Abundance and breeding distribution of seabirds in the northern part of the Danco Coast, Antarctic Peninsula

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Abstract
Seabird abundances and breeding distribution have the potential to serve as ecological indicators. The western Antarctic Peninsula is one of the three sites in the world with the greatest increases in local temperature during the last 50 years. The aim of this study was to monitor the distribution and abundance of breeding populations of seabirds in the northern sector of the Danco Coast, north-west of the Antarctic Peninsula, during the breeding season 2010/11. The birds were the Wilson’s storm petrel (Oceanites oceanicus), South Polar skua (Stercorarius maccormicki), kelp gull (Larus dominicanus), Antarctic tern (Sterna vittata), snowy sheathbill (Chionis alba), chinstrap penguin (Pygoscelis antarctica), southern giant petrel (Macronectes giganteus), gentoo penguin (Pygoscelis papua), Cape petrel (Daption capense) and Antarctic shag (Phalacrocorax bransfieldensis). Annual breeding population growth increased in pygoscelids, southern giant petrel and sheathbill, and for the remaining species, breeding population trends were stable. Given that seabird populations can provide valuable information on the conditions of their feeding and nesting environments, this study highlights the need to maintain basics monitoring studies.

Studies of seabird populations can provide valuable indicators on the conditions of their feeding and nesting environments in relation to global-scale processes (Croxall et al. 1988). Climatic and oceanographic variability and change have been shown to affect seabirds, often with profound consequences, like reduced breeding success and altered breeding cycles for some species (Chambers et al. 2011). Three regions in the world are recognized as having warmed more rapidly during the last 50 years (Vaughan et al. 2003). Located in the Southern Hemisphere, one of these three regions includes the region west of the Antarctic Peninsula (Smith et al. 1999; Vaughan et al. 2001; Gille 2002; Cook et al. 2005). The populations of various species of penguins in this region have shown responses to increases in air temperature, retreat of the glaciers and decreases in the frequency of cold years in association with a decrease of sea ice in winter and its negative effects on the abundance of krill (Siegel & Loeb 1995; Loeb et al. 1997; Fraser & Hofmann 2003). In this context, long-term surveys are essentials to document population trends.

The present study evaluated the breeding population size and distribution of marine birds in the northern sector of the Danco Coast, Antarctic Peninsula, including the Antarctic Specially Protected Area (ASPA) No. 134.

Study area and methods
The study was conducted in the northern sector of the Danco Coast during the 2010/11 breeding season, which lasts from 24 December 2010 until 20 February 2011. Several sites were surveyed between Cape Herschell and...
Spring Point (Fig. 1). The sampling area covered the Mar Rock, Cierva Point, Moss Island, Midas Island and Sterneck Islands, all lying within ASPA No. 134. Counts of apparently occupied nests of penguins were made by eye from the single highest point of each selected area (exposed rocky patches), with contiguous areas covering each colony in its entirety. Counts of apparently occupied nest of flying birds were made by eye and by using 40 × binoculars. We obtained the number of apparently occupied nests in each area based on the mean of the three counts (Table 1). Counts of Wilson’s storm petrels (Oceanites oceanicus) were also made but were not considered due to their high inaccuracy. The presence of two possible nests of brown skua (Stercorarius lomnbergi) was noted in Cierva Point, but for this study we considered all these birds as South Polar skuas (Stercorarius maccormicki). Changes in breeding population sizes were compared with those obtained in 1997/98 (Favero et al. 2000) for the same sampling localities. The annual breeding population growth rate was calculated as $\lambda = (N_{s2}/N_{s1})^{1/T}$, where $N$ represents the breeding population size and $s$ the season ($s1$: 1997/98 and $s2$: 2010/11) and $T$ is the number of seasons between the two surveys ($T = 13$). Lambda ($\lambda$) indicates if the population increases ($\lambda > 1$), decreases ($\lambda < 1$) or remains stable ($\lambda = 1$) through time (Caswell 1989).

Results

The survey registered the presence of a total of 11 species of seabirds, 10 of them breeding in the study area. We recorded the presence of snow petrel (Pagodroma nivea) on two visits to Moss Island. Although no nests were found, we suspect that this highly cryptic species breeds on the island. The species seen to be breeding were, from most common to least common: Wilson’s storm petrel, South Polar skua, kelp gull (Larus dominicanus), Antarctic tern (Sterna vittata), snowy sheathbill (Chionis alba), chinstrap penguin (Pygoscelis antarctica), southern giant petrel (Macronectes giganteus), gentoo penguin (Pygoscelis papua), Cape petrel (Daption capense) and Antarctic shag (Phalacrocorax bransfieldensis). Sterneck Island was the site with the highest number of breeding species (nine species), followed by Py and Alcock and Midas islands (eight species) and then by Moss Islands and Cierva Point (seven species). No other site exceeded six species of seabirds present.

