Biological Conservation 211 (2017) 76–84

Contents lists available at ScienceDirect

Biological Conservation

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

# Using globally threatened pelagic birds to identify priority sites for marine conservation in the South Atlantic Ocean

Maria P. Dias[a,*], Steffen Oppel[b], Alexander L. Bond[c], Ana P.B. Carneiro[a], Richard J. Cuthbert[c], Jacob González-Solís[d], Ross M. Wanless[e,h], Trevor Glass[f], Ben Lascelles[a], Cleo Small[b], Richard A. Phillips[g], Peter G. Ryan[h]

[a] BirdLife International, Cambridge, UK
[b] RSPB Centre for Conservation Science, Cambridge, UK
[c] RSPB Centre for Conservation Science, Sandy, UK
[d] University of Barcelona, Barcelona, Spain
[e] BirdLife South Africa, Cape Town, South Africa
[f] Tristan da Cunha Conservation Department, Edinburgh of the Seven Seas, Tristan da Cunha
[g] British Antarctic Survey, Natural Environment Research Council, Cambridge, UK
[h] Percy FitzPatrick Institute of African Ornithology, DST-NRF Centre of Excellence, University of Cape Town, Cape Town, South Africa

ARTICLE INFO

*Keywords:*
Important bird and biodiversity areas
Marine Protected Areas
Seabirds
Threatened species
Tristan da Cunha

ABSTRACT

The Convention on Biological Diversity aspires to designate 10% of the global oceans as Marine Protected Areas (MPAs), but so far, few MPAs protect pelagic species in the high seas. Transparent scientific approaches are needed to ensure that these encompass areas with high biodiversity value. Here we used the distribution of all globally threatened seabirds breeding in a centrally located archipelago (Tristan da Cunha) to provide guidance on where MPAs could be established in the South Atlantic Ocean. We combined year-round tracking data from six species, and used the systematic conservation-planning tool, 'Zonation', to delineate areas that would protect the largest proportion of each population. The areas used most intensively varied among species and seasons. Combining the sites used by all six species suggested that the most important areas of the South Atlantic are located south of South Africa, around the central South Atlantic between 30°S and 55°S, and near South America. We estimated that the longline fishing effort in these intensively used areas is around 11 million hooks on average each year, highlighting the need for improved monitoring of seabird bycatch rates and the enforcement of compliance with bird bycatch mitigation requirements by fisheries. There was no overlap between the identified areas and any of the existing MPAs in the South Atlantic. The conservation of these highly mobile, pelagic species cannot be achieved by single countries, but requires a multi-national approach at an ocean-basin scale, such as an agreement for the conservation of biodiversity beyond national jurisdiction under the United Nation Convention on the Law of the Sea.

## 1. Introduction

The designation of Marine Protected Areas (MPAs) is an important mechanism to conserve marine areas of biological importance (Game et al., 2009). In 2016, MPAs covered 5.6% of the global ocean surface (Boonzaier and Pauly, 2016; Juffe-Bignoli et al., 2014), which remains substantially less than the 10% envisioned by the Convention on Biological Diversity by 2020 (CBD, 2010). Most existing MPAs are in near-shore waters, and there are very few MPAs to protect the diverse pelagic ecosystems of the world (Game et al., 2009). Many of the world's most charismatic animals such as marine mammals, seabirds, turtles, sharks, and tuna inhabit pelagic ecosystems. Because these species often face a diverse range of pressures due to their extensive movements (Croxall et al., 2012; Tuck et al., 2003; Žydelis et al., 2009), many pelagic species are now highly threatened, and there is a critical need to identify and designate an effective global network of pelagic MPAs to protect these species and the food webs on which they depend.

