

# Number and distribution of Adélie penguin (*Pygoscelis adeliae*) breeding sites in the Robinson Group of islands, Mac.Robertson Land coast, east Antarctica

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Received October 2006

**ABSTRACT.** In November 2005, the first comprehensive survey for Adélie penguin (*Pygoscelis adeliae*) breeding sites in the Robinson Group of islands, situated 25 to 55 km east of Australia's Mawson station (67.602°S, 62.879°E) was conducted. Breeding Adélie penguins were found on 30 of the 149 islands, with the number of nests on each island ranging from fewer than 10 to several thousand. With the exception of those islands in the southeast, nesting Adélie penguins were found throughout the Robinson Group. In this paper, the spatial coordinates and presence/absence of breeding penguins for all 149 islands are reported so that researchers may interpret the results in relation to possible future survey work. All locations reported in this paper are in decimal degrees.

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## Introduction

The Adélie penguin (*Pygoscelis adeliae*) is a widely distributed and abundant penguin species in the Antarctic (Woehler 1993), and as a consumer of krill and fish is an important component of the Antarctic marine ecosystem. There is considerable interest in the status and trends of Adélie penguin breeding populations because they are considered likely to reflect the influence of human-induced perturbations such as fishing (Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) 2003) and climate change (Croxall and others 2002, Weimerskirch and others 2003, Ainley and others in press) on the ecosystem.

Given the broad distribution of the species, and the remoteness and inaccessibility of much of its breeding habitat, it has not been possible to undertake a comprehensive, synoptic survey of the circumpolar distribution of breeding sites, nor, consequently, of abundance. Instead, knowledge of circumpolar distribution and abundance has been arrived at by collating the results of many separate, independent surveys undertaken over many years at smaller scales (Woehler 1993; Woehler and Croxall 1997; Ainley 2002). Woehler (1993), for example, derived a circumpolar abundance estimate of 2.5 million breeding Adélie penguin pairs from count data published in numerous reports in the primary and secondary literature prior to 1993, but noted that the estimate should be considered a minimum because there were likely to be many areas and sites for which no data existed.

The Mac.Robertson Land coast between longitudes 62–64°E has many hundreds of islands offering potential breeding habitat for Adélie penguins. Prior to this study the number of breeding sites known to exist along this section of coast was 21 (Horne 1983; Woehler and others 1989). However, only one of these 21 breeding sites occurs in the many scores of islands in the eastern half of this section of coast (that is between longitudes 63–64°E), collectively known as the Robinson Group of islands, hereinafter cited as the Robinson Group (Fig. 1). Horne (1983) gives a count of 434 chicks at Macey Island on 11 February 1972 by the Australian National Antarctic Research Expedition (ANARE). From inspection of published information and collations thereof it is difficult to determine whether the Robinson Group is largely unoccupied by breeding Adélie penguins, or whether it is largely unsurveyed: as the extent of search effort is sometimes not reported and findings of absences are rarely reported in the literature. However, the recent finding of a hand-drawn map of a portion of the Robinson Group by a member of the 1972/73 ANARE (K. Kerry unpublished data) indicated that the published record of breeding sites was definitely incomplete. This motivated the first comprehensive survey of breeding sites in the region, which is reported in this paper.

## Methods

During 21–26 November 2005, a 380 km<sup>2</sup> area off the Mac.Robertson Land coast, east Antarctica was surveyed for islands occupied by breeding Adélie penguins. This area, known as the Robinson Group, is a collection of approximately 150 islands lying between 25 and 55 km to the east of Australia's Mawson Station (67.602°S, 62.879°E). The survey encompassed the known extent of these islands from Child Rocks (67.427°S, 63.246°E) to an un-named island 5.2 km to the south-east of Austskjera (67.548°S, 64.106°E), and from the edge of the continent out to the Douglas Islands (67.380°S, 63.389°E) 15 km to the north. During the survey the party was based at a small

