Status of pinnipeds on mid-Atlantic ridge islands, South Atlantic Ocean

M.N. Bester

Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Private Bag X20, Hatfield, Pretoria 0028, South Africa

Email: mnbester@zoology.up.ac.za

Orcid identifier: 0000-0002-2265-764X

Abstract

The status of pinnipeds on mid-Atlantic ridge islands is reviewed to detect trends that may relate to climate change. Small numbers of southern elephant seals *Mirounga leonina* breed on Gough Island (40°S, 10°W) and at Bouvetøya (54°24′S, 03°21′E) where numbers remained small over ~68 years. Vagrant southern elephant seals wandered farther north to tropical Saint Helena Island (15°57′S, 5°41′W) in historical times but have not been recorded there more recently. This suggests a contraction of their distributional range, as manifested in the decline in numbers to imminent extinction at Gough Island. At Gough Island and at Tristan da Cunha (37°05′S, 12°17′W) leopard seals *Hydrurga leptonyx* and Antarctic fur seals *Arctocephalus gazella* are occasional seasonal transients from Antarctic and sub-Antarctic islands and the circumpolar sea ice farther to the south. Large populations of Antarctic fur seals *A. gazella* and sub-Antarctic fur seals *A. tropicalis* breed at Bouvetøya and Gough Island respectively. The current state of both populations is uncertain as other populations of conspecifics in the South Atlantic and South Indian oceans, are in decline ostensibly contingent upon reduced food availability, likely precipitated by climate change.

Keywords: Leopard seal, Southern elephant seal, Fur seals, Saint Helena and Ascension islands, Tristan da Cunha Islands, Bouvetøya

Introduction

The Mid-Atlantic Ridge (MAR) is a mid-ocean ridge located along the floor of the South Atlantic Ocean, equidistant to Africa and South America. Portions of it extend above sea level to form islands in the South Atlantic (Fig. 1): Ascension Island (07°59′S, 14°25′W), Saint Helena Island (15°57′S, 5°41′W), Tristan da Cunha Islands (37°05′S, 12°17′W), Gough Island (40°20′S, 10°00′W) and Bouvetøya (54°24′S, 03°21′E). These islands are variously inhabited and/or visited by pinnipeds for which the population states are uncertain.

The Southern Ocean is undergoing substantial changes associated with anthropogenically driven climate change (Turner et al. 2014; Gutt et al. 2015). In the Southern Ocean, rapid climate change is expressed through various pathways, e.g. westerly wind stress is increasing and shifting poleward, sea-surface temperatures are increasing and sea-surface temperature isotherms, previously associated with oceanic fronts, are shifting towards the pole, and the sea ice extent is decreasing (Young et al. 2011; Bracegirdle et al. 2013; Meijers et al. 2019; Hindell et al. 2020). These substantial changes increasingly impact Southern Ocean predator species' numbers, distribution, diet, behaviour, and life-history (Forcada and Trathan 2009; Younger et al. 2016; Cristofari et al. 2018; Weimerskirch et al. 2018; Rodríguez et al. 2019; Ropert-Coudert et al. 2019; Bestley et al. 2020; Rogers et al. 2020; Strycker et al. 2021).

Sentinel species that indicate an ecosystem response to changing environmental conditions are often very wide-ranging and noticeable within an ecosystem, integrating environmental information and responding to environmental changes in a way that might be otherwise unmeasurable (Hazen et al. 2019). With the Southern Ocean ecosystems under pressure from resource exploitation and climate change (Chown and Brooks 2019), tracking the ranging behaviour of marine predators may provide information to assist with protection of such ecosystems (Hindell et al. 2020; Requena et al. 2020). It may also be useful for testing the projected outcomes of predicted environmental change on Antarctic seals (Siniff et al. 2008). Understanding temporal patterns of marine mammal occurrence is also important for establishing conservation strategies (Prado et al. 2016).

The responses to climate change by seals utilising islands of the South Atlantic MAR are unknown. Climate change is likely to have impacts at all trophic levels and in seabirds and marine mammals, most responses will be evident as changes in behaviour, phenotypic expression or in genotype (Trathan et al. 2007). These may result in, amongst others, changes in distribution (Forcada and Trathan 2009; Strycker et al. 2021), which at its simplest, may present as a pole-ward shift in ranges (Trathan et al. 2007; Péron et al. 2014; Cristofari et al. 2018). This study investigates the population states and possible range shifts of pinnipeds as sentinel species that breed and/or visit MAR islands in the South Atlantic Ocean that may relate to climate change.