In pygoscelids, gentoo penguin breeding colonies showed increases in all localities analysed (Table 2). The breeding colonies of chinstrap penguin showed increases and decreases, but the overall trend for the study area was an increase (Table 3). In flying birds the annual population growth rates showed increases in southern giant petrel and sheathbill and decreases in Cape petrel and kelp gull. For the remaining flying birds, breeding population trends were stable (Table 4).

![Fig. 1 Map of the study area showing the different localities sampled and the Primavera Base (marked with an open circle) and the Antarctic Specially Protected Area (ASPA) No. 134 (light grey), including the marine areas between the islands and the mainland.](image-url)
Discussion

Spots censuses can give misleading impressions of the actual status of populations (Croxall et al. 1988). However, in order to understand ecological drivers for the population trends observed in seabirds, it is still necessary to have a regional vision of the status of the populations, and for that purpose, even opportunistic visits to colonies provide valuable information (Lynch et al. 2008). Species richness among the sites studied ranged between two and nine, with the Wilson’s storm petrel present in all localities. In general, the breeding populations of pygoscelids, southern giant petrels and snowy sheathbills increased, whereas those of Cape petrels and kelp gulls decreased. These increases and decreases could be attributed to the variability of the environment and/or different counting techniques used in other decades in association with different meteorological conditions. For this reason, arbitrarily and applying a more conservative approach, we only discuss here those species for which annual population growth rate ($\lambda$) was below 0.97 or above 1.03.

Population trends of pygoscelids penguins in the Antarctic Peninsula and associated islands have been studied by numerous authors (Woehler & Croxall 1997; Hinke et al. 2007; Sander, Balbão, Costa et al. 2007; Sander, Balbão, Polito et al. 2007; Carlini et al. 2009; Trivelpiece et al. 2011; Lynch, Ron et al. 2012; Lynch, William et al. 2012; among many others). The contrasting trends between species are of particular interest because as top predators, they integrate and/or magnify changes in the lower levels of the food chain. Thus, penguins, who have different affinities to sea ice, provided some of the first evidence linking changes in the physical environment to their biological responses (Fraser et al. 1992; Rombolá et al. 2003; Forcada et al. 2006; Trathan et al. 2007; Nicol et al. 2008; Forcada & Trathan 2009). Ice reduction will adversely impact the winter over survival of krill larvae and the reproductive output of female krill and as consequence diminish krill recruitment (Flores et al. 2012), which in turn impacts krill availability to top predators. Furthermore, sea-ice loss impacts directly on the wintering habitats of sea-ice dependent species like Adélie penguins (Pygoscelis adeliae), and favours an increase in ice-intolerant gentoo and chinstrap penguins (Mc Clintock et al. 2008). Climate warming also brings more years with more

### Table 2
Number of breeding pairs per location for gentoo penguin in the northern sector of Danco Coast. Parentheses indicate the year the count was conducted. Lambda ($\lambda$) represents the annual breeding population growth rate, $N$ represent the breeding population size and $s$ the season ($s_1$: 1997/98 and $s_2$: 2010/11).

| Locality          | Novatti [1978] | Poncet & Poncet [1987] | Quintana et al. [1998] | Favero et al. [2000] ($Ns_1$) | This study ($Ns_2$) | $\lambda$ |
|-------------------|----------------|-------------------------|------------------------|-------------------------------|---------------------|----------|
| Cierva Point      | 559–614 (1954-58) | 600 (1984)              | 800–1041 (1991–96)     | 593 (1998)                     | 2680                | 1.12     |
| Sterneck Island   | 450 (1987)      |                         |                        |                               |                     |          |
| Py Point          | 130 (1987)a     |                         |                        | 390 (1998)*                    | 140                 |          |
| Charles Point     |                 |                         |                        |                               |                     |          |
| Total             |                 |                         |                        | 1888                          | 6270                | 1.10     |

aLocalties grouped.