The processes by which MPAs are identified, designated, and enforced are complex (Game et al., 2010; Hobday et al., 2014; Kaplan et al., 2010). The approaches differ enormously depending on whether MPAs are designated opportunistically, if their location is based on strict scientific criteria that aim to maximise biodiversity

* Corresponding author at: BirdLife International, David Attenborough Building, Pembroke Street, Cambridge CB3 3QZ, UK.
*E-mail address:* maria.dias@birdlife.org (M.P. Dias).

http://dx.doi.org/10.1016/j.biocon.2017.05.009
Received 6 December 2016; Received in revised form 28 April 2017; Accepted 9 May 2017
Available online 16 May 2017

benefits (BirdLife International, 2010; Jessen et al., 2011; Smith et al., 2014), or whether the social and economic costs are considered in the site selection process (Ban, 2009; Mazor et al., 2014). In addition, the complex ocean governance environment, particularly in the high seas, poses additional challenges to the designation of MPAs or the implementation of other area-based management tools in areas beyond national jurisdictions. Due to the commitment of many national governments to protect a certain proportion of the marine area within their jurisdiction, there is the risk that large MPAs are designated that fail to meet scientific principles of systematic conservation planning (Barr and Possingham, 2013; Devillers et al., 2014). To avoid the protection of large marine areas that are of comparatively low biodiversity value and do not adequately represent the full range of marine ecosystems, it is fundamental that identification of MPAs is based on transparent scientific approaches (Fernandes et al., 2005; Gleason et al., 2010; Klein et al., 2009).

Many species which depend on pelagic ecosystems can travel large distances (Block et al., 2011). However, long-term studies have revealed considerable site fidelity or consistent use of well-defined habitats for many species or populations, despite their mobility (Arthur et al., 2015; Dias et al., 2011; Wakefield et al., 2015). Sites and habitats used persistently by multiple species or populations would be suitable candidates for enhanced management or protection as an MPA (Lascelles et al., 2014). Understanding the spatial distribution of pelagic species is therefore crucial for the identification of sites with high biodiversity value; however, due to the logistical difficulties in sampling pelagic areas, our knowledge of site use by many marine animals is comparatively poor. The movements and distribution of large and charismatic mega-fauna, including marine mammals or seabirds, is much better understood than that of invertebrates and most fish (Chown et al., 1998; Mora et al., 2008; Tittensor et al., 2010). Moreover, seabirds can act as umbrella species and represent the spatial distribution of diverse organisms at lower trophic levels (Aslan et al., 2015; Williams et al., 2014). By considering seabirds as a surrogate group representing wider marine biodiversity, robust analyses of their spatial distribution should therefore avoid the designation of MPAs in areas of low biodiversity value.

The South Atlantic Ocean is a globally important ecosystem with a high diversity of seabirds, fish, and marine mammals (Trebilco et al., 2011; Williams et al., 2014), but has a relatively poor coverage of MPAs, despite demonstrated high biodiversity especially around the Falkland Islands (Juffe-Bignoli et al., 2014), and off the coast of South America (Ramos et al., 2016; Tancell et al., 2016; Yorio, 2009) and southern Africa (Ludynia et al., 2012). Given its global importance for pelagic biodiversity, delineating MPAs using objective criteria based on umbrella species would fill a critical gap in terms of conservation. Here we use a unique dataset covering the year-round distribution of all globally threatened seabirds breeding in a centrally located archipelago in the South Atlantic (Tristan da Cunha) to fill this critical data gap and provide guidance on where potential MPAs could be established in the region. The seabird community of Tristan da Cunha represents a variety of trophic levels and foraging guilds, and the spatial distributions of several of the larger species have been studied using various tracking devices (Cuthbert et al., 2005; Reid et al., 2014; Reid et al., 2013). We combined the tracking data from this pelagic guild to determine which areas are likely to be the most important for these and other pelagic species in the central South Atlantic Ocean.