Methods

Antarctic seal literature within the Mammal Research Institute (MRI) collection, as well as those sourced from the University of Pretoria's Merensky library were scrutinised. The library at the Port Elizabeth Museum at Bayworld, South Africa was a valuable source of research papers that are difficult to come by. A Google Scholar internet search was done using various key words, some of which are included in the listing after the abstract (above).

Results and Discussion

Arctocephalus gazella

The second largest breeding population of Antarctic fur seals occurs at Bouvetøya, where pup numbers increased (mean annual rate) by 30.6 % from 1989 to 1996 (estimated 15,523 births), perhaps due in part to significant immigration. This population has been stable over the period 1996 to 2001 (Hofmeyr et al. 2005), but another population of *A. gazella* in the South Atlantic, beyond the MAR at South Georgia (Fig. 1), has shown decline due to climate driven fluctuations in prey availability (Forcada and Hoffman 2014). Elsewhere on the southern MAR, Antarctic fur seals are occasional seasonal vagrants on the Tristan da Cunha Islands (Bester et al. 2014). Outside of the MAR they can range from the Antarctic continent to the Falkland Islands (Fig. 1) and South America (Forcada and Staniland 2018).

A. tropicalis

The largest population of sub-Antarctic fur seal occurs on Gough Island (some 63% of the world population - Hofmeyr et al. 2016a). Although the populations on the northern group of the Tristan da Cunha Islands (Tristan da Cunha, Inaccessible and Nightingale) have increased over the last 40 years (Bester et al. 2019), the status of the population at Gough Island (GI) is uncertain. The population has possibly recovered to pre-exploitation levels, approaching carrying capacity (Bester et al. 2006), numbering some 300,000 animals with an estimated 60,000 pups born around 2005/2006 (Bester and Ryan 2007). Recent counts of pups (in 2017) at a number of (but not all) beaches on the leeward eastern coast of GI showed marked increases over 40 years on some beaches, but negligibly on other largely open boulder beaches (Bester et al. 2019).

As central-place foragers, the foraging success of fur seal mothers determines the growth and vitality of their offspring. The negative trend in the weaning mass of pups at GI between 1993 and 2014 suggests a rise in limiting factors that is hypothesized to relate to population size increases (Oosthuizen et al. 2016). Given the low weaning mass of GI fur seal pups (Bester and Van Jaarsveld 1997; Oosthuizen et al. 2016), continued population growth there seems unlikely (Oosthuizen et al. 2016). At Marion Island in the South Indian Ocean, weaning mass of *A. tropicalis* pups has also been in decline, and although average mass at weaning there still remains above the physiological limits of growth (Oosthuizen et al. 2016), the population recently started to decline in numbers (Wege et al. 2016).

Vagrant sub-Antarctic fur seals appear at Bouvetøya (Hofmeyr et al. 2006), likely from the closest population at GI some 1,750 km to the northwest on the MAR. Genetic profiling of vagrant sub-Antarctic fur seals found on the Atlantic seaboard of Brazil suggested that the majority of the vagrant individuals came from GI (Ferreira et al. 2008), the closest breeding site to the Brazilian coast (Fig. 1). The only seal ever recorded at Ascension Island, an adult male sub-Antarctic fur seal in 2010, was located some 3,587 km to the north of GI, a likely source, on the MAR (Bester 2021). The nearest confirmed sighting to Ascension Island of another vagrant *A. tropicalis* was in Gabon at 03º41'S, 10º56'E (Zanre and Bester 2011), almost 2,844 km due east on the West African coast.

