

# POPULATION FLUCTUATION OF *Pygoscelis papua* AND *Pygoscelis antarctica*, ELEPHANT ISLAND, SOUTH SHETLANDS, ANTARCTICA

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**Abstract:** Reproductive population size of both the Gentoo penguin (*Pygoscelis papua*) and Chinstrap penguin (*Pygoscelis antarctica*) has changed over the last decades in many sites in the South Shetlands Islands. We evaluated the population sizes of these species on Stinker Point, Elephant Island, South Shetlands, Antarctic, during the breeding season 2009, 2010 and 2011, and we compared with preterit studies. Over the last 40 years, the number of breeding pairs here have shown fluctuations, with changes of up to 32%. It is possible that these fluctuations are related to the variation in prey availability and/or climate change. However, additional census and demographic surveys in Elephant Island are clearly needed to determine whether the decline represents a long-term trend or random circumstantial fluctuations.

**Keywords:** Gentoo penguin, Chinstrap penguin, breeding pairs, abundance

## Introduction

Penguins comprise 90% of the total Antarctic avian biomass (Croxall *et al.*, 2002). Only King penguin (*Aptenodytes patagonicus*), Macaroni penguin (*Eudyptes chrysolophus*), Rockhopper penguin (*E. chrysocome*), Adelie penguin (*Pygoscelis adeliae*), Gentoo penguin (*P. papua*) and Chinstrap penguin (*P. antarctica*) breed on ice-free areas of the Antarctic Peninsula coast and sub-Antarctic Islands (Woehler, 1993). Of the five penguin species occurring on Elephant Island the Gentoo and Chinstrap penguin are the most abundant. The Gentoo penguin is circumpolar in breeding and the largest colonies are found in the Falklands, South Georgia and Kerguelen Islands. Smaller populations can be found in Macquarie Island, Heard Island, McDonald Islands, South Shetland Islands and Antarctic Peninsula (Peterson, 1979). The Gentoo penguin is the least abundant of the Antarctic breeding penguin species, with 314.000-520.000 breeding pairs, and has suffered a major decline over the last two decades (BirdLife, 2009). Chinstrap penguin populations, ≈7.4 million breeding pairs, are found breeding mainly in sub-Antarctic Islands

and along the Antarctic Peninsula (Woehler, 1993). The number of breeding pairs has shown fluctuations in the last 50 years, due to climate changes, Antarctic krill (*Euphausia superba*) availability, variation in total area of ice-free sites suitable for breeding and increase in tourism and fishing activities (Conroy *et al.*, 1975; Jablònski, 1984; Woehler & Croxall, 1997; Croxall *et al.*, 2002; Hinke *et al.*, 2007; Trivelpiece *et al.*, 2011).

On Elephant Island, South Shetlands, Gentoo and Chinstrap penguins co-exist and breed in large colonies near each other (Petry, 1994). We compare the breeding population size over the last 40 years of Gentoo and Chinstrap penguins on Stinker Point, Elephant Island, and we calculated the population growth rates during this period.

## Materials and Methods

Three observers conducted a direct counting of nests of Gentoo and Chinstrap penguins, to estimate the numbers of breeding pairs on Stinker Point (61° 07' 31" S; 55° 19' 26" W),

Elephant Island, South Shetlands Archipelago. The total population was determined for each site by averaging all total counts that differed less than 10% according to the standard CCAMLR (The Commission for the Conservation of Antarctic Marine Living Resources) Ecosystem Monitoring Program Methods (CCAMLR, 2004).

Average annual growth rate was calculated using the Yáñez Index,  $i$  (Yáñez *et al.*, 1984), following:  $i = [(BPpr/BPps)^{1/n} - 1] \times 100$ ,  $BPpr$  stands for the number of breeding pairs at present,  $BPps$  stands for the number of breeding pairs in former surveys and  $n$  stands for the years that passed by. The average population growth rate was calculated and compared with data collected in 2009, 2010 and 2011, data from past studies such 1970 (Furse & Bruce, 1972) and 1985, 1986, 1987, 1988, 1990, 1991 (Petry, 1994).

