisheries and Aquaculture, the Secretary of Fisheries of the municipality of Rio Grande, the Public Ombudsman, the Ministry of Labour and Employment and fishers' representatives, a final draft was agreed to by all parties. The final agreed draft of the questionnaire was then used as a test survey with fishers from the main localities of the estuary to test the census survey questionnaire for both content and language. A final revision of this questionnaire was made, taking into account the results of the test. Once the final questionnaire was completed, it was presented at an inception workshop to a wide range of stakeholders.

The final survey questionnaire was divided into two parts and can be seen in Annex 1. The first part of the questionnaire identifies the interviewee, including his/her name, ID information, boat registry, access to social benefits, personal and family information, and aimed at gathering information at the household level. The second part of the questionnaire was designed to be anonymous because of the sensitive questions it contains; for example, the use of fishing gear and practices (some of them not allowed by law), fishing effort and capacity, livelihood strategies (some of them conflicting with the legislation), as well as trust in the institutions. By making the second part of the questionnaire anonymous, the survey design attempted to strengthen the veracity of the information declared during the interview and to capture the complexity of the fishery with accuracy without putting fishers at risk. This questionnaire was only directed at individual fishers who are involved in capture activities. The anonymous questionnaire was further divided into two other sections (A and B). Fishers who possessed the means of production (gear and boats) answered sections A and B, while fishers who were only crew members answered only section B. Despite the identification of respondents in part A of the anonymous questionnaire, the identity of all informants was held in complete confidence in the data analysis and results.

Inception workshop

An inception workshop was held at the *Centro de Convívio dos Meninos do Mar* (CCMAR-Federal University of Rio Grande [FURG]) on 19 October 2009 to officially launch the study

and to discuss the project's objectives and methodology with main stakeholders of the small-scale fisheries of Patos Lagoon. A total of 70 people participated in the inception workshop. They included representatives from various institutions and fisher communities. The relevant workshop documentation is in Annex 2.

At the workshop, a Letter of Intention was signed between FURG and the Ministry of Fisheries and Aquaculture with the objective to formalize a partnership with the Ministry, and thus obtain its logistic support to the project, and, most importantly, to secure a formal agreement that any results coming out of the project would be fully trusted by the Ministry and used as a basis for policy and management actions. The idea of pursuing a formal recognition of the study was a strategy to guarantee that the results could be used by government agencies without being challenged on the grounds that it was not an initiative of the Ministry or other institutions involved in fisheries management. This initiative was previously discussed and agreed between the parties and formalized at the workshop.

Following the presentation of the goals of the study and the methodology to be applied, the floor was open for comments and discussion. All comments received were supportive of the initiative and the questions raised demonstrated that the census questionnaire was fairly complete and relevant to the issues of interest to small-scale fishers. The inception workshop was also important for informing community leaders of the project's objective and approaches, and for helping to minimize any misunderstandings that could interfere with fieldwork in the fishing villages. One such misunderstanding identified before the workshop was that the study would be used as an instrument to prosecute fishers who are operating illegal fisheries. In this sense, making the questions related to fishing operations part of the anonymous questionnaire was fundamental to obtain acceptance from fishers to participate in the study. In addition, during the workshop and in radio interviews given by the study coordinators before and after the workshop, it was emphasized several times that: (i) the study would fill important data gaps on small-scale fisheries; (ii) it was in the best interest of fishers to tell the truth during the interviews so that any policy and management actions would be reflective of their actual situation; and (iii) the identity of fishers would not be revealed for any purpose besides the development of a registry of fishers by the Ministry of Fisheries and Aquaculture. This was an extremely important aspect of the study.

Selection and training of enumerators

To start the fieldwork, it was necessary to select and train the field staff. Qualified enumerators and field supervisors of this study included students registered at the university. They were selected based on their academic credentials and previous experiences with interviews and community members of local fishing villages. A total of 16 enumerators and 2 supervisors were hired to implement the survey. A training course was run for three days to train the selected enumerators in the survey questionnaires (including both content and survey methodology).

Enumerators were encouraged to record any additional information on the questionnaire that they obtained through conversation with the respondent, which would also be used in data analysis. The enumerators were trained to interpose a suitable statement that reassured the respondent of the confidential nature of the information they had reported and that the intention was to provide correct data on artisanal fisheries. They were also trained to enter "zero" or a cross bar on the questionnaire to make sure that they did not forget to ask a question in cases where a question should be skipped or could be answered.

