Marine Policy 71 (2016) 111–120

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Fishers' knowledge indicates short-term temporal changes in the amount and composition of catches in the southwestern Atlantic

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ARTICLE INFO

Article history:
Received 5 September 2015
Received in revised form
8 May 2016
Accepted 11 May 2016

Keywords:
Overfishing
Small-scale fisheries
Fisheries management
Fishing down food webs
Ecological shifts
Food security
Fishing impacts

ABSTRACT

The scarcity of data on fish catches difficult management of small-scale fisheries in developing countries. This study applies fishers' knowledge to investigate temporal changes in the amount (biomass) and composition (major ecological categories) of fishing resources exploited by small-scale coastal fisheries in the southeastern Brazilian coast. Four hypotheses were investigated: (1) The amount of fish caught reported by fishers would decrease over time. (2) Older fishers would report higher fish catches than younger fishers. (3) Recent interviews would mention large-sized predators less often. (4) Recent interviews would mention less high valued fishing resources. Interviews with 421 fishers in 36 communities in the southeastern Brazilian coast were analyzed, covering a time span of 14 years, from 1995 to 2009. The hypothesis 1 was confirmed, 3 was partially confirmed, while 2 and 4 were not confirmed. Fishers' age was unrelated to all variables. The results from fishers' interviews indicated the temporal trends of: (1) a decrease in the biomass of fish caught; (2) an increase in the occurrence of smaller fish and invertebrates in the catch; (3) an increase of high value fishing resources; and (4) maintenance of large predators. The first two indicators suggest excessive fishing, but the later indicators (3 and 4) suggest that the socioecological system of the southeastern Brazilian coast had not yet undergone major ecological shifts.

1. Introduction

Coastal fisheries worldwide have shown declining catches, stock collapses and increasing fishing effort, which claim for scientific assessments of trends in catches to support effective management measures aiming to revert overexploitation [2,56]. Besides negative social and economic consequences, excessive fishing pressure has caused ecological regime shifts in coastal ecosystems, due to severe declines in populations of marine organisms that perform important ecological functions, such as large predators, large herbivores and even small pelagic fish [16,17,26,27,62]. Overfishing may cause a decline in the overall trophic level of coastal ecosystems, thus simplifying food chains, according to the concept of fishing down the food web [55]. This pattern has been challenged by recent studies, according to which overfishing would progressively reduce the abundance of those species with the highest market value, thus shifting the economic revenues from fishing, irrespective of trophic level [63].

Small-scale tropical fisheries are socio-ecological systems, on which healthy coastal ecosystems are required to guarantee food security [13,19]. These small-scale fisheries are particularly challenging to manage in developing countries, due to their heterogeneity (multi-species and distinct fishing gears), widespread landing sites and scarcity of data on fish catches and fishing effort [7,23,47]. Furthermore, conventional top-down management approaches, such as gear restrictions or marine protected areas, have not been always adequate to small-scale fisheries, generating conflicts and lack of compliance by fishers [44,45,58]. These two major problems of scarcity (or lack) of data on fish landings and management strategies poorly designed to local fishing dynamics could be circumvented by the data-less management approach [38]. This approach consists in using any available information on local fishing dynamics (fish catches, fish biology, management options, fishing grounds), including fishers' local ecological knowledge [40,64], besides scattered data on fish ecology or fish catch and effort [6,38] to propose management strategies. Recent studies have successfully applied fishers' knowledge to investigate temporal trends in abundance of fishing resources and changes in ecological conditions in a range of freshwater and coastal

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http://dx.doi.org/10.1016/j.marpol.2016.05.008
0308-597X/

ecosystems [18,22,35,39,61]. Nevertheless, most of these studies address particular fish species more susceptible to fishing pressure, such as reef fish or sharks [31,59], while fewer studies investigate temporal changes in the amount and composition of fish catches by comparing distinct data-bases, such as governmental landing statistics and fishers' knowledge [21]. Information on temporal trends in fish catches are required to support management interventions and policy measures better suited to the needs and concerns of Brazilian small-scale coastal fishers [6,7]. In Brazil, previous studies analyzed fishers' knowledge to reconstruct temporal changes in abundance of some target fish species in the tropical northeastern coast [18,21,31], but fewer studies have addressed changes in fish abundances in the more populated and potentially more heavily impacted southeastern coast [42]. Moreover, studies usually concentrate in particular fishing communities and few studies analyze a large amount of interviews with fishers from a broad geographic area [10].

This study aims to apply fishers' knowledge to investigate temporal changes in the amount (biomass) and composition (major ecological categories) of fishing resources exploited by small-scale coastal fisheries in a large geographical area in the southeastern Brazilian coast. Data from interviews with fishers were analyzed to address two main questions. Is the amount of fish caught related with time of the interview or with the age of interviewed fishers? Is the composition of fish caught (number of species and frequency of citations) related with time of the interview or age of interviewed fishers? The observed trend in the abundance of catches reported by fishers was compared with fish landings from official governmental statistics in the same region and studied period. Based on available evidence on temporal trends in coastal fisheries, four hypotheses were investigated: (1) The amount of fish caught reported would decrease over time with less fish caught reported by fishers in recent years. (2) Older fishers would report higher fish catches than younger fishers. (3) Composition of fish landings differ over time: recent interviews would mention less large-sized predators compared with older interviews. (4) Recent interviews would mention less high valued fishing resources compared with older interviews.

