

Local extinction imminent for southern elephant seals *Mirounga leonina* at their northernmost breeding site, Gough Island – South Atlantic Ocean

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Abstract

The continued decline in the small breeding population of southern elephant seals *Mirounga leonina* at Gough Island (40°19'S, 9° 57'W) over a period of 46 years (1973 – 2019) signals the likely extirpation of the species at the northernmost extent of its breeding range in the Southern Ocean. The estimated number of births declined from a high (n = 38) in 1975 to a low (n = 2) in 2019, a 95% reduction at an average decrease of 2.15% per annum. The estimated mean time to extinction of this population from a linear regression model is 2 years (95% CI: 0 – 23 years). This decline is consistent with observed or forecasted population trends of some other marine top predators at the northern extent of their breeding ranges in the Southern Ocean; adding to the prevailing evidence that environmental change is the most plausible hypothesis explaining the range reduction of these marine species limited by a paucity of breeding grounds.

Keywords: pinniped, Tristan da Cunha, population decline, local extinction, range shift, climate change

Introduction

Southern elephant seals *Mirounga leonina* have a circumpolar distribution in the Southern Ocean with major breeding populations close to the Antarctic Polar Front (Laws 1994). The worldwide population of southern elephant seals, estimated at 650,000 in the mid-1990s, have no recent integrated estimate throughout its entire distribution (de Bruyn et al. 2016). Traditionally, three distinct provinces/populations were distinguished: South Georgia, Macquarie and Îles Kerguelen, with the Gough Island population thought to be affiliated with South Georgia (Laws 1994). These distinctions are unclear as the Península Valdés population on the mainland of South America and at the Falkland (Malvinas) Islands are now thought to be a province/population distinct from those at South Georgia. Additionally, some other colonies have unknown affiliations. Furthermore, the Gough Island population might be prone to gene flow from other provinces/populations (Reisinger and Bester 2010). Thus, there may be at least five and perhaps more, distinct breeding populations (de Bruyn et al. 2016).

The northernmost breeding locality for the species is Gough Island (40°19' S, 9°57' W), south Atlantic, which supported a small population at last count in 1998 (Bester et al. 2001). Previous studies at Gough Island (Bester 1980, 1990; Bester et al. 2001) provided some evidence for a decrease of the elephant seal population over the period 1955 to 1998 which was uncharacteristic for elephant seal populations in the Atlantic sector (Bester et al. 2001).

The objective of this study was to determine the present status of the southern elephant seal population at Gough Island where the small breeding population is vulnerable to any adverse factors (Bester 1990). Based on observed or forecasted population declines of several other top predators in the Southern Ocean at the northern extent of their breeding ranges (Weimerskirch et al. 2003) and on preliminary evidence of declines at Gough Island (Bester et al. 2001), we anticipate that this population of southern elephant seals is verging on local extinction.

