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Climate change and regional human pressures as challenges for management in oceanic islands, South Atlantic



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ABSTRACT

This study aimed to determine the main anthropogenic pressures and the effectiveness of management practices in marine protected areas (MPAs) (Rocas Atoll and Fernando de Noronha Archipelago, South Atlantic). The MPAs exhibited high management effectiveness over the last 25 years due to the control of local pressures (i.e., fishing and tourism). However, the increase in regional and global pressures, such as invasive species, marine debris, and climate change stressors (sea-level rise, extreme events, range shifts of species, warming, and ocean acidification), are environmental risks that need to be considered during conservation. Strategies for large scale marine spatial planning, as well as proposals for an integrated management of MPAs (including coral reef islands and seamounts) by the articulation of a network, which reduces regional human pressures and improves ocean governance were discussed. This study provided insights into the challenges faced in the management of MPAs in a rapidly changing ocean.

1. Introduction

Coral reefs are marine ecosystems with highly diverse species, goods, and ecosystem services (ES) (Hoegh-Guldberg et al., 2017). The importance of reefs can be highlighted by the important ES they provide, such as protection of coasts and islands against extreme waves and tides (Elliff and Kikuchi, 2017), abundance of organisms associated with trophic food webs (i.e., fishery resources) (Neubauer et al., 2013), and biogeochemical carbon balance (Rossi, 2013). Coral reefs have also increased in their estimated value, in terms of ES, from ~8000 to ~352,000 \$/ha/y due to their recreational value and evidence that they function in storm and erosion protection (Costanza et al., 2014). The sustainability and protection of these ES and the associated biodiversity needs to be a priority in ocean governance to avoid the rise of mediocrity in coral reefs (Mumby, 2017).

Reef environments have been protected mainly through the establishment of marine protected areas (MPA) in coastal and oceanic habitats, with differing results based on the region (Mora and Sale, 2011; Gill et al., 2017) and the resilience of the coral reef (Mora et al., 2016). Despite satisfactory implementation of MPAs and management of local pressures, these ecosystems are susceptible to degradation because of the regional and global impacts of human pressures (Halpern et al., 2015; Altieri et al., 2017). The policy discussion on MPAs worldwide usually focuses on coastal tropical reefs, although extensive marine

zones, including some reefs located in the offshore regions, such as seamounts and atolls, lack effective protective measures or environmental management (Edgar et al., 2014).

The management of offshore MPAs worldwide (including atolls and islands) is a challenge for the multiple stakeholders involved in ocean governance (Morais et al., 2015; Andrade and Soares, 2017). Little or no availability of freshwater and fisheries, susceptibility to erosion, the presence of endemic species, and vulnerability to climate change are complex factors that must be considered in the management of oceanic reefs (Woodroffe, 2008). Moreover, it is necessary to understand the management practices, and cumulative stressors that affect offshore MPAs in order to discuss the challenges faced and the role of science in improving ocean governance.

This study aimed to determine the main anthropogenic pressures and the effectiveness of management practices in marine protected areas (MPAs) located in the Tropical South Atlantic Ocean (Rocas Atoll and Fernando de Noronha Archipelago, Brazil). I also presented an overview of the environmental characteristics and effective management practices. Considering local, regional, and global human drivers (Oesterwind et al., 2016) at the only atoll in the South Atlantic (Rocas Atoll), the major anthropogenic pressures, such as marine pollution (i.e., microplastics), exotic species, range shifts of species, acidification, sea-level rise (SLR), and the effects of global warming, were reviewed. Finally, strategies for large scale marine spatial planning, as well as