Mirounga leonina

The first record of southern elephant seals breeding at Bouvetøya was one adult male with six females, of which four had pups (Riiser-Larsen 1930 in Kirkman et al. 2001). A small breeding population still existed in 1998 based on the presence of weaned pups (Kirkman et al. 2001). Southern elephant seals were formerly abundant at Tristan da Cunha (Wace and Holdgate 1976), where it was thought that 1,000 pups were born in 1811, and 'as many more on the other two', i.e. Inaccessible and Nightingale islands, according to Jonathan Lambert (Holdgate 1958, page 19). The southern elephant seal populations of the Tristan da Cunha Islands (TdCI) were eventually decimated by sealing for oil extraction (Wace and Holdgate 1976). Only a small breeding population occurs at GI where 30 pups were born in 1973 (Shaughnessy 1975), which then slowly declined to 18 pups by 1998 (Bester et al. 2001) and became practically extinct by 2019 (Jones et al. 2020).

Much further north from Tristan da Cunha (2,430 km) at Saint Helena Island, a presumed female 'sealionesse' was found ashore (and killed) in 1656 (Temple and Anstey 1936). Variously called '*manati*, or *manatee*, sea-cow, or sea-lion' from which 'a considerable quantity of oil may be obtained', it 'sometimes visits the shores' (Barnes 1817). Barnes (1817) quotes a person, late of the island, that 'There is also here the manatee, commonly called the sea-cow, though it certainly is the sea-lion, mentioned by Lord Anson in his Voyage around the World' (Barnes 1817). The drawing and description by Peter Mundy of the 'sealionesse' (Temple and Anstey 1936) was of a southern elephant seal (Fraser 1935). Similarly 'sea-lyons' of Lord Anson (Anson 1748), sighted at the Juan Fernandez Islands off the west coast of Chile, turned out to be southern elephant seals, from a detailed description of their physical appearance and behaviour.

The claim that southern elephant seals historically bred on Saint Helena Island (SHI) (https://wiki2.org/en/Manatee_of_Helena), erroneously attributed to Alava and Carvajal (2005), has no substance. Neither is there evidence that historically SHI was largely populated by semi-aquatic manatees which often came onto land like seals (Retching 1936). The nearest point (northern Angola) on the tropical African coast where the aquatic, shallow water, mainly herbivorous West African manatee *Trichechus senegalensis* occur (Reeves et al. 2002), is approximately 2,200 km distant. SHI is therefore completely beyond the range of *T. senegalensis*.

Hydrurga leptonyx

Leopard seals breed in the Antarctic pack ice, where they were now and then observed during the cruises of the Norvegia (Sivertsen 1954). Scheffer (1958) claims that ‘specimens’ were collected on Bouvetøya during the Norvegia expedition in 1928-1929 (Scheffer 1958, page 122), while Holdgate et al. (1968) thought this to have been only one individual. Sivertsen (1954) clearly states that only one leopard seal was collected on 15 January 1929, but ‘near Bouvetøya’. Therefore, leopard seals have never been recorded ashore on Bouvetøya. None was recorded during six summer expeditions to Bouvetøya (December to February) in the period 1996/97 to 2017/18 (G. Hofmeyr and C. Oosthuizen, pers. comm.). Leopard seals might be expected to occur year-round there such as at Heard Island (Gwynn 1953) in similar latitudes (53°S, 73°30’E) in the Southern Indian Ocean. However, they may turn up as seasonal transients during winter and spring (April to October) as observed at Bird Island, South Georgia (Jessop et al. 2004). Unfortunately, the timing of the summer expeditions to Bouvetøya (see above) did not include the period of seasonal terrestrial haulout of leopard seals.

Further north on the MAR only two leopard seals were seen at GI, the first on an unreported date (Bester 1987) and the second in 2005 (Wilson et al. 2006). At Tristan da Cunha, a positively identified leopard seal, a rare visitor to Tristan, was killed on 5 September 1910. Only two earlier sightings were recorded by the islanders (Barrow 1910). In 1942, islanders mentioned ‘sea-leopards with spotted coats’ (Booy 1957). Elliott (1953) also mentioned unidentified large spotted seals of fierce disposition that were previously seen very occasionally by the Tristan islanders. He considered these to perhaps be leopard seals, or Weddell seals *(Leptonychotes weddellii).* Therefore, a number of confirmed records of leopard seals come from Tristan da Cunha, the most recent in 2016 (Bester et al. 2017) and 2019 (L. Ferreira, pers. comm.). Leopard seals at the TdCI are non-breeding vagrants as they breed towards the outer reaches of the circumpolar Antarctic pack ice in spring (Joiris 1991; Reeves et al. 2002). They largely remain within this outer region as the pack ice retreats during the austral spring and summer (Bester et al. 1995).

