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Resolving environmental issues in the southern Brazilian artisanal penaeid-trawl fishery through adaptive co-management

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ABSTRACT

Many conventional management strategies have been demonstrated to be ineffective in achieving sustainable fisheries, and new approaches are required to overcome existing environmental, social and economic problems. Adaptive co-management represents the combination of a learning-by-doing approach (adaptive management) involving all related and legitimate stakeholders in the decision-making process (collaborative management). In this study, the relevant experiences from a fishery in southern Brazil are reported. The first section of the paper summarizes the broad history of national fisheries and their management. Then the southern Brazilian artisanal penaeid-trawl fishery is briefly described and the three main problems associated with the common gears used are discussed, including their (1) poor size and species selectivities, (2) poor efficiencies, and (3) their mechanical impacts on benthic habitats. Finally, a framework is proposed to address the environmental and socio-economic issues in the fishery and its implementation discussed via an adaptive co-management approach.

Introduction

Artisanal or small-scale fisheries are an invaluable source of sustenance, income and employment for many coastal communities throughout developing countries, representing an essential livelihood strategy for millions of families and greatly contributing towards poverty alleviation. The importance of such fisheries in terms of global production is indisputable, given that they contribute towards more than half of the estimated wild harvest total of ~100 million tonnes per annum (which is mostly destined for direct human consumption), employ more than 31.5 million capture fishers and support around 84 million people in associated employment [1].

Artisanal fisheries have an established tradition in Brazil, initiated by indigenous tribes who harvested fish and molluscs, evidence of which can be found in large mounds of shells called 'Sambaquis'. After Portuguese and Spanish migrants arrived in the XVI century, larger-scale commercial fisheries developed, especially in southern Brazil, which encompasses the states of Paraná, Santa Catarina and Rio Grande do Sul and is bordered by the cities of Curitiba and Rio Grande (Fig. 1). While industrial fisheries still exist throughout Brazil, artisanal fisheries have continued to remain more important, accounting for ~65% (or 505 812 t) of the total annual national production [2], and involving a plethora of fishing methods, ranging from simple hook-and-line to more complex active gears like benthic trawls and seines [3–5] (Fig. 2).

Historical recognition of the need to sustain Brazilian fisheries resources has led to various attempts at regulation. However, like for many overseas fisheries, national management has been a considerable challenge [6], mostly reflecting a shortfall in the required science [7–9].

Internationally, it is commonly recognized that there is not one universally appropriate fisheries management strategy [10]. Rather, fisheries should be considered independently, with management implemented after debate among all stakeholders. For this reason, collaborative management or co-management has been proposed as an alternative approach to fisheries governance where decision-making processes and accountability are more evenly spread among governments and stakeholders [11,12]. Shifting from a command-and-control to a collaborative approach is one rationale to improve the robustness of management institutions [13,14]. Another perspective on fisheries management relies on the recognition of fisheries as complex adaptive systems [15]. Focusing on a learning approach, adaptive management embraces uncertainty, treats fisheries management as 'experiments' and emphasizes so-called "learning-by-doing" [16,17]. The adaptive co-management approach is an outcome from collaborative management and adaptive management experiences, with emphasis on learning and linking functions of governance [18–20].

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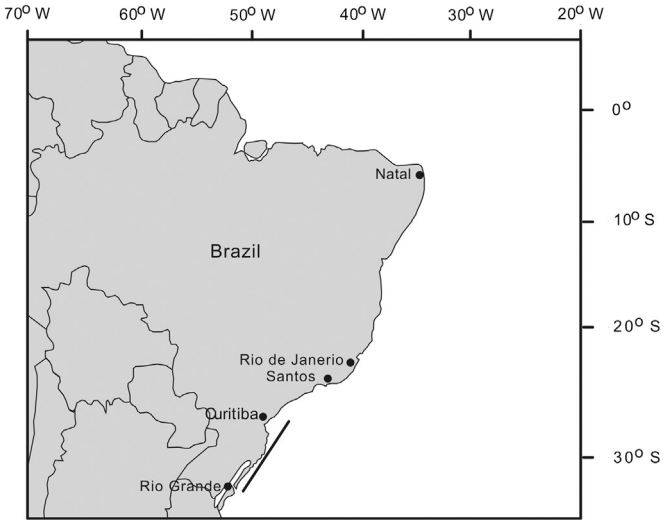

Fig. 1. Map of Brazil and the area encompassed by the southern Brazilian artisanal penaeid-trawl fishery.

