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First census of breeding seabirds between Cap Bienvenue (Terre Adélie) and Moyes Islands (King George V Land), Antarctica: new records for Antarctic seabird populations

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Abstract Breeding population sizes of penguins, fulmarine petrels and skuas were estimated for the first time on a major part of the Terre Adélie coast and a section of the King George V Land coast during the 1997/1998 austral summer. We counted 106,400 breeding pairs and 12,400 Adélie penguin (*Pygoscelis adeliae*) chicks by direct counts, and 6960 breeding pairs from aerial photographs. Minimum breeding populations for other species are (direct counts): Antarctic fulmar (*Fulmarus glacialis*) 6861 pairs, Antarctic petrel (*Thalassoica antarctica*) 4574 pairs, cape petrel (*Daption capense*) 194 pairs, snow petrel (*Pagodroma nivea*) 767 pairs, south polar skua (*Catharacta macconnicki*) 129 pairs and subantarctic skua (*Catharacta lonnbergi*) 1 breeding bird. We discovered 29 new seabird breeding locations in King George V Land, including 6 Antarctic fulmar, 4 Antarctic petrel, 3 cape petrel, 6 snow petrel and 10 south polar skua colonies. The largest colonies found contained up to 4205 breeding pairs of Antarctic fulmars. Population sizes of all species obtained in this study are higher than those found during previous partial surveys. Although these differences are in great part due to differences in survey methods, they also reflect real population changes. Our minimum population sizes obtained for a small portion of the Antarctic coast (< 2%) suggest an underestimation of the estimated world breeding populations for several species of Antarctic seabirds.

Introduction

To ensure the conservation of, and monitor changes in Antarctic ecosystems, adequate information on the distribution and abundance of animal populations is

needed. Consequently, the Scientific Committee for Antarctic Research (SCAR) encourages integration of all available data on the distribution and abundance of Antarctic seabirds. However, it is only recently that several reviews provided a synopsis of the current knowledge of the breeding distributions and numbers of Antarctic seabirds (Woehler and Johnstone 1991; Woehler 1993; Croxall et al. in press; Woehler and Croxall 1996; Hodum et al., in press; Patterson et al., in press; van Franeker et al., in press). These reviews reveal a considerable lack of accurate census data for most species, and suggest the probable existence of undiscovered breeding sites. It is important to remedy these deficiencies in order to have reliable baseline data against which to assess possible future population change and the potential influence of human activities. This paper documents and updates breeding locations and numbers of several Antarctic seabird species along the Terre Adélie coast and a portion of the King George V Land coast. Only two sites have been recently and accurately surveyed along this coast: the Pointe Géologie archipelago where nearly all seabird species have been regularly monitored since 1952 (Jouventin et al. 1984), and the Cape Denison area where a relatively accurate census of breeding species was made in 1982 (Ensor and Bassett 1987). Although several expeditions have visited this portion of the Antarctic coast (Mawson 1915; Falla 1937; Cendron 1953; Sapin-Jaloustre 1960; Isenmann et al. 1969), estimates of seabird breeding populations remain inaccurate due to lack of rigorous censuses.

Materials and methods

We surveyed a major part of the Terre Adélie coast and a small part of the King George V Land coast, Antarctica from Cap Bienvenue (66°43'S, 140°31'E) to Moyes Islands (67°S, 143°56'E) from 14 to 28 December 1997 and from 15 to 20 January 1998 to census breeding seabirds (Fig. 1). Landings and aerial photographs were made using a "Lama" helicopter based on a supply ship.

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Official place names and their latitudinal and longitudinal positions have been taken from original reports when available. When no official names were available, latitudinal and longitudinal positions of localities were determined using a GPS Global Positioning System (Appendix 1).

Counts were made for each breeding species. For Adélie penguin (*Pygoscelis adeliae*) counts of breeding adults and chicks were made from Cap Bienvenue to Cape Hunter. No counts were made between Cape Denison and Moyes Islands because of the limited time available, except at Garnet Point and Cape Pigeon Rocks. At most sites, direct counts of birds incubating their eggs (14–28 December) or counts of chicks (15–20 January) were made. Large colonies (> 100 pairs) were divided into 100-pairs sectors using natural features and the total number of sectors in the colony was summed up to derive a total colony estimate. In smaller colonies (< 100 pairs) pairs were individually counted. Some colonies situated on islets were counted by aerial photographs. To minimise disturbance from the helicopter, and to get accurate counts, we flew at 200 m above colonies to take photographs. Photographs were taken with a 38 mm lens using a numeric Kodak DC 120 camera.