The TdCI sightings are the northernmost for leopard seals at the MAR islands. More northern records for the species in the eastern Atlantic Ocean comes from, for example, Hout Bay (34°01'S) South Africa (Best 1971; Vinding et al. 2013) and off Rio de Janeiro (21°40'S), Brazil (Rosas et al. 1992) in the western Atlantic Ocean. Elsewhere, the northernmost island sighting of a leopard seal was at ~21°14'S on Rarotonga, Cook Islands (Berry 1960), and another a little more south at 25°04'S latitude on Pitcairn Island (Stewart and Grove 2014) in the Pacific Ocean. Although it is therefore unsuprising that none has been recorded much further north (in the Atlantic Ocean) at SHI (15°57'S), it is not implausible as another true Antarctic phocid, the Weddell seal (*L. weddellii*) that breeds even further south on the fast ice of Antarctica, made the journey to tropical Trindade Island (Fig. 1) at 20°31′S, 29°19′W, Brazil, by July 9, 2015 (Frainer et al. 2017).

Conclusions

It is moot whether the lack of southern elephant seal sightings on SHI in recent times signifies a contraction of its distributional range. Extralimital sightings of marine predators may simply be due to navigational errors acting independently or in concert with other factors (Woehler 1992; Carpenter-Kling et al. 2017). However, the imminent extinction of the southern elephant seal population at GI (Jones et al. 2020) is in concert with a reduction in numbers at the northern extent of the range of other Southern Ocean marine predators (Péron et al. 2012; Prado et al. 2016; Cristofari et al. 2018). Such reductions in numbers of the marine predators are ostensibly precipitated by climate-driven foraging habitat and ecosystem changes (Learmonth et al. 2006; Crawford et al. 2014; Forcada and Hoffman 2014; de Bruyn et al. 2016; Cristofari et al. 2018; Weimerskirch et al. 2018).

The vast north-south distances between MAR islands and low frequency of seal stranding events (this study) make inferences based on extralimital sightings about range contractions of seals in the South Atlantic difficult. On the other hand, extralimital sightings of hundreds of seals of various species (Procksch et al. 2020) along the continuous, north-south orientated South American continental coastline (e.g. Oliveira et al. 2011; Prado et al. 2016, Procksch et al. 2020), suggested that the slight decrease in frequency of temperate/polar marine mammals and the increased occurrence of subtropical/tropical species on the Brazilian coast since the late 1990s might be associated with environmental changes linked to climate change (Prado et al. 2016). The Antarctic fur seal population in the South Atlantic Ocean at Bird Island, South Georgia (Forcada and Hoffman 2014) and the sub-Antarctic fur seal population in the South Indian Ocean at Marion Island (Wege et al. 2016) are declining, ostensibly contingent upon reduced food availability, precipitated by climate change (Hofmeyr et al. 2016a, b). The reduction in frequency of extralimital sightings of temperate/polar seals along the western seaboard of the South Atlantic Ocean, and the observed declines in Antarctic fur seals and sub-Antarctic fur seal numbers, begs an update of the state of the large populations of fur seals on the MAR at Bouvetøya and Gough Island.

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Compliance with ethical standards

Conflict of interest: I declare that I have no conflict of interest.

Ethical approval: Past field procedures on which this review is based were cleared by the University of Pretoria Animal Ethics Committee (Project Number EC077-15), executed under an Environmental Research Permit, including the Wildlife and Protected Areas Research Permit, of the Tristan da Cunha Government.