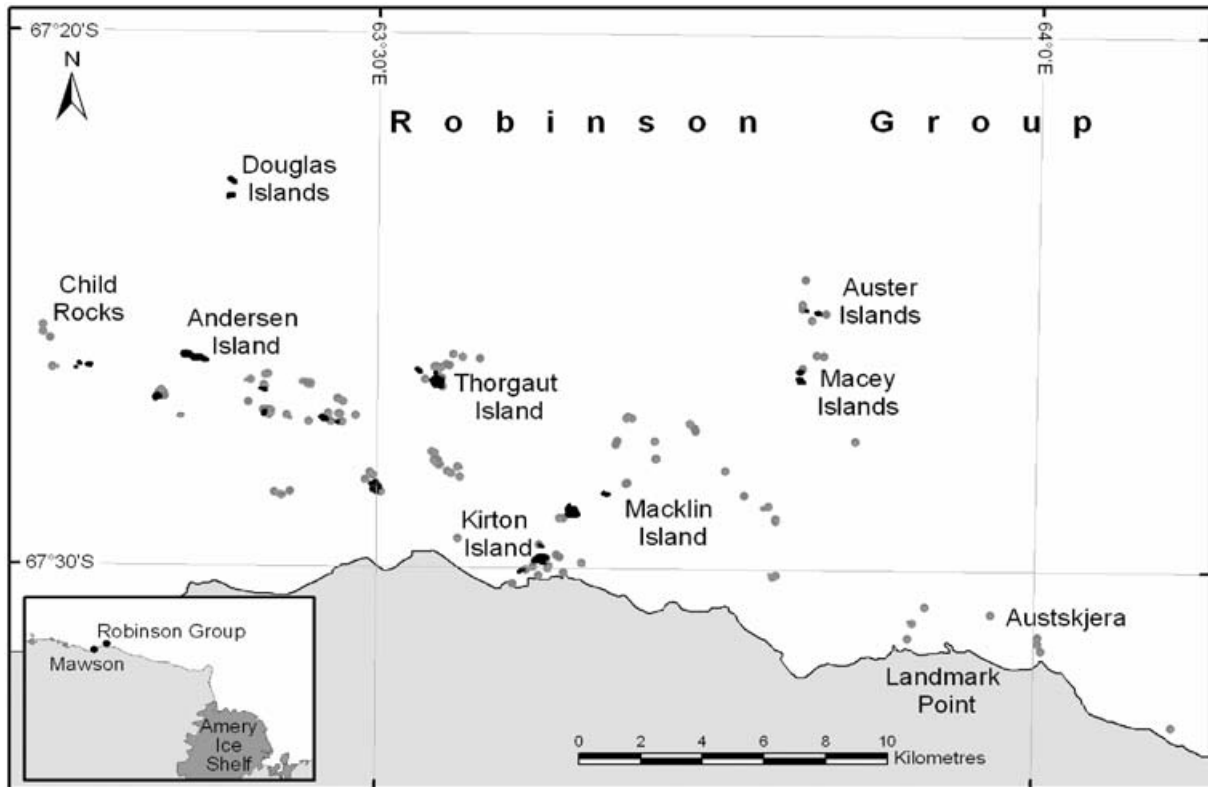


Fig. 1. Map of the Robinson Group of islands. Islands at which breeding Adélie penguins were present or absent are filled in black or grey respectively. The large area of grey at the bottom of the figure is continental ice.

field hut on Macey Island ( $67.438^{\circ}\text{S}$ ,  $63.818^{\circ}\text{E}$ ), which is situated towards the eastern edge of the Robinson Group. Observations at Bechervaise Island near Mawson station indicate that, at the time of year during which the survey was conducted, all breeding penguins have established nests which are occupied by at least one breeding adult (Kerry and others 1995; C. Southwell unpublished data).

At the time of the survey, the sea ice conditions were very good, enabling travel between the islands using 4WD quad bikes (all-terrain vehicles) equipped for sea ice conditions. The islands in this region are patchily distributed into small clusters of islands (in this paper referred to as sub-Groups) and a series of individual islands. From maps and satellite images, 27 waypoints were created using a geographic information system (GIS; Oziexplorer version 3.90.3) and these waypoints were used to navigate to all areas in which islands were known to exist. In addition, tracks were plotted between these survey points that allowed visual scanning for islands in areas that would not otherwise be visited. Because of the excellent field conditions during the survey, surrounding islands and island sub-Groups could be seen from each survey location. This permitted the identification and survey of a number of islands not recorded on existing maps. In situations in which uncertainty existed concerning whether an island had been visited before, the island was approached and GPS was checked concerning the location of the nearest logged waypoint. From this