Our main objectives were to quantify the use of distinct areas in the South Atlantic by six seabird species, and delineate areas that are used consistently by a large proportion of each population. We used international criteria and thresholds for Important Bird and Biodiversity Areas (IBAs) (BirdLife International, 2010; Lascelles et al., 2016) to systematically identify areas of particular conservation relevance. Such areas could contribute to the establishment of a network of pelagic MPAs in the South Atlantic Ocean, or the adoption of intensive measures to reduce the risk of bycatch in longline fishing operations, a major threat for the pelagic seabirds breeding at Tristan da Cunha and other South Atlantic islands (Bugoni et al., 2008; Cuthbert et al., 2005; Wanless et al., 2009). We therefore also examined the distribution of longline fishing effort in the South Atlantic, and quantified the effort in the areas of greatest importance for the tracked seabirds as a proxy for by-catch risk. Ours is one of the few studies published to date to assess the combined use of pelagic areas by a suite of marine top predators (Delord et al., 2014; Le Corre et al., 2012; Tancell et al., 2016), and the first to combine year-round data for all threatened seabirds breeding in a single island group.

## 2. Methods

### 2.1. Study area

The Tristan da Cunha archipelago consists of four major islands, separated by 20–400 km: Inaccessible (37°18′S, 12°39′W; 14 $km^2$), Nightingale (37°25′S, 12°29′W; 4 $km^2$), Gough (40°18′S, 9°57′W; 65 $km^2$) and Tristan da Cunha (37°07′S, 12°16′W; 96 $km^2$), the only island with a permanent human population. These four islands host colonies of 25 seabird species, of which six are globally threatened. Four of these species breed exclusively in the Tristan da Cunha archipelago (Tristan Albatross *Diomedea dabbenena*, Atlantic Yellow-nosed Albatross *Thalassarche chlororhynchos*, Spectacled Petrel *Procellaria conspicillata*, Atlantic Petrel *Pterodroma incerta*).

For the purpose of our spatial marine prioritization, we defined our study area in the South Atlantic Ocean from 12°S to 80°S, and from 65°W to 35°E.

### 2.2. Tracking data

We compiled the available tracking data for all six globally threatened seabird species (Critically Endangered—CR, Endangered—EN or Vulnerable—VU) that breed in the Tristan da Cunha archipelago: Tristan Albatross (CR), Sooty Albatross *Phoebetria fusca* (EN), Atlantic Yellow-nosed Albatross (EN), Spectacled Petrel (VU), Atlantic Petrel (EN), and Northern Rockhopper Penguin *Eudyptes moseleyi* (EN). Most species were tracked during their breeding and non-breeding seasons from their major colonies between 2000 and 2013 on Gough and Inaccessible islands; some of these data were used in previous studies focusing on individual species (Cuthbert et al., 2005; Reid et al., 2014; Reid et al., 2013). However, Northern Rockhopper Penguins were only tracked during the non-breeding season. Of all 380 tracks of adult birds, 231 were collected with satellite transmitters (Platform Terminal Transmitters, PTTs), and 149 with Global Location Sensor (GLS) devices, providing a total of 70,786 bird locations. Locations collected with PTTs were filtered using the R package "argosfilter" and then interpolated to obtain hourly positions. GLS data were processed following the procedures described in detail by Phillips et al. (2004).

### 2.3. Identification of marine important bird and biodiversity areas (IBAs) for each species and season

An Important Bird and Biodiversity Area (IBA) is defined as a site known to regularly hold significant numbers of a globally threatened species, or a site that supports > 1% of the global population of a congregatory seabird species (i.e., at least 20% of a colony with > 5% of the world population; Fishpool and Evants, 2001; Lascelles et al., 2016). Because all birds for our analysis were tracked from colonies holding a significant proportion of the world population (> 5%; Table 1), important foraging sites used by birds from these colonies would meet the criteria to be designated as global IBAs (Lascelles et al., 2016). We analysed each dataset following the procedures developed by BirdLife International to identify marine IBAs using seabird tracking data (BirdLife International, 2010; Lascelles et al., 2016). Many sea-