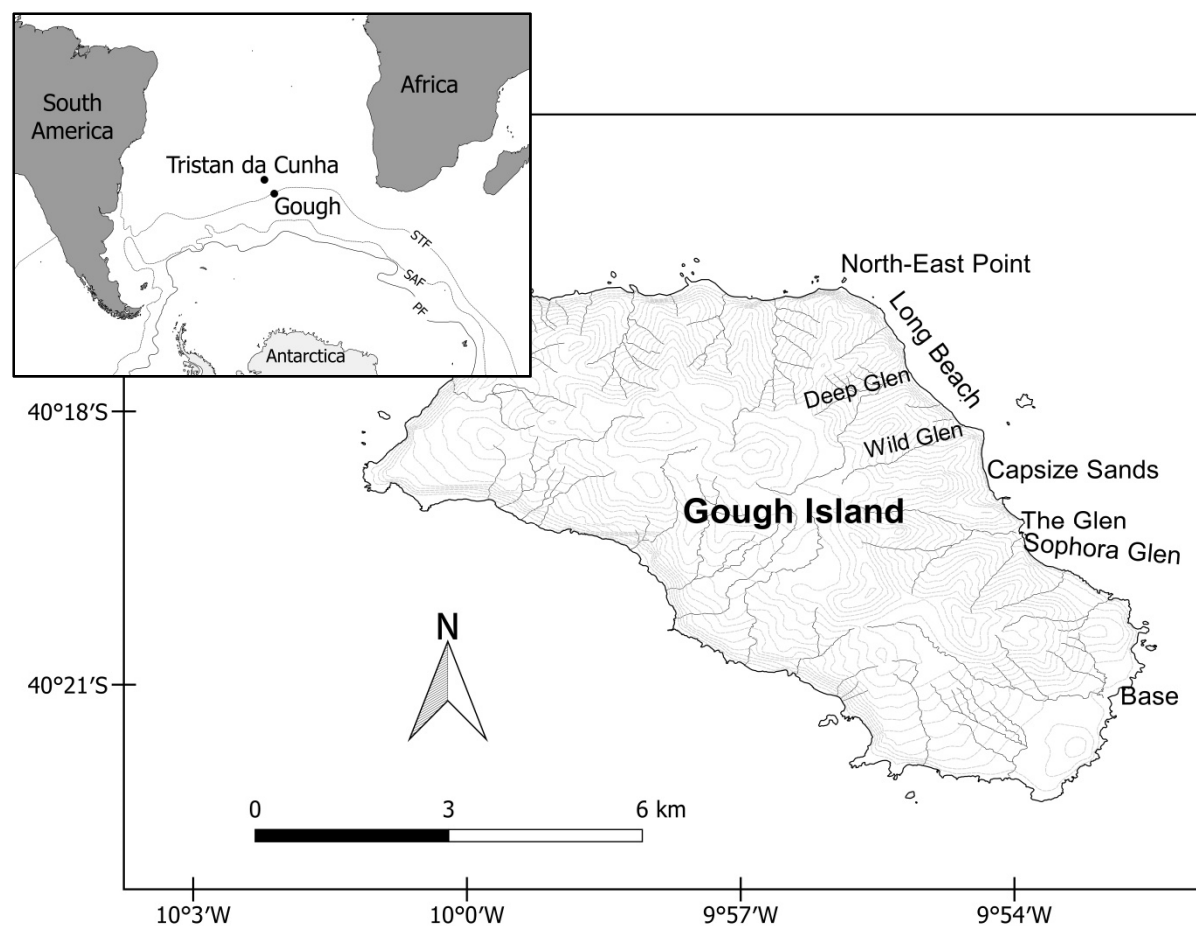


Fig. 1 Map of Gough Island with the southern elephant seal breeding sites mentioned in the text and the island's position in the South Atlantic Ocean (inset) in relation to the sub-Tropical Front, sub-Antarctic Front and Polar Front

Methods

Following methods of previous elephant seal surveys at Gough Island from 1973 to 1998, where two to three observers carried out counts on foot during all years, except 1998 when the beaches were observed from a boat close inshore (Bester et al. 2001), near the peak haul-out of breeding females and before the last weaned pups depart (early November, Shaughnessy 1975; Bester 1980). In 2019, two observers (CWJ and MMR) counted southern elephant seals during the austral spring breeding season along the north-east coast between Sophora Glen and North-East Point on Gough Island (Fig. 1), the only stretch of coastline where elephant seals are known to breed (Shaughnessy 1975; Bester 1980). Counts were done (a) from a power boat close inshore at Sophora Glen, and along Capsize Sands, and (b) on foot at The Glen and from Reef Point to

North-East Point (Fig. 1). The latter area includes Long Beach (between Wild Glen and Deep Glen) where the largest harem was found in all previous surveys (Bester 1990; Bester et al. 2001). The intention was to estimate the number of births following Bester (1980), by combining counts of adult females with pups, adult females without pups (assumed to be pregnant and still to pup), and weaned pups (their mothers absent), along with those of dead and abandoned pups. The survey was done on 11 October, marginally before the maximal haulout of breeding adult females (~13 October, Bester 1980) and well before the last adult females depart (early November - Shaughnessy 1975; Bester 1980).