In order to obtain the most reliable and accurate information, enumerators were thoroughly trained on key concepts, aspects and problems associated with artisanal fisheries and their management. In addition, they were provided with census materials available at the Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística,* www.ibge.gov.br) and key bibliography involving all aspects of artisanal fisheries in the Patos Lagoon estuary.

Census fieldwork

Fieldwork in the estuary of Patos Lagoon was carried out from October 2009 to October 2010. For the purpose of this study, the estuary was defined according to Decree MMA/SEAP No. 03/2004. This decree regulates small-scale fisheries in the estuary of Patos Lagoon, defined as "the area encompassed between Arambaré (32°50'S) and the mouth of Patos Lagoon in Rio Grande (32°10´S)". The area is bordered by the municipalities of Rio Grande, Pelotas, São Lourenço do Sul, Turuçu, Arambaré and Tapes on the west shore and by the municipalities of São José do Norte, Tavares and Mostardas on the east shore, as shown in Figure 1. All these municipalities were covered in the study.

Census fieldwork was preceded by the mapping of fishing communities for the entire area covered by the census with the assistance of government officials and community leaders. Figure 3A shows a sample of the mapping exercise using satellite images. The location of fisher households within the communities was done using two types of approaches, depending on the characteristics of the communities.

For isolated rural communities, where the majority of the households depend on fisheries, households were mapped and identified using recent satellite images such as the ones available on Google Earth (Figure 3B). The mapping exercises were done with the participation of fishing community leaders. During the exercise, a preliminary estimate of the number of fishers was calculated in each locality.

Figure 3A: Example of the mapping in the municipality of Pelotas. **Figure 3B:** Fisher households identified in the rural community of Torotama in the municipality of Rio Grande

For communities inserted in urban areas, the mapping of households was preceded by an analysis of fishers' lists obtained from community leaders, government officials (Municipal Secretary of Fisheries and IBAMA), Fishers' Colonies and syndicates, and fishers' associations and cooperatives. From these different and complementary sources, a final list of people was produced and mapped according to the names and addresses provided. Also, through the snowball sampling technique in the field (Czaja and Blair, 1996), fishers identified other fishers in their neighbourhoods who were not on the original lists. The maps were also used to keep records and monitor areas where enumerators had covered or where they would need to return to in case of not finding a fisher at home. The data gathered through the census survey covered 100 percent of the artisanal fisheries localities of the estuary. In Figure 4, the areas in grey show the artisanal fishers' localities that were covered in the survey. No localities of artisanal fishers were identified in the municipality of Turuçu, which is shown in white.