## Results

In the last 40 years the numbers of breeding pairs of Gentoo and Chinstrap penguins have shown fluctuations, with changes of up to 32%. We recorded 915 breeding pairs of Gentoo penguin in 2009, 905 pairs in 2010, and 1652 in 2011 an increase of 82.5% (Table 1). The average annual growth for Gentoo penguin was positive between 1970-1987 and 1987-1988, unlike between the years of 1988-1991 and 1991-2010, when breeding pairs declined in number (Table 1). For the Chinstrap penguin, we recorded 3974 breeding pairs in 2009, 5250 pairs in 2010, and 5279 in 2011 with increase 32.1% and 0.55% (Table 2). Between 1970-1985, the population size remained stable (increase 0.28% per year), unlike between 1986-2010 when fluctuations showed considerable increase and decline (Table 2).

## Discussion

Comparing our data with studies from Furse & Bruce (1972) and Petry (1994), we can see changes in population size of Gentoo and Chinstrap penguins, at Stinker Point, Elephant Island. Such changes are indicative of environment quality in which a population depends on variable food resources and it is also important to understand and to predict the effects of environmental change (Croxall *et al.*, 2002). For long-living birds such as penguins, a 2 to 3% annual change in population size can be quite significant, and the only way to evaluate this parameter is through monitoring studies (Trivelpiece & Trivelpiece 1990).

Several factors may regulate bird reproductive success, one of them is the availability of nesting sites (Ainley & Boekelheide, 1990). Despite the increase in ice-free areas in the South Shetland Islands, and consequently the exposure of new places suitable for breeding sites over the years (Jablonski, 1984), local climate events such as excessive accumulation of snow and snowstorms limit the nesting sites of penguins, as observed in our study in December 2009, when many breeding pairs of both species lost their eggs and abandoned their nests. Food availability, predation and climate change also influence the population fluctuation of the penguins, and specific behaviors of each species may help compensate for or moderate effects of changing environmental conditions (Miller *et al.*, 2010; Trivelpiece *et al.*, 2011). Our results show that population fluctuation for the Elephant Island Gentoo penguins varies less than for its Chinstrap penguins. Even though the two species co-exist, they exhibit very different behaviors in respect to reproduction timing, feeding ecology and

**Table 1.** Average annual growth rate ( $i$ ) of Gentoo penguin population at Stinker Point, Elephant Island 1970-2011.

| Period    | Breeding pairs | $i$ (%) |
|-----------|----------------|---------|
| 1970-1987 | 1000-1879      | 3.8     |
| 1987-1988 | 1879-2192      | 16.7    |
| 1988-1991 | 2192-1929      | -4.2    |
| 1991-2009 | 1929-915       | -4.1    |
| 2009-2010 | 915-905        | -1.1    |
| 2010-2011 | 905-1652       | 82.5    |

**Table 2.** Average annual growth rate ( $i$ ) of Chinstrap penguin population at Stinker Point, Elephant Island 1970-2011.

| Period    | Breeding pairs | $i$ (%) |
|-----------|----------------|---------|
| 1970-1985 | 12455-13000    | 0.28    |
| 1985-1986 | 13000-12200    | -6.15   |
| 1986-1987 | 12200-11969    | -1.89   |
| 1987-1988 | 11969-13383    | 11.81   |
| 1988-1990 | 13383-12218    | -4.45   |
| 1990-2009 | 12218-3974     | -6      |
| 2009-2010 | 3974-5250      | 32.1    |
| 2010-2011 | 5250-5279      | 0.55    |

winter habitat selection (Trivelpiece *et al.*, 1987). There is evidence that Gentoo penguins remain in the vicinity of breeding areas during the winter (Bost & Jouventin, 1990), unlike local Chinstrap penguins which move nearer to the Antarctic convergence (Williams, 1995; Wilson, 1998; Trivelpiece *et al.*, 2007). Under adverse conditions during winter, such as low prey availability and excessively ice conditions, only old, experienced Chinstrap penguins return to breeding colonies at the beginning of the breeding season (Trivelpiece & Trivelpiece 1990). Thus, the survival of juveniles, their recruitment and return rates to colonies may be affected by adverse winter conditions, as suggested by Carlini *et al.* (2009).

Our results corroborate the evidence of penguin population decline reported in Antarctica. Trivelpiece *et al.* (2011) suggested conservation status review for Chinstrap penguin given the magnitude of their global population decline and limitations of distribution range. In contrast, Gentoo penguins are circumpolar in distribution and are more generalist feeders, giving them a distinct survival advantage (Bost & Jouventin, 1990).

## Conclusion

Yet, we conclude that, at Stinker Point, Elephant Island, continued monitoring and demographics studies are

needed for both penguin species to determine with confidence whether the observed population decline is a long-term trend or represents transient local environmental fluctuations and whether changes in conservation efforts will be required to maintain future global and regional populations of these species.

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