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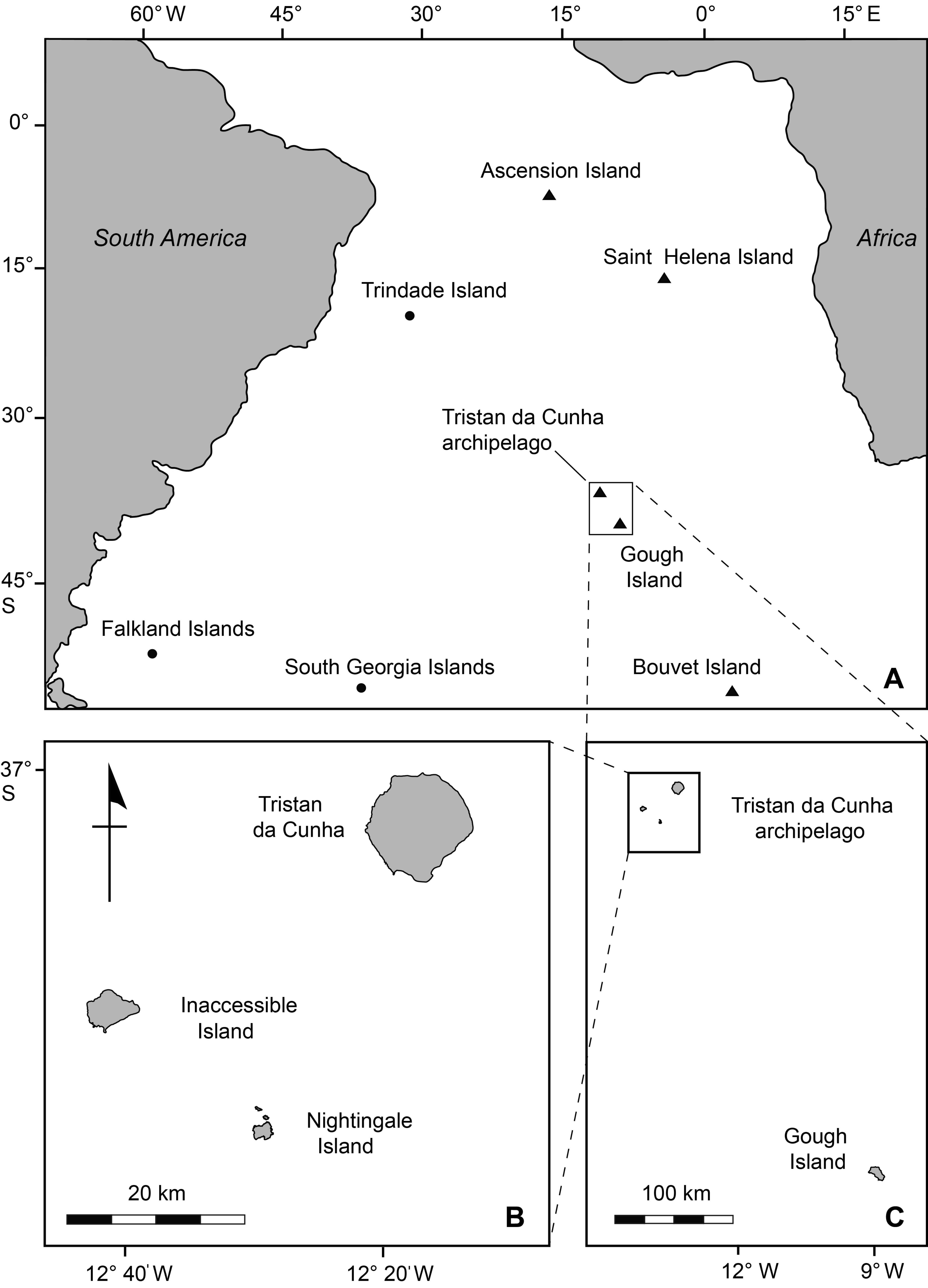
Fig. 1 Location of the islands in the South Atlantic Ocean which are mentioned in the text. Islands on the mid-Atlantic Ridge (MAR) are indicated with black triangles, and those outside of the MAR are indicated with black dots.


60° W
45°
30°
15°
0°
15° E
0°
15°
30°
45°
S
South America
Africa
Ascension Island
Saint Helena Island
Trindade Island
Tristan da Cunha
archipelago
Gough
Island
Falkland Islands
South Georgia Islands
Bouvet Island
A
37°
S
Tristan
da Cunha
Inaccessible
Island
Nightingale
Island
20 km
B
12° 40' W
12° 20' W
Tristan da Cunha
archipelago
Gough
Island
37°
S
40°
S
100 km
C
12° W
9° W