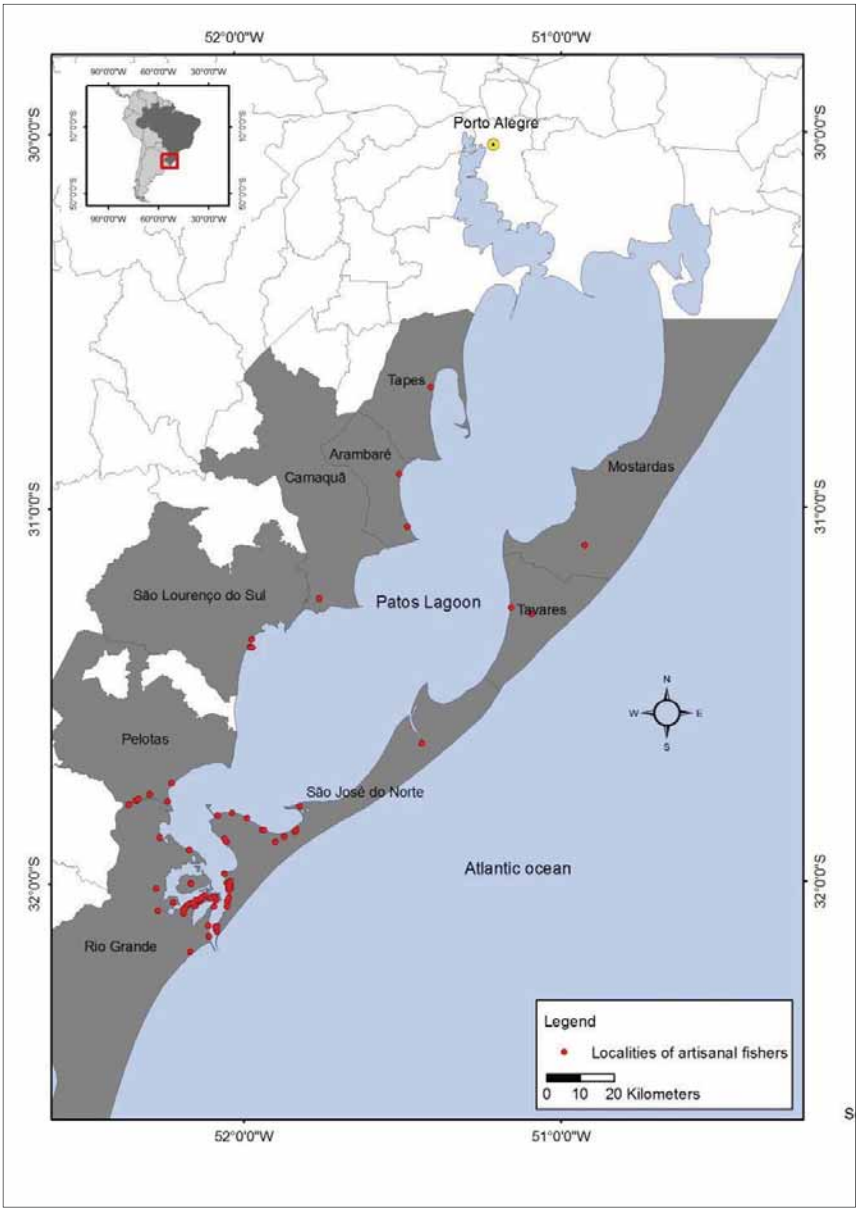

Figure 4: Location of artisanal fishers' localities in the municipalities of the Patos Lagoon estuary

A thorough analysis was necessary for determining the best season and most appropriate time during the day to carry out the survey work. This is crucial for a successful survey. After this analysis, it was decided to implement the survey during two periods: the first part was carried out between November 2009 to January 2010, and the second from May 2010 to October 2010. It was necessary to stop data collection from February to mid-May because these are the most active months of the shrimp fishing season and it is difficult to find fishers at their homes to conduct the survey. The closed season for fishing in the estuary is from 1 June to 30 September, and therefore the best period for conducting interviews, as almost all of the fishers were at their villages fixing their nets and maintaining their equipment.

Whenever possible, the schedule for the census was arranged in advance. In most cases, however, previous arrangements were difficult to make as most respondents did not have a phone. Repeated visits were necessary when fishers were not found at home. In some cases, the supervisors had a contact person (e.g. fisher and/or wives of fishers) in the locality who either

introduced enumerators to the fishers or arranged a place where the survey could be conducted. The contact person proved to be important in making the interviewing process more efficient.

The census was an enormous operation and extremely time consuming, as enumerators collected data every day, including some weekends and holidays, and worked at least eight hours per day (in some cases even more) in urban and rural fishing villages. Some fishing villages in the estuary are easy to reach while others are more isolated and journeys may take up to two-and-a-half hours by car or boat. In cases of bad weather, these villages are not accessible.

Census data were collected through face-to-face interviews at fishers' homes, warehouses or in the field (Figure 5). On average, the duration of each interview was 40 minutes. On some occasions, interviews were done through task forces of two types: a task force organized by community leaders for the purpose of the census and a task force organized by the Ministry of Labour and Employment for fishers' applications for unemployment benefits.

Figure 5: Enumerators conducting census interviews in the field

The enumeration operation followed a well-designed and controlled day-to-day plan, organized and carried out methodically and according to a predetermined plan and time schedule. Data collected were checked at the end of each day by supervisors to evaluate and give the enumerators an insight into the types of mistakes respondents may have made. They also assessed the nature and extent of errors, advised on what precautions should be taken to avoid them and made corrections where necessary. Supervisors collected questionnaires at the end of each day and stored them at the office to be coded and digitized.

The study team also identified measures that would improve the collection of data and data quality. For instance, enumerators visited villages only after a public announcement had been made for their arrival. In other villages, radio broadcasts turned out to be a more effective way of communicating. Radio interviews with project coordinators were held to explain the objectives and the importance of the fisheries census, as well as to inform fishers of the type of information that would be collected, what this information would be used for, the days the enumerators would arrive, and to encourage fishers to respond to and collaborate with the

census to ensure the maximum coverage. In other villages, a leading fisher accompanied the supervisors and enumerators to facilitate easy access into the communities, to find fishers to be interviewed, and also to make the presence of the enumerators the least awkward for the interviewees. These measures greatly improved data quality. In addition, a pamphlet indicating the purpose of the census was distributed to fishers and was placed in common public places normally frequented by fishers.

Once at the fishing village, supervisors distributed a map to enumerators indicating the village sectors and houses to be covered under the responsibility of each enumerator. Supervisors also walked through the village informing residents about the objectives of the census and explaining that fishers would receive a visit from an enumerator that day or during subsequent days.