Results and Discussion

Only one harem, an adult male with two adult females each attending their pup with black lanugo pelage (< 23 days old) (Fig. 2), was located at the southern end of Long Beach at Wild Glen (Fig. 1). A lone adult male and two large subadult males were also encountered along Long Beach. Elephant seals were absent from all other sites that were searched during the survey in 2019.



Fig. 2 The harem of two females found at Wild Glen, with one of the two young pups with black lanugo coat in the foreground while the other pup is out of frame. 11 October, Gough Island (photograph by Michelle Risi)

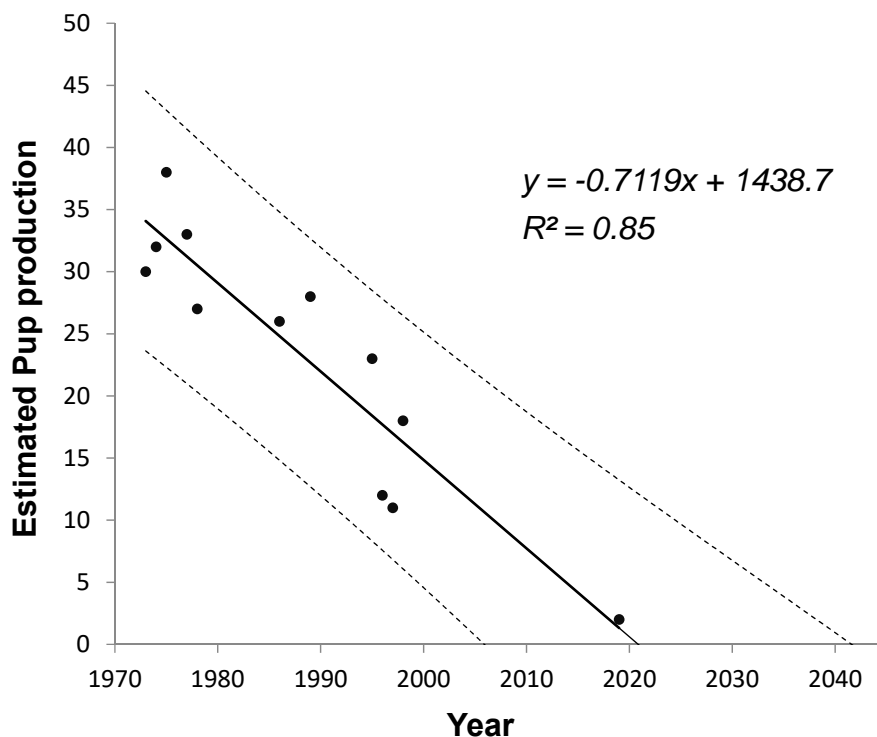


Fig. 3 Linear regression of the decline in southern elephant seal pup production between 1973 and 2019. Dashed lines represent 95% confidence intervals.

We use estimated pup production and not total numbers of females as an index of population change for southern elephant seals on Gough Island. From 1973 to 2019 pup production varied between 38 and 2 (Table 1), highest numbers being recorded in the 1970s (38 to 27), followed by lower numbers in the 1990s ($n = 23$ to 11), to the lowest ($n = 2$) recorded in 2019, showing a significant decline (Fig. 3, $F_{1,10} = 56.7$, $P < 0.001$, $R^2 = 0.85$). Given the low number of breeding female elephant seals hauled out ($n = 2$), just before the estimated haul-out peak (~13 October at Gough Island), and the parabolic nature of the haul-out of breeding female elephant seals (Le Boeuf and Laws 1994), it is unlikely that a significant number of additional pregnant females would have hauled out later in the 2019 season (this study). Similarly, any post-weaning dispersion of weaned pups (underyearlings) which could have resulted in an undercount, does not commence until early November (Bester 1980), and is therefore of no consequence here (Table 1).

