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Artisanal fisheries and artificial reefs on the southeast coast of Brazil: Contributions to research and management

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ABSTRACT

This work aims to analyse the contribution of artificial reefs (ARs) to marine biota based on fishers' local ecological knowledge (LEK) of the species associated with ARs. Data were collected from November 2016 to May 2017 through 60 ethnographic interviews with artisanal fishers at the northern coast of Rio de Janeiro. Local fishers use seven methods to catch fish, with trawl nets being the most frequent (32.5%, n = 41). Some fishers use more than one gear of fish equipment, allowing the capture of several species throughout the year and to alternate the target species. The fishers reported 25 species associated with the ARs, although 15 species appeared after the installation of the artificial complex. The most frequent were the sheepshead (*Archosargus probatocephalus* 43.3%, n = 26), black margate (*Anisotremus surinamensis* 41.7%, n = 25), spiny lobster (*Panulirus* sp. 33.3%, n = 20), caribbean spiny lobster (*Panulirus argus* 31.7%, n = 19), and smooth puffer (*Lagocephalus laevigatus*, 31.7%, n = 19). The fishers described several ecological functions of the ARs, acting as a species reproduction site (25.93%, n = 21), increasing fish weight (18.5%, n = 15), attracting fish (16.0%, n = 13) and reducing industrial fishery (8.6%, n = 7). The interviewees had consistent LEK about local marine biota, especially species associated with the ARs. They maintained a positive perception of the ARs and pointed to the need for public policies when installing new artificial structures that can increase fish stocks in the region.

1. Introduction

Artisanal fishery practice is a traditional activity that can be autonomous with familiar participation, and usually characterizes a local fishery community (Diegues, 2008; Silva, 2014). In these practices, the fishermen explore the coastline with small vessels and equipment that have low autonomy (little space to store the fish and low speed and capacity of displacement) and capture aquatic species for subsistence or small-scale commercialization (Clauzet et al., 2005; Oliveira et al., 2016). In artisanal fishery, the fishermen can use their own mean of production or into partnerships, and act onshore or offshore by vessels of < 20 gross tonnage (Brasil, 2009, 2011). Artisanal fishermen usually are organized in fishing colony or association with a local leader as representative. On the other hand, the industrial fishery activity use medium and large vessels, operating along the continental and ocean waters and their production is exclusively for trade (Vianna, 2009; FIPERJ, 2013). The active fishing gears are based on the target species and combined with different catching instruments (*e.g.* trawls, dredges and seine nets) (Silva, 2014).

The main differences between the fishery activities are related to the catch capacity of the fish and the use of high technology equipment by industrial fishing, since there is a high financial investment and consequently not accessible to the artisanal communities (Silva, 2014). The intensive fishing both in the artisanal and industrial categories occur through an uncontrolled exploitation of the resources and can affect the environment sustainability. The advance of industrial fishery and the degradation of coastal environments threaten local fish stocks and, consequently, the social-environmental relationship of artisanal fishers,

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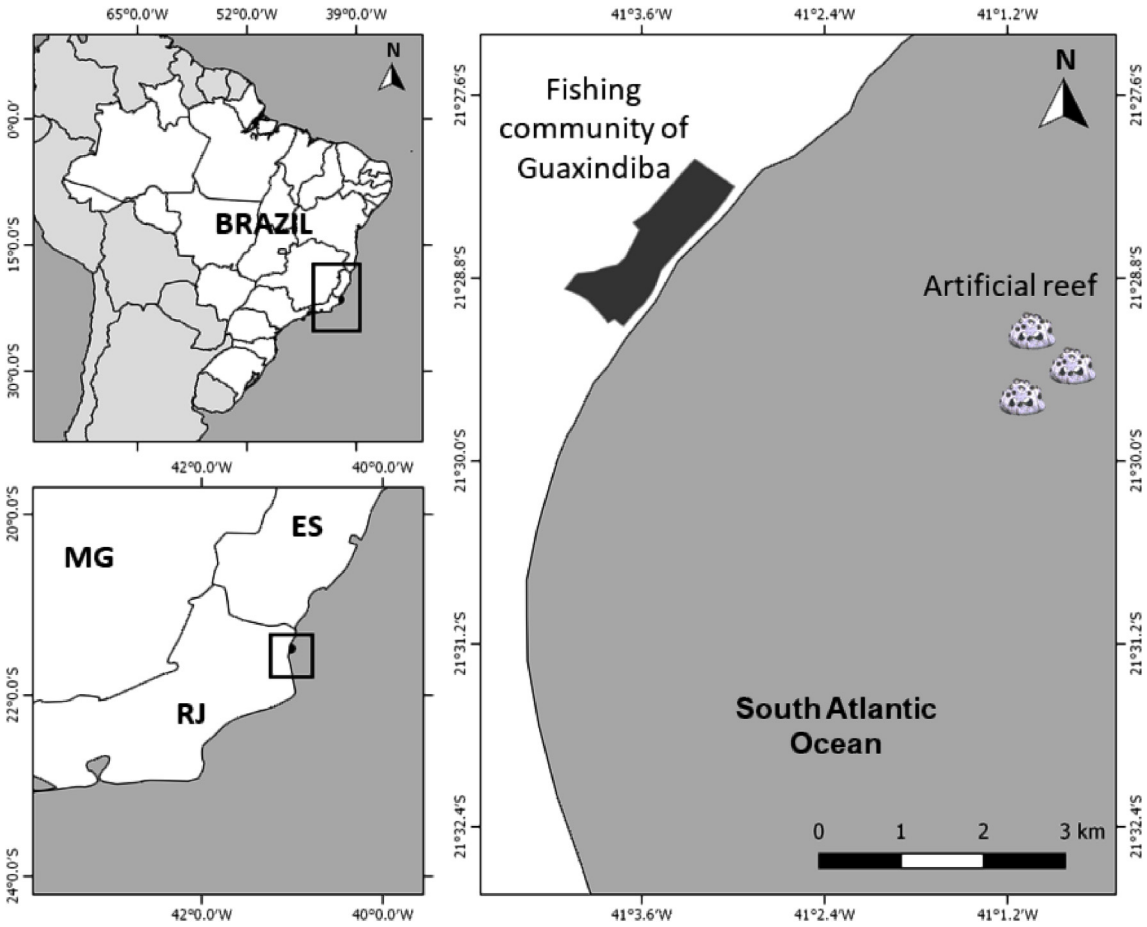