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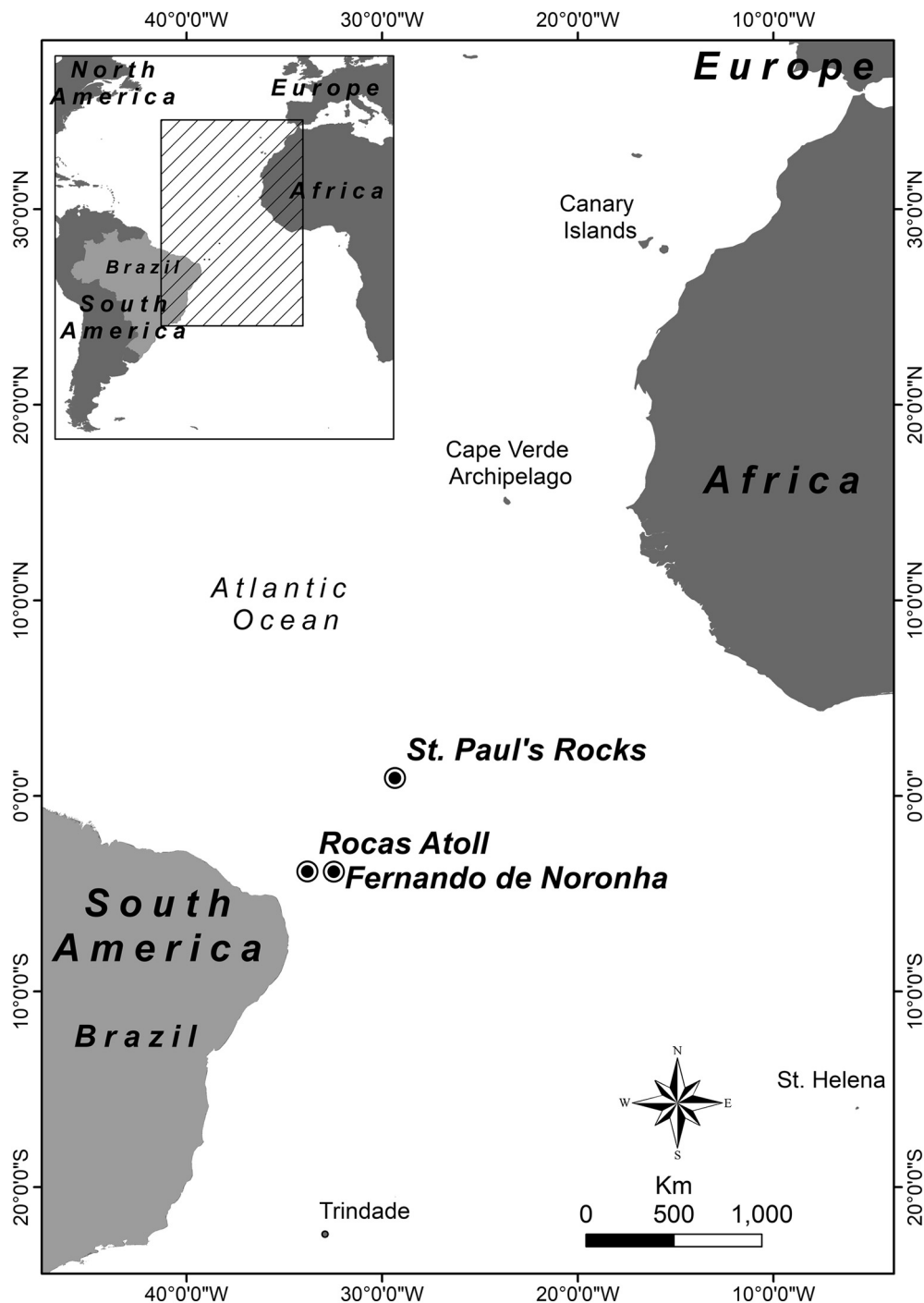


Fig. 1. Map of the Tropical South Atlantic islands (highlighted in bold).

proposals for an integrated management of MPAs (including coral reef islands and seamounts) by the articulation of a network in South Atlantic, which reduces regional human pressures and improves ocean governance were discussed.

2. Characteristics and management of offshore MPAs in the tropical South Atlantic

2.1. The insular environment

Oceanic islands in the tropical South Atlantic are important marine habitats where tropical reefs occur. These islands include the Fernando de Noronha Archipelago, Rocas Atoll (the only atoll in the South

Atlantic), and the Saint Paul and Saint Peter Archipelago (Fig. 1). They vary in size, the largest being Fernando de Noronha, and distance from the mainland, the most remote being Saint Paul and Saint Peter Archipelago, and have distinct biodiversity and insular ecosystems. These environments are considered recent, as they are located in the tropical region of the youngest ocean (South Atlantic) on earth, and constitute one of most important biodiversity hotspots worldwide (Hachich et al., 2015; Barroso et al., 2016). They can provide ecological insights into the high biodiversity and resilience against climate change of oceanic islands (Leão et al., 2016; Soares et al., 2017).

One of most important oceanic islands in the South Atlantic, in terms of marine conservation, is Rocas Atoll. In recent geological history, approximately 425 atolls have been observed. Most of them are

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