For fulmarine petrels (Antarctic fulmar *Fulmarus glacialisoides*, Antarctic petrel *Thalassoica antarctica*, cape petrel *Daption capense*, snow petrel *Pagodroma nivea*) counts were made from Cap Bienvenue to Moyes Islands. Direct counts of incubating or brooding birds were made on each breeding colony. We used binoculars to count Antarctic petrel colonies situated on small islets near Cape Hunter. At the time counts were made, Antarctic fulmars, cape petrels, snow petrels and Antarctic petrels were incubating, and some Antarctic petrels had just hatched their chicks. We could not evaluate losses of eggs or chicks that occurred before counting and, thus, population sizes reported here are minimum estimates.

For Wilson's storm petrel (*Oceanites oceanicus*) no count was attempted due to the difficulty of finding nest sites under rocks, and the restricted amount of time available at each location. However, we found several occupied nests, and at each locality visited we indicated whether the species bred there or not.

For south polar skua (*Catharacta maccormicki*) and subantarctic skua (*Catharacta lonnbergi*) direct counts of breeding birds (with eggs or chicks) were made at each visited site from Cap Bienvenue to Moyes Islands, except at Cape Denison and nearby islands.

Counts accuracy for each species was estimated following Woehler (1993). With the counting methods used for Adélie penguins counts accuracy was estimated at ± 5 to 10%. As pairs of fulmarine petrels and south polar skuas were essentially individually counted, counts were probably accurate to $\pm 5\%$. As previous counts were essentially rough estimates, these counts were possibly accurate to ± 25 to 50%.

Results

Eight species of seabird were found breeding between Cap Bienvenue and Moyes Islands. The numbers of breeding pairs for each species and for each locality are summarised in Tables 1 and 2. We also included the estimates made during previous surveys. Twenty-nine new breeding localities were discovered during the survey on the King George V Land coast (Table 2): six were for Antarctic fulmars, four for Antarctic petrels, three for cape petrels, six for snow petrels and ten for south polar skuas. Three inland nunataks (Mount Aurora, Mount Murchison and Madigan Nunatak), ranging from 25 to 70 km inland, were also visited, but no breeding species were found at any of these sites.

At Cape Denison we searched for nests of Antarctic prions (*Pachyptila desolata*) but we found no evidence of nesting. We found one subantarctic skua (*Catharacta*

Fig. 1 Map of the Antarctic coast between Pointe Géologie and Mertz Glacier indicating the main locations surveyed from December 1997 to January 1998