All respondents were approached by acknowledging that they were selected as a potential respondent in the research project and asked about their availability and desires to participate in the census.

The following are the steps that enumerators followed before beginning the interview. They first identified themselves by showing an identification card, and then followed by giving a clear explanation about the project, stating: (i) the purpose and objectives of the census; (ii) the confidential nature of the interview, and that the data supplied were for statistical purposes only and would not be used against them by any organization or for law enforcement purposes, such as investigation against fraud for the unemployment benefit or for taking away their fishing licences; (iii) that individual information would not be made available to anyone outside the project, and that the census information would only be released in an aggregate or in such a way that it was impossible to identify individual data; (iv) why the respondent was selected; (v) the importance of their collaboration; and (vi) the possible benefits they could receive by accepting to participate in the census. All questions were asked in the same order and the enumerators were instructed not to provide comments that would influence the answers.

The fishers were very keen to participate in the survey. In fact, in many localities, several fishers asked to participate in the census. Two points contributed to this success: (i) questions were well developed beforehand and included the inputs and revisions given by fishers during the pre-test; and (ii) participants could clearly perceive the purpose of the questions and intuitively understood that the outcome of the census would be in their best interests.

There were also tough experiences, as some fishers had “researcher fatigue”. They had participated in many such interviews but saw little benefit from them. One fisher expressed his anger saying that he would not respond to the questions because every time “somebody like us” went to the community the end result was some law that worked against them instead of one that worked for them. When this situation occurred, enumerators and supervisors allowed fishers to talk and then they reinforced the objectives of the research and, most importantly, explained the importance of their collaboration with no promises made. Then time was given for reflection about their willingness to participate in the census. In all cases, after reconsidering, they agreed to participate.

Semi-structured interviews

While the census methodology provided an overall updated picture of the status of small-scale fisheries and served as a basis to identify the main characteristics of fisheries in the Patos Lagoon estuary, there was a need to explore the economic performance of selected typologies more deeply and to better understand the issues affecting the development of responsible small-scale fisheries in the estuary.

To secure this information, semi-structured interviews were carried out to obtain information on the technical and economic aspects of the various fishing units. The questions, interview

structure and language were along the lines of those previously tested. Fishers, who were recognized by the local fishing community as highly knowledgeable and representative of the type of fishing livelihoods in the community, were recommended for the interviews. These interviews were anonymous, which allowed the fisher to speak freely for two to three hours.

For this process, a total of ten fishers from some of the main fishing localities of the estuary were interviewed. Interviews focused on collecting data to characterize the fishing units, the fishing dynamics, and the economic and financial performance of the operations. Following Tietze *et al.* (2001), the information collected included the size and number of vessels, fishing gear used, vessel and gear acquisition costs, and the dynamics of costs and earnings of the fishing operation. The earnings were calculated as the volume of the main commercial species captured multiplied by the unit price during a typical year. Information on earnings they had obtained outside the fishery (e.g. working in the city or in agriculture) and/or from government aid (e.g. unemployment benefit during fishing closure) was also collected. In the calculation of costs, operational and fixed costs were considered. The operational costs included: labour, fuel, oil, gas for the gas lamps used in shrimp fyke net fisheries, ice, and vessel and gear maintenance. The fixed costs included: boat safety inspection fees, onshore facilities maintenance, fishing licence fees, union and association dues, vessel insurance, leasing and rental of vessels, vessel and gear depreciation, and loan payments, among other costs. All costs and earnings data are expressed in Brazilian reais (R$1 = US$0.64, 2010).

To assess the economic and financial performance of fishers, the following indicators were used:

- *net profit:* value of landings minus all costs;
- *net profit/total earnings:* expresses the net profit as a percentage of the total earnings;
- *rate of return on investment:* calculated as the ratio of the net profit and the invested capital, indicates the profitability of the investment in relation to other alternative investments; and
- *rate of economic dependence on fishing:* calculated as the ratio between the total earnings from the fishery and the total earnings from all economic activities in the household, this indicator assesses the economic importance of fisheries livelihoods.

Attempts were also made to calculate the above indicators in situations of increased risks (i.e. during bad fishing seasons) to better characterize the vulnerability of the different fishing units.

Data obtained in the semi-structured interviews were analysed in conjunction with census data to identify the vulnerabilities of fishing systems, to identify and analyze the most vulnerable groups of fishers, and to understand the features that make some fishers environmentally, economically and socially more vulnerable than others.