Fig. 1. Location of the regional artisanal fishermen, the municipality of São Francisco de Itabapoana and the ARs installed in northern RJ, southeast Brazil. Southwestern states: MG – Minas Gerais, ES – Espírito Santo, RJ – Rio de Janeiro.

who are separated from their historical fishing grounds by these impediments (Islam and Tanaka, 2004; Crain et al., 2009; Vasconcellos et al., 2011).

The installation of artificial reefs (ARs) helps to maintain local marine biota by providing refuge and feeding areas for local species, in addition to inhibiting industrial fishery, since the ARs prevent the intensive fishing and the use of bottom gears (Seaman and Jensen, 2000; Conceição and Nascimento, 2009). These artificial structures are also used to support artisanal fishers because they can help maintain fish stocks (Pickering et al., 1998; Baine and Side, 2003). Brazilian legislation regulates the licensing and installation of ARs in the Territorial Waters and in the country's Exclusive Economic Zone (IBAMA/Brasil, 2009; Normative Instruction n.22 of July 10, 2009). This legislation indicates that the interests of fishers should be considered before ARs are approved for construction and installation in a given region (Seixas et al., 2013).

In southeast Brazil (19°S - 24°S), many artisanal fishing ports support the economy of traditional communities (Begossi et al., 2011; Cantareli et al., 2016; Musiello-Fernandes et al., 2017). The state of Rio de Janeiro (RJ) has 16 fishing ports and contributes more than 60.000 t of fish year^{-1} to the market through extractive marine fishing (ICMBIO/Brasil, 2011; FIPERJ, 2015). Guaxindiba port (21°29′S, 41°00′O), located in northern RJ, is characterized by fishing of shrimp, weakfish, corvine, catfish and shark (Di Beneditto, 2001; Vianna, 2009). However, factors such as degradation of coastal environments, pollution of rivers and mangroves, oil activities and the use of low selectivity fishing gears have reduced fish stocks on the coast of RJ and are potential threats to artisanal fishery in this area. (Vianna, 2009; FIPERJ, 2013). In addition, along the north coast of the state of RJ social problems have been reported resulting from conflicts between fishery communities and port activities (Oliveira et al., 2016).

In 1996, a reef complex composed of reef balls was installed on the north coast of RJ near the fishing community of Guaxindiba. The goal of this complex was to increase marine biota biomass and abundance, and, consequently, the artisanal fishing rates (Godoy et al., 2002). Reef balls are structures made by concrete and composed of several holes. These structures are widely used worldwide (USA: Sherman et al., 2002; Indonesia: Bachtiar and Prayogo, 2010; Caribbean: Young et al., 2012; Brazil: Santos et al., 2011), due to special features that make them ideal for creating habitats for several marine species as fish, lobsters, oysters, and prevents industrial fishing.

Studies in zoology and ecology related to invertebrates and fish associated with reef balls have been carried out for at least 15 years in the northern RJ (Godoy et al., 2002; Zalmon et al., 2002; Brotto et al., 2006; Santos et al., 2008, 2010, 2011; Gatts et al., 2014; Rocha et al., 2014; Santos and Zalmon, 2015). Artisanal fishermen have used these ARs as an ancillary fishing area to capture some target species. However, there is no information from fishermen's local ecology knowledge (LEK) on the species associated and on the impact of human actions on the biological community distributed in these artificial structures.

Ethnoecological studies usually are not taken into account for the management of coastal resources, despite their direct and regular contact of the fishermen with fishery resources (Johannes, 2002; Drew, 2005; Silvano et al., 2009). From these studies, it is possible to understand the behaviour and occurrence of the species, as well as understand the effects of environmental impacts on coastal ecosystems. Ethnoecological studies are often not appreciated by researchers and public managers (Huntington, 2000; Silvano and Begossi, 2012;