Table 1 Counts of southern elephant seal adults and pups on the north-east coast of Gough Island during austral spring breeding seasons from 1973 - 2019. These are point estimates, not maximum population sizes as pup production was used as the index of population change. Total pups were determined by combining counts of adult females with pups, adult females without pups (assumed to be pregnant and still to pup), and weaned pups (their mothers absent), along with those of single pups which include dead and abandoned pups.

| Date | Adult Females | | | Single pups | Total pups | Source |
|------------------------|---------------|-----------|--------------|-------------|------------|--------------------|
| | Adult Males | with pups | without pups | | | |
| 08 November 1973 | 5 | 0 | 0 | 30 | 30 | Shaughnessy 1975 |
| 16 October 1974 | 13 | 26 | 3 | 3 | 32 | Bester 1980 |
| 29 October 1975 | 16 | 12 | 3 | 23 | 38 | Bester 1980 |
| 26 October 1977 | 16 | 12 | 1 | 20 | 33 | Bester 1980 |
| 31 October 1978 | 12 | 9 | 0 | 18 | 27 | Bester 1980 |
| 22 October 1986 | 9 | 10 | 10 | 6 | 26 | Bester 1990 |
| 17 October 1989 | 11 | 16 | 7 | 5 | 28 | Bester 1990 |
| 17 October 1995 | 8 | 16 | 7 | 0 | 23 | Bester et al. 2001 |
| 19 October 1996 | 6 | 10 | 2 | 0 | 12 | Bester et al. 2001 |
| 23 October 1997 | 9 | 10 | 1 | 0 | 11 | Bester et al. 2001 |
| 24 October 1998 | 11 | 7 | 5 | 6 | 18 | Bester et al. 2001 |
| 11 October 2019 | 2 | 2 | 0 | 0 | 2 | This study |

Tristan da Cunha (37°S, 12°W), 380 km north-east of Gough Island and north of the sub-Tropical Convergence (STF), supported a large breeding population before the seal exploitation period of the 19th century, with approximately 1000 pups born in 1810 (Wace and Holdgate 1976), however only sporadic births were recorded there from 1973 to 1998 (Wace and Holdgate 1976; Bester et al. 2001). Similarly, in recent decades only single births have been recorded at Amsterdam Island (37°S, 77°E), north of the STF in the South Indian Ocean (Laws 1994). Likewise, before the 19th century elephant seals bred north of the STF in the Macquarie province, now only infrequent pupping occurs on the New Zealand mainland, and a 97% reduction in the breeding population at Campbell island (52°35S, 169°E), south of the STF but north of the sub-Antarctic Front (SAF), occurred from 1947 to 1986 (Taylor & Taylor 1989). Thus it is apparent that southern elephant seal populations north of the STF in more temperate waters are functionally extinct, and are critically scarce in the sub-Antarctic region north of the SAF (Baker et al. 2010; this study), with the only large concentrations now found at breeding sites near the Antarctic Polar Front (APF) (Learmonth et al. 2006).

The series of census counts reported here, suggests that the Gough Island population has drastically declined (Bester 2001; this study) to an unsustainable level, with a 95% reduction at an average decrease of 2.15% per annum since 1975. The current population of southern elephant seals at Gough Island, located just to the south of the STF in colder waters, is also likely to become extinct as at the former breeding colony islands north of the STF. The estimated mean time to extinction of this population from the linear regression model is 2 years (95% CI: 0 – 23 years, Fig. 3). Reasons for the decline in elephant seal numbers at Gough Island and elsewhere in the Southern Ocean remain obscure, although it is thought to be most likely a result of foraging habitat and ecosystem changes mediated by shifts in oceanic temperatures and circulation patterns (see Weimerskirch et al. 2003; Learmonth et al. 2006; de Bruyn et al. 2016). This is consistent with observed or forecasted declines in abundance of some other populations of marine top predators in the Southern Ocean at the northern extent of their breeding ranges (e.g. Gentoo Penguins *Pygoscelis papua* Crawford et al. 2014; Light-mantled Albatross *Phoebastria palpebrata* Schoombie et al. 2015; King Penguin *Aptenodytes patagonicus* Cristofari et al. 2018; *A. patagonicus* Weimerskirch et al. 2018). Such declines are likely related to foraging zones being shifted further from the breeding colony and the energetic costs associated with longer foraging trips of these ocean living predators that are limited to a paucity of breeding islands in the Southern Ocean.

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Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflict of interests.

Ethical approval: Field procedures were approved by the Animal Ethics Committee of the University of Pretoria.

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