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Citizen science contributes to the understanding of the occurrence and distribution of cetaceans in southeastern Brazil – A case study

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ABSTRACT

Citizen Science projects involve ordinary people in scientific research, providing new insights and perspectives. Interested members of the public may contribute valuable information as they learn about wildlife in their local communities. This study investigates the spatiotemporal occurrence and distribution of cetaceans off the coast of Rio de Janeiro, Brazil, based on data obtained by citizen scientists (opportunistic observations - 2013/2016) and by cetacean researchers (dedicated observations - 2011/2016). The citizen scientists recorded 178 sightings of eight cetacean species along the whole Rio de Janeiro coast. Boat surveys (N = 118) were conducted by the authors in two Marine Protected Areas (MPA) and adjacent waters, resulting in a total of 77 records of four cetaceans species. Within the same area surveyed, citizen scientists contributed 98 reports of these four species. There was a high degree of information overlap, although the citizen scientists also expanded the database on the occurrence and distribution of cetaceans. The citizen scientists also confirmed the occurrence in the study area of four additional cetacean species, not recorded during the surveys. Opportunistic observations obtained from citizen scientists are thus a fundamentally important complementary tool for this type of investigation. The distribution records of the two datasets were also broadly compatible, in particular for the inshore sightings and the seasonal distribution of three of the four principal species. Overall, then, the data provided by from citizen scientists off the coast of Rio de Janeiro were validated by the boat surveys, which focused specifically on the area of the MPAs and adjacencies. The information provided by the combined dataset provides important insights for the creation of a buffer zone, which provide an additional layer of protection for the region's marine biota.

1. Introduction

Citizen Science is a term that refers to the voluntary participation of non-scientific personnel in the collection and/or processing of data during a formal scientific project (Silvertown, 2009; Conrad and Hilchey, 2011; Wiggins and Crowston, 2011). Projects of this type may encompass a diversity of approaches, involving varying levels of participation from both project managers and participants, on scales ranging from local communities to large populations (Roy et al., 2012). In addition to basic data, Citizen Science projects may contribute to policy-making, education, community capacity-building, and site and species management (Kapos et al., 2009). Worldwide, there has been increasing recognition of the importance of Citizen Science as a tool for the monitoring of biodiversity, especially in the context of budgetary restrictions, the paucity of specialists, and the lack of other institutional resources (Silvertown, 2009; Conrad and Hilchey, 2011). As Citizen Science continues to grow, collaboration among existing and future partnerships will be essential to its success as way to connect scientific research to public outreach and education while providing additional resources to professional surveys to conservation projects (e.g., Bonney et al., 2009; Lepczyk et al., 2009; Constantino et al., 2012).

While marine and coastal Citizen Science programs are still relatively rare in comparison with terrestrial initiatives, they are still increasing in number (Roy et al., 2012), and have contributed an additional capacity for the monitoring of biodiversity on broad temporal and spatial scales (Miller-Rushing et al., 2012; Ward et al., 2015). Citizen Science projects have contributed to a wide range of coastal and marine studies, including the monitoring of reef systems (Pattengill-Semmens and Semmens, 2003), beach habitats (Osborn et al., 2005), invasive crab species (Delaney et al., 2008), and sea turtle populations (Williams et al., 2015), as well as population studies of harbour porpoise, *Phocoena phocoena* (Camphuysen, 2011), whale-shark, *Rhincodon*

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typus (Davies et al., 2013), and humpback whale, *Megaptera novaeangliae*, and common bottlenose dolphin, *Tursiops truncatus* (Tonachella et al., 2012; Embling et al., 2015), a study of whale calls (Shamir et al., 2014), and a whale recovery program (Frans and Augé, 2016). In developing countries, such as Brazil, where resources for conservation are typically scarce, Citizen Science plays an important role in the monitoring of biodiversity. A comparative analysis of cases of biodiversity and natural resource monitoring systems with local communities participation in Brazil and Namibia allowed for a greater understanding of the relationships between resource monitoring systems, local empowerment, and conservation (Constantino et al., 2012).

Several studies have examined data quality in Citizen Science programs by determining predictors of participant success (for example see reviews of Danielsen et al., 2005; Dickinson et al., 2010; Aceves-Bueno et al., 2017). Harvey et al. (2002) using simultaneous measurements from an underwater stereo-video system the accuracy and precision of length estimates of reef fish and found volunteer data to be more variable than professionally collected data. Oldekop et al. (2011) report that volunteers' performance was comparable to scientists testing the accuracy of non-researchers in biodiversity monitoring exercises using fern species richness in the Ecuadorian Amazon.

There are a range of citizen science monitoring approaches depending on the contribution of the scientists and that of the public volunteer. In marine megafauna, such as cetaceans, accurate taxonomic identification can requires a long time of specialized training and remains a barrier of data quality among diverse data collectors. In our study, citizens were not recruited and trained in workshops to obtain data on sightings and check their ability to provide datasets of quality as part of validation mechanism in a project carried out in a social networking free service.