2. Material and methods

2.1. Study site

This study was based on data from fishers' interviews conducted in 36 fishing communities in the southeastern Brazilian coast, from the North of São Paulo state to the South of Rio de Janeiro state (Fig. 1). These fishing communities are distributed in four major regions, from North to South (Fig. 1): (1) Angra dos Reis and Ilha Grande Bays (n=17 communities), (2) Paraty Bay (n=11); (3) Ilha Bela (n=4); (4) São Paulo northern coast, including the cities of Ubatuba and Bertioga (n=4). These regions were arbitrarily defined according to the proximity among communities, similar fishing dynamics (gear used, market orientation, tourism influence) and habitat features, such as the presence of bays, estuaries and islands [4,13,46].

2.2. Fishing communities

The studied coastal fishers living along the southeastern Brazilian coast belong to the caiçara cultural group, who descend from indigenous people and Portuguese and practice small-scale agriculture and fishing [3,7]. These artisanal fishers use small to medium sized boats, paddled canoes and various kinds of fishing gear, including gillnets, hand lines and trawling, to catch pelagic and reef fishes, shrimp and squid [3–5,13,42]. More recently, some caiçara fishers have increasingly dedicated to tourism related activities to supplement their income [4,46]. The studied caiçara fishing communities are located along some of the last remnants of the threatened Atlantic Forest ecosystem in southern Brazil, which had caused conflicts between resident fishers and governmental authorities who establish conservation units that restrict traditional agriculture and fishing activities [3–5]. Recently enforced marine protected areas (MPAs) and intense large scale fishing in coastal areas have also raised conflicts with small-scale fishers in the southeastern Brazilian coast [11,12,44,45].

2.3. Interviews with fishers

Data were gathered from standardized interviews with 421 caiçara fishers made during several independent research projects along 14 years, from 1995 to 2009. These interviews are stored in the archives of the non-governmental organization (NGO) Fisheries and Food Institute (FIFO, http://www.fisheriesandfood.org). The fishing communities included in the studies and the interviewed fishers were selected by following defined criteria, such as dedication to fishing as the main economic activity, being older than 18 years age, living in the community for at least 10 years. The researchers interviewed fishers individually through a standardized and structured questionnaire. Although the content of questionnaires differ among studies, these usually addressed issues related to socioeconomic characteristics (age, scholar level, jobs, income), fishing behavior (fishing grounds, gear used) and fishing resources exploited (main species caught, amount of catches). More details on sampling procedures and topics addressed in interviews can be found in the resulting publications of these

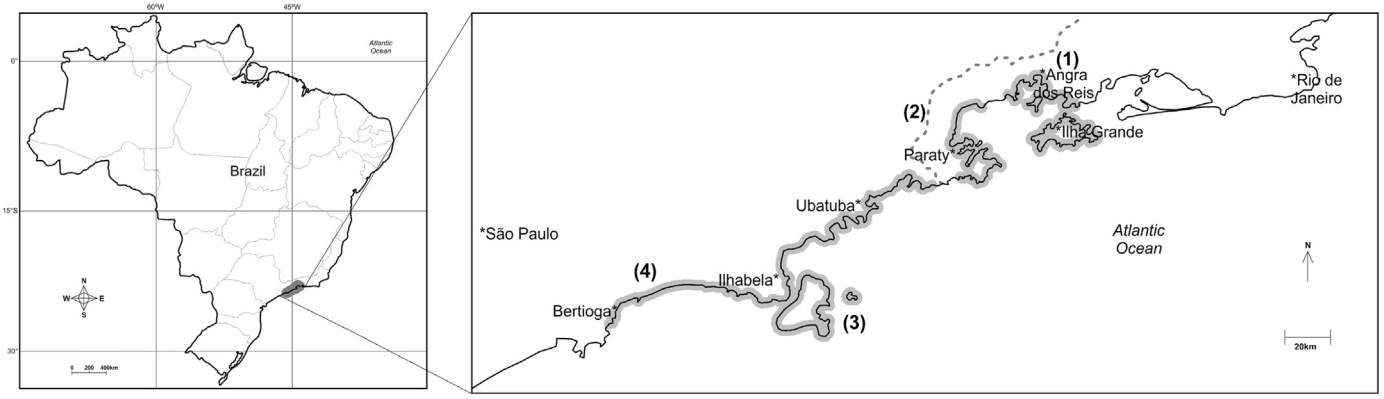

Fig. 1. Location of the studied region in the southeastern Brazilian coast, indicating the four regions: (1) Angra dos Reis and Ilha Grande Bays, (2) Paraty Bay, (3) Ilha Bela, (4) São Paulo northern coast.