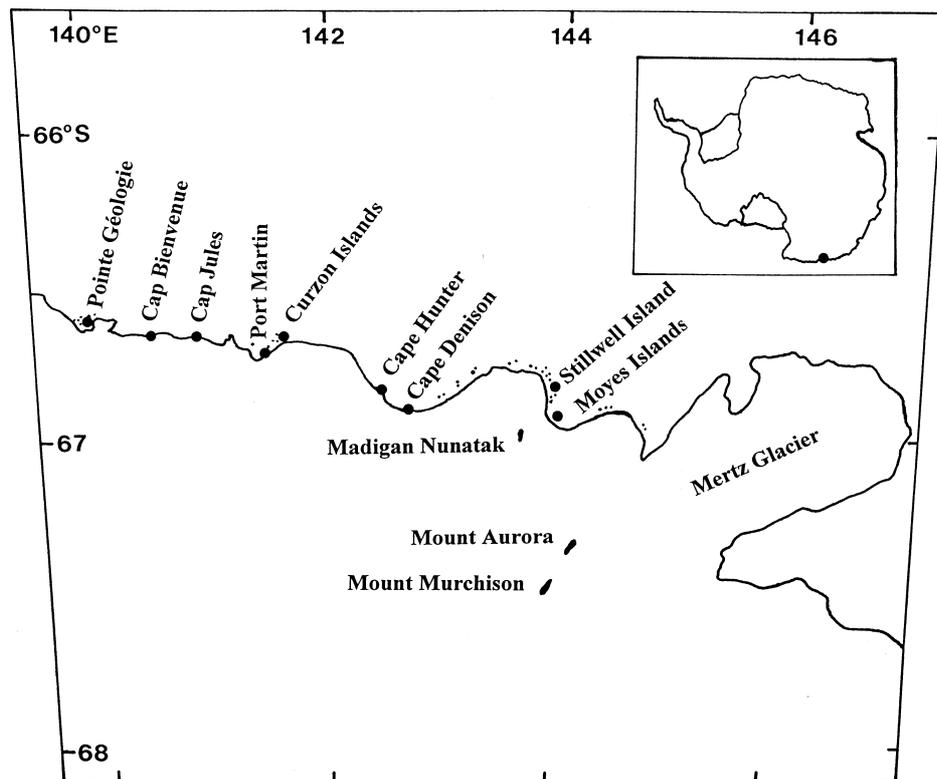


Table 1 Minimum population sizes (breeding pairs) of Adélie penguins for each visited locality between Cap Bienvenue and Moyes Islands in 1997/1998 and previous counts. See Materials and methods for information on the accuracy of the counts

| Locality | Adélie penguin | | | Previous counts | Reference |
|-------------------|------------------------|---------------------------|----------------|-----------------|--------------------------|
| | Pairs counted directly | Pairs counted from photos | Chicks counted | | |
| Cap Bienvenue | 15,023 | | | 6,000–10,000 | Thomas (1986) |
| Cap Jules | 41,559 | 1,700 | | 5,000–15,000 | Thomas (1986) |
| Port Martin | 20,171 | | | 8,000–16,000 | Thomas (1986) |
| Nunatak Lacroix | | | 1,810 | | |
| Pointe Cézembre | | 580 | | | |
| Mirages Island | | 3,518 | | | |
| Conchée Island | | 924 | | | |
| Laplace Island | | 240 | | | |
| Curzon Islands | 12,641 | | | | |
| Cape Hunter | 15,997 | | | Medium colony | Isenmann et al. (1969) |
| Stillwell Island | § | § | § | | |
| Cape Pigeon Rocks | | | 9,000 | 705 | Ensor and Bassett (1987) |
| “Island A” | 0 | 0 | 0 | | |
| “Island B” | § | § | § | | |
| “Island C” | § | § | § | | |
| “Island D” | § | § | § | | |
| Garnet Point | | | 1,600 | 680 | Ensor and Bassett (1987) |
| Moyes Islands | § | § | § | | |
| Total | 105,391 | 6,962 | 12,410 | 20,385–42,385 | |

§ not counted

lonnbergi) breeding with a south polar skua at Port Martin. Capdeville et al. (1995) recorded one breeding pair of chinstrap penguin (*Pygoscelis antarctica*) at Port Martin in 1991, but we did not find further evidence of nesting during our survey.

To estimate the accuracy of counts made with aerial photographs we performed both counting methods (direct and aerial photograph) on five Adélie penguin colonies ranging from ca. 50 to ca. 3000 pairs. On average, the number of breeding pairs counted by aerial photographs was $6.8 \pm 1.5\%$ lower than the number of pairs counted directly. This difference between counts probably reflects the presence of non-breeding birds attending the colony. However, due to the small sample size, the numbers of breeding pairs of Adélie penguins presented in Table 1 are uncorrected.

Discussion

Two main conclusions can be drawn from the results of this survey. First, population sizes for all species are higher than those reported during previous surveys. These differences may be due to one or both of two factors: (1) real population changes, and (2) differences in survey methods.

Studies have shown that Adélie penguin, Antarctic fulmar and south polar skua populations have been increasing for several decades in East Antarctica (Conroy 1975; Jouventin et al. 1984; Thomas 1986; Woehler 1993;

Barbraud and Baker, in press). For example, the Adélie penguin population at Pointe Géologie increased by 43% between 1984 and 1998 (T. Micol and P. Jouventin, unpublished data). It is thus likely that the increase in numbers between our survey and previous surveys partly reflects a real population change for those species.