### Table 3
Number of breeding pairs by location for chinstrap penguin in the northern sector of Danco Coast. Parentheses indicate the year the count was conducted. Lambda ($\lambda$) represents the annual breeding population growth rate, $N$ represent the breeding population size and $s$ the season ($s_1$: 1997/98 and $s_2$: 2010/11).

| Locality         | Muller-Schwarze [1975] | Poncet & Poncet [1987] | Woehler [1993] | Favero et al. [2000] ($Ns_1$) | This study ($Ns_2$) | $\lambda$ |
|------------------|-------------------------|-------------------------|----------------|-------------------------------|---------------------|----------|
| Cape Herschel    |                         |                         | 316 (1998)     | 650                           | 1.06                |          |
| Kay Rock         |                         |                         | 21 (1998)      |                               | 0.00                |          |
| Mar Rock         | 200 (1971)              | 500 (1984)              | 1553 (1998)    | 2763                          | 1.05                |          |
| Midas Island     | 1100 (1987)             | 200 (1987)              | 546 (1998)     | 180b                          | 0.92                |          |
| Sterneck Island  |                         |                         | 152b (1998)    | 33                             | 0.89                |          |
| Py Point         | 10 (1987)a              |                         | 13 (1998)b     | 10                             | 0.98                |          |
| Charles Point    |                         |                         | 157 (1987)     | 0                              | 0.98                |          |
| Alcock Island    | 7710 (1971)             | 10000 (1971)            | 3000 (1990)    | 605 (1998)                     | 1100                | 1.05     |
| Spring Point     | 85 (1984)               | 60 (1990)               | 605 (1998)     |                               | 0                   |          |
| Spathly Island   |                         |                         | 180 (1998)b    | 110                            | 0.96                |          |
| TOTAL            | 9770                    | 11895                   | 3060           | 3386                          | 4846                | 1.03     |

bPossible underestimation.
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Number of breeding pairs per location for the species Antarctic shag (AS; Phalacrocorax bransfieldensis), southern giant petrel (SGP; Macronectes giganteus), Cape petrel (CP; Daption capense), snowy sheathbill (SS; Chionis alba), South Polar skua (SPS; Stercorarius maccormicki), kelp gull (KG; Larus dominicanus) and Antarctic tern (AT; Sterna vittata), in the northern sector of the Danco Coast. Lambda (\(\lambda\)) represents the annual breeding population growth rate, \(N\) represent the breeding population size and \(s\) the season (s1: 1997/98 and s2: 2010/11).

| Locality          | AS     | SGP    | CP     | SS     | SPS    | KG     | AT     |
|-------------------|--------|--------|--------|--------|--------|--------|--------|
|                   | Ns1   | Ns2   | \(\lambda\) | Ns1   | Ns2   | \(\lambda\) | Ns1   | Ns2   | \(\lambda\) | Ns1   | Ns2   | \(\lambda\) | Ns1   | Ns2   | \(\lambda\) |
| Cape Herschel     | 28    | 24    | 0.99   | 0      | 0     | 0      | 2      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      |
| Cierva Point      | 0     | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      |
| Kay Rock          | 0     | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      |
| Mars Rock         | 0     | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      |
| Moss Islands      | 0     | 0     | 0      | 0      | 0     | 1      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      |
| Midas Islands     | 21    | 21    | 1      | 0      | 71    | 1.01  | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      |
| Sancia Point      | 0     | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      |
| Sterneck Island   | 0     | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      |
| Py Point          | 28    | 34    | 1.03   | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      |
| Charles Point     | 0     | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      |
| Alcock Island     | 2     | 0     | 0      | 0      | 31    | 1.17  | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      |
| Spring Point      | 0     | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      |
| Sprightly Island  | 0     | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      | 0      | 0     | 0      |
| Total             | 92    | 79    | 0.99   | 92     | 161   | 1.04  | 68     | 42    | 0.96   | 16     | 27    | 1.04  | 242   | 335   | 1.02  | 608   | 437   | 0.97  | 195   | 248   | 1.02  |

*aSpring Point and Sprightly Island were grouped in Ns1.

*bPossible underestimation.

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highly probable that the increases in abundance of snowy shearwaters recorded in the present study are related to breeding population growth observed in pygoscelids. In contrast, the possible causes that could explain the decrease in the breeding populations of cape petrels and kelp gulls remain unknown.

The study area has a high species richness, both animal and vegetable (Dirección Nacional del Antártico 2002). In turn, the highest abundance of birds, primarily pygoscelids, was within ASPA No. 134. The singular topography, along with the abundance and diversity of species, provides favorable conditions for the formation of numerous microhabitats, providing an exceptional scientific value to the area (Dirección Nacional del Antártico 2002). The present study highlights the need to maintain basics monitoring studies.

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