Data storage, processing and analysis

A database was created in Microsoft Excel to store all the data collected by the project. The main activities in data processing involved the following:

- *Monitoring and checking the questionnaires:* when enumerators returned the completed questionnaires, they were placed in a dedicated storage space to avoid damaging or misplacing them. Questionnaires were grouped according to localities and/or municipalities and identified by appropriate forms relevant to the filing system adopted.

Monitoring and control of questionnaires was key to avoid misplaced questionnaires because during the processing, questionnaires were removed from storage multiple times for manual editing, data entry and verification, and for double checking figures when computer editing detected potential errors.

- *Checking, editing and coding:* checking during data processing was done to achieve consistency within the data and consistency within and between tables to detect, verify, correct or eliminate outliers, as these extreme values are major contributors to errors. Random reviews of the checking and coding operations was done to develop a pattern for correcting errors and for interpreting difficult-to-read handwritten responses. Editing also involved revising or correcting the entries in the questionnaires. The need for revising recorded data occurred normally in cases of illegible editing and correcting the answers by the enumerators. Coding refers to the operation where original information from the questionnaire, as recorded by enumerators, is replaced by a numerical code required for processing.

- *Data entry and verification:* refers to the transfer of data from questionnaires to computer-readable media, which took up large amounts of time and resources. This operation was performed by data entry clerks and by enumerators when not in the field. All data for the questionnaire were entered as soon as possible after collection. Data entry was verified by the census supervisor who reviewed and/or corrected the work done by the initial data entry clerk. Verification was done on a sample basis so as to monitor the performance of the data entry clerks and to correct any mistakes made when the data were transferred from the questionnaire to the computer document.

- *Computer editing:* computer editing involved checking the general credibility of the data by computer with respect to missing data, range tests, and logical and/or numerical consistency. Examples encountered included non-responses, improbable or impossible entries and internal inconsistencies. Computer editing aimed at discovering not only errors in questionnaires, but also errors committed at the data entry stage. Data processing errors included those errors made when transferring information from the questionnaire to the computer document, either from illegible handwriting or other reasons. These errors were discovered by data entry verification, by computer checking for data consistency, and by routine controls comparing the computer data storage and the census questionnaire. The errors detected were corrected manually after comparison with the census questionnaire.

Both descriptive and simple statistical tools were used in the analysis of data generated by the census and the semi-structured interviews, including percentage distribution and measures of central tendency.

In some cases, comparisons were made between urban and rural localities. The rural localities were defined using criteria such as distance from urban centres and share of primary activities (including agriculture and fisheries) in employment and economic value (UNECE, 2007).

Estimating the number of artisanal fishers in the Patos Lagoon estuary

The census data enabled the study team to assess the total number of active fishers in the estuary of Patos Lagoon. To account for possible errors in fieldwork, an approach was developed to evaluate the accuracy of census point estimates. The level of error in the enumeration of fishers from each locality was assessed using the following criteria: (i) level of coverage of fisher households in the locality; (ii) number of households visited where no one was at home; and (iii) number of people interviewed who were unlikely to be fishers. While criteria (i) and (ii) would lead to an underestimation of the number of fishers, criteria (iii) would overestimate the numbers of fishers.

Each locality was assigned, by consensus among the study team, a maximum level of error related to each of the three criteria. The level of error followed a quali-quantitative scale: very good (5 percent); good (10 percent); medium (15 percent); poor (20 percent); and very poor (25 percent). For instance, a locality that had a good coverage (10 percent error), a low number of households visited with no interviews performed (10 percent error) and a perceived poor level of accuracy in identifying and interviewing fishers (20 percent error) was assigned a level of error varying from –20 percent to +20 percent around the point estimates.

The approach was applied only to the municipalities with the highest concentration of fishers, i.e. São José do Norte, Rio Grande and Pelotas (see Chapter 3). Confidence bounds for the total number of fishers per municipality and for the whole estuary were estimated through Monte Carlo simulations, where the estimated number of fishers from each locality was sampled from triangular distributions having the census enumeration as mode and the assigned errors (as defined above) as lower and upper limits. A total of 10 000 simulations were performed to obtain the confidence bounds.

Final workshop

Results of this study were presented to stakeholders during the workshop "Status and perspectives for the artisanal fisheries of the estuary of Patos Lagoon: results from the census of artisanal fisheries", which was held on 13 April 2011 at the Federal University of Rio Grande. Besides serving as a venue to publicize the main findings of the study, the workshop was also useful to validate the results and to obtain further information from stakeholders that was used in the interpretation of the data collected.