However, there are also differences in survey methods. Most previous surveys were either conducted at a distance from vessels (Ensor and Bassett 1987) or were too brief to allow for thorough and accurate counts (Isenmann et al. 1969). Thus, previous estimates probably largely underestimated population sizes. Using the highest values from Thomas (1986) concerning breeding pairs of Adélie penguins at Cap Bienvenue, Cap Jules and Port Martin, and our values, one can calculate an increase of 94% with our census. Assuming that the population change was identical to the one found in the neighbouring locality (Pointe Géologie), then counts made by Thomas (1986) underestimated, by 51% at least, the breeding population of Adélie penguins at these localities. It is difficult to make such an estimation for fulmarine species as few numbers are available from previous counts. However, with considerable differences between old and new counts, the contribution of differences in survey methods is probably much higher than for Adélie penguins as fulmarine species are difficult to count at distance from vessels, and their count requires more time than for Adélie penguins.

All birds had already begun the breeding season when the survey was made, and thus the counts reported here are minimum values, as they do not include failed

Table 2 Minimum population sizes (breeding pairs) of fulmarine petrels and south polar skuas by visited locality between Cap Bienvenue and Moyes Islands in 1997/1998 and previous counts.

Localities where Wilson's storm petrels were observed breeding are also indicated. See Materials and methods for information on the accuracy of the counts

| Locality | ^a Antarctic fulmar | ^b Antarctic petrel | ^c Cape petrel | ^d Snow petrel | ^e South polar skua | Wilson's storm petrel | Previous counts | Reference |
|-------------------|-------------------------------|-------------------------------|--------------------------|--------------------------|-------------------------------|-----------------------|---|--------------------------|
| Cap Bienvenue | 0 | 0 | 0 | 20 | 4 | Breed | ^d few, ^e 2–5 | Thomas (1986) |
| Cap Jules | 0 | 0 | 2 | 93 | 46 | Breed | ^c few, ^d few, ^e 10 | Thomas (1986) |
| Port Martin | 0 | 0 | 0 | 0 | 6 | Breed | ^e 10 | Thomas (1986) |
| Nunatak Lacroix | 0 | 0 | 0 | 0 | 1* | ? | | |
| Pointe Cézembre | 0 | 0 | 0 | 0 | ? | ? | | |
| Mirages Island | 0 | 0 | 0 | 0 | ? | ? | | |
| Conchée Island | 0 | 0 | 0 | 0 | ? | ? | | |
| Laplace Island | 0 | 0 | 0 | 0 | ? | ? | | |
| Curzon Islands | 0 | 0 | 0 | 0 | 8* | Breed | | |
| Cape Hunter | 0 | 3,807 | 0 | 53 | 6* | Breed | ^b 1,000 | Isenmann et al. (1969) |
| Stillwell Island | 2,155 | 0 | 2 | 10 | 5 | Breed | ^a 190, ^c 1, ^d 10, ^e 3 | Ensor and Bassett (1987) |
| Cape Pigeon Rocks | 501* | 0 | 106 | 97* | 8* | Breed | ^c large colony | Falla (1937) |
| “Island A” | 1,497* | 223* | 19* | 336* | 30* | Breed | | |
| “Island B” | 920* | 57* | 49* | 114* | 3* | ? | | |
| “Island C” | 708* | 345* | 0 | 54* | 2* | ? | ^e 95, ^e 3 | Ensor and Bassett (1987) |
| “Island D” | 1,015* | 142* | 0 | 21* | 8* | Breed | | |
| Four islets | 65* | 0 | 0 | 0 | ? | ? | | |
| Garnet Point | 0 | 0 | 0 | 0 | 1* | ? | | |
| Moyes Islands | 0 | 0 | 16* | 2* | 1* | Breed | | |
| Total | 6,861 | 4,574 | 194 | 767 | 129 | | | |

*New colony; ? status uncertain.