Given their behavioral plasticity, longevity, and vast home ranges, cetacean research presents a number of challenges, especially considering the time and resources needed for the collection of data. This restricts the ability of research groups to monitor the occurrence of cetaceans continuously, resulting in major gaps in the data.

The charismatic appeal of cetaceans facilitates the involvement of local people in conservation projects through Citizen Science programs. The longevity of cetaceans, and the size of their home ranges also contribute to their potential as flagship species for marine conservation and the management of MPAs.

In this context, we evaluated the contribution of Citizen Science to the collection of data on the occurrence and distribution of cetaceans off the coast of Rio de Janeiro by comparing the data collected by cetacean researchers (*i.e.*, the authors) with those provided by citizen scientists. We also hoped to contribute to the Brazilian National Action Plan for the conservation of cetaceans by providing reliable data on distribution patterns and helping to define priorities and critical conservation areas (ICMBio, 2011a, b).

2. Methods

2.1. Study area

The city of Rio de Janeiro, located on the eastern coast of Brazil, is one of most densely populated cities in Latin America with approximately 6,500,000 inhabitants (IBGE, 2016). On April 13, 2010, the Cagarras Archipelago Natural Monument (MoNaCa), a category III (Day et al., 2012) Marine Protected Area (MPA), was created by Brazilian Federal Law number 12,229. The whole of the Cagarras Archipelago - the Cagarras, Palmas, Comprida and Redonda islands, and the Filhote da Cagarras and Filhote da Redonda islets – are all included in the MoNaCa. As the archipelago is 5 km off the coast of Rio de Janeiro, it is vulnerable to pollution from sources such as the Ipanema submarine sewage outfall, and the waters of Guanabara Bay (Weerelt et al., 2013). The marine biodiversity of the MoNaCa is also affected by the intense local traffic of small and medium-sized vessels, and presence of cargo ships moored offshore. The Itaipu Marine Extractive Reserve (RESEX Itaipu) is a category V (Day et al., 2012) Marine Protected Area, was established on September 30, 2013 by Rio de Janeiro state law number 44,417. The reserve was created to protect the rights of local fisherman, and to prevent overfishing. Previous studies (e.g., Lodi and Monteiro-Neto, 2012; Lodi et al., 2014; Lodi & R. Tardin, unpublished data) have recorded the occurrence of cetaceans in both MPAs.

We focused on two study zones. Zone #1 corresponds to the coastline between Sono Beach in Paraty (23°21′23.81″ S, 44°38′53.59″ W) and Macaé (22°24′12.78″ S, 41°42′45.22″ W) (see Fig. 1), while zone #2 corresponds to the area surveyed by boat by the authors (see Fig. 2), between Tijucas and Maricás islands, focusing primarily on the waters around the MoNaCa and the RESEX Itaipu. authors (see Fig. 2).

2.2. Data collection

We recorded data on the occurrence and distribution of cetaceans off the coast of Rio de Janeiro from the two sources, that is, the records obtained opportunistically by the Citizen Scientists, and the data from the boat surveys.

2.2.1. Citizen scientists

For the Citizen Science data, we obtained records of the occurrence of cetaceans from the Facebook page “Onde estão as baleias e os golfinhos?” – Where are the whales and the dolphins? (https://www.facebook.com/groups/baleiasgolfinhos.rj), which was created by the authors in 2013. This Citizen Science group is composed of 4941 members (between October 9, 2013, and September 17, 2016). These individuals vary considerably in their ages, educational background, and in their knowledge and experience of cetaceans.

Facebook was chosen as a platform for the inclusion of data of the volunteers (citizens scientists), for being social media and virtual social network of broad and easy access and free. The group was widely spread in different categories of other groups and fan pagens of Facebook with themes linked directly or indirectly to the sea (e.g. universities, nautical sports, marine protected areas, fishing, tourism, among others). Over time, the members themselves began to disclose the group and request the inclusion of other members.

Most of the members of the group were residents of Rio de Janeiro state or visitors from other Brazilian states involved in the tourism or diving industries. These volunteers recorded the occurrence of cetaceans by posting photographs or video footage on the group's Facebook page. The information posted for each sighting included the geographical coordinates or location of the sighting, group size, the presence of calves, and details of the animals' behavior. When the geographical coordinates were unavailable, we contacted the informant to obtain information on the location of the sighting. Approximately 94% of the records were obtained from boats or during nautical sports and other recreational activities.

The records were filtered to guarantee reliability. For species identification, we selected only the photographs and video footage in which the diagnostic features of the taxon (i.e., body size and shape, coloration pattern) were clearly visible.

As the citizen scientists had a wide range of occupations, we classified them in three principal classes: (1) occupations related to the sea, nautical sports, and tourism (e.g., sailor, scuba diver, fisher, etc.), (2) Natural Sciences (e.g., biologist, oceanographer, geologist, etc.), and (3) Social sciences (e.g., writer, businessperson, teacher, etc.).

2.2.2. Boat surveys

We conducted boat surveys between August and December, in 2011 and 2012, throughout the year in 2014 and 2015, and between January and September 2016. The boat used was a 10 m diesel trawler, and surveys were conducted only when favorable climatic conditions prevailed (no more than Beaufort scale 2). The surveys were conducted