Fig. 2. Artisanal fishing boat from southern Brazil.

While there is plenty of literature discussing the different types of functional fisheries management approaches and their utility [7,12,21–25], there are few case studies documenting adaptive co-management experiences (see e.g., [18,26]). Also, there is a need for more systematic approaches and comprehensive frameworks to facilitate selecting the most appropriate strategy for a particular fishery.

The aim of this article is to discuss the implementation of a comprehensive framework using an adaptive co-management approach in the southern Brazilian artisanal penaeid-trawl fishery, one of the most important national artisanal sectors. As part of this work, an argument is presented to suggest that modifications and refinements to penaeid trawls to address key environmental concerns, that historically have been developed independently, should be incorporated within broader approach from the onset, and with regard to adaptive co-management.

History of fisheries management in Brazil

The progression of a co-management approach to artisanal fisheries in Brazil first requires adequate comprehension of the history and culture associated with previous strategies, all of which were characterised by diverse levels of organization (bureaucracy) and institutional arrangements. Prior to colonization, all fishing activity in Brazil was self-managed, whereby indigenous people mostly sustainably harvested from their various regions. Although subsistence-based, there is evidence that such fisheries were nevertheless complex and sophisticated, involving gears like bone hooks, and small nets made from woven fibres collected from forests [3].

The arrival of Portuguese and Spanish migrants in the XVI century marked the development of larger-scale commercial fisheries. Owing to the greater similarly to European climates, many settlements developed in the more southern states and contributed towards the initial development of industrial fleets, initially at Santos in São Paulo State [5]. Following a rapid increase in the numbers of fishers and vessels, the exploitation of fishery resources required the emergence of the first natural-resource management organizations.

Throughout history, Brazil has experienced multiple degrees of linked organizations of civil society and social movements as forums in local, regional, national and international levels that have cumulatively improved human and civil rights, environmental protection and democracy. There were various institutional arrangements that shaped the three key sectors – fisheries, protected areas and coastal management – of natural resource management along the coastal zone. While it might be expected that fisheries and protected areas should be embedded within coastal management, they have been managed by different policies, institutional arrangements, levels of stakeholder participation and leading organizations [5,27–30].

Modern fisheries management in Brazil can be divided into three development stages (Table 1). During the first stage, the Brazilian Navy held the jurisdiction of fisheries management. In 1923, the Navy created the "Diretoria de Pesca e Saneamento" (Board of Fisheries and Sanitation), which was aimed at promoting fisheries. In the same year, the Navy also created the first stakeholder organizations called "Colônias de Pescadores" (fisher' communities or guilds) that were essentially loose regional collectives [31]. Even today, such communities still persist as the main representative organization of artisanal fishers, although other forms of social organization also occur. In 1938, the "Código de Caça e Pesca" (Code of Hunting and Fishing) was the first fishing regulation enforced by the Hunting and Fishing Service under the Ministry of Agriculture. Even though incentives for fishery development were incipient, they facilitated the first steps towards industrialization [32].

The creation of the "Superintendência para o Desenvolvimento da Pesca—SUDEPE" (Superintendence for the Development of Fishing) in 1962 (1962–2009) marked a new, second stage of fisheries management in Brazil, characterized by the empowerment of a government institution that actively progressed fisheries development. This second stage can be subdivided into four different institutional periods (Table 1). The first institutional period (1962–1989) was distinguished by a rapid expansion of industrial fisheries. Government incentives were initiated to develop industrial fleets, which effectively reduced the relative importance of artisanal fisheries that needed to share fishing grounds and resources [4,5,31]. Supported by subsidies, the expansion of fishing industries as well as modernization of vessels increased total landings in Brazil from 220,000 t in 1960 to nearly 750,000 t in 1984 [33] and much of the increased catch came from southern states [34].

The second institutional period (1989–1998) was distinguished by a general change in the fisheries-governance ideology, mostly from food production and development to environmental protection. The "Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis—IBAMA" (Brazilian Institute of