breeders. For Adélie penguins, one might assume that what was happening at Pointe Géologie was characteristic of what was happening throughout the surveyed area at the same time. One can then adjust the number of breeding pairs counted during the survey using the incubation success (the number of pairs that hatched their eggs divided by the number of pairs that laid eggs) and fledging success (the number of pairs that hatched their eggs divided by the number of chicks before departure) measured at Pointe Géologie on study colonies. Counts made during the first trip (14–28 December) were adjusted using the incubation success, while counts made during the second trip (15–20 January) were adjusted using fledging success (90.68% and 81.18%, respectively: T. Micol and P. Jouventin, unpublished data). We then estimated the minimum population size for visited localities between Cap Bienvenue and Moyes Islands during our survey to be 139,187 breeding pairs. If one includes the breeding population of Pointe Géologie in 1997/1998 (41,800 breeding pairs, T. Micol and P. Jouventin, unpublished data), we obtain a minimum population size of 180,987 breeding pairs between Pointe Géologie and Moyes Islands. This is about 7% of the estimated total world population of 2–2.61 million pairs (del Hoyo et al. 1992; Woehler 1993). Populations of Adélie penguins in the Australian Antarctic Territory (AAT) are increasing (Woehler and Croxall 1996) and account for 27% of the total population. As the area between Pointe Géologie and Moyes Islands represents a small proportion of the AAT coast (ca.3%), we suggest

that the breeding population of Adélie penguins is largely underestimated in this part of Antarctica.

The second important finding from this study is the discovery of previously undescribed colonies of small fulmarine petrels and south polar skuas. This confirms the suggestions made by several authors for Antarctic petrels (van Franeker et al., in press), cape petrels (Hodum et al., in press) and snow petrels (Croxall et al. in press) that unknown colonies have yet to be discovered. Although Ensor and Bassett (1987) found Antarctic fulmars, cape petrels and snow petrels breeding on some islands of the Way archipelago, they underestimated population sizes (Table 2). Similarly, the Antarctic petrel colony at Cape Hunter was found to be much larger than previously thought (Isenmann et al. 1969). Relatively large and previously unknown colonies of south polar skua were found at Cap Jules and “Island A” in the Way archipelago. These findings suggest that important colonies of south polar skua remain undiscovered and, consequently, suggest an underestimation of the world breeding population for this species (5000–8000 breeding pairs, del Hoyo et al. 1996).

This paper is the first attempt to monitor the breeding distribution and population sizes of seabirds on a major part of the Terre Adélie coast. Better information on the western part of this coast is now required. Surveys of poorly known parts of the King George V Land and Wilkes Land coasts (between Pointe Géologie and Casey) are also required for more accurate estimates of breeding population sizes of seabirds in this part of Antarctica.

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Appendix 1 Positions of all place names mentioned in the text

| Locality | Latitude | Longitude |
|-------------------|----------|-----------|
| Cap Bienvenue | 66°43'S | 140°31'E |
| Cape Denison | 67°00'S | 142°40'E |
| Cape Gray | 66°50'S | 143°33'E |
| Cape Hunter | 66°58'S | 142°20'E |
| Cap Jules | 66°44'S | 140°55'E |
| Cape Pigeon Rocks | 66°59'S | 143°47'E |
| Casey | 66°17'S | 110°32'E |
| Conchée Island | 66°47'S | 141°29'E |
| Curzon Islands | 66°46'S | 141°34'E |
| Four Islets | 66°56'S | 143°54'E |
| Garnet Point | 66°59'S | 144°16'E |
| "Island A" | 66°58'S | 143°57'E |
| "Island B" | 66°56'S | 143°57'E |
| "Island C" | 66°57'S | 143°55'E |
| "Island D" | 66°57'S | 143°54'E |
| Laplace Island | 66°47'S | 141°28'E |
| Mirages Island | 66°48'S | 141°27'E |
| Pointe Cézembre | 66°48'S | 141°26'E |
| Pointe Géologie | 66°39'S | 139°55'E |
| Port Martin | 66°49'S | 141°24'E |
| Madigan Nunatak | 67°10'S | 143°45'E |
| Mount Aurora | 67°30'S | 144°05'E |
| Mount Murchison | 67°26'S | 144°08'E |
| Moyes Islands | 67°00'S | 143°56'E |
| Nunatak Lacroix | 66°50'S | 141°20'E |
| Stillwell Island | 66°55'S | 143°55'E |
| Way archipelago | 66°50'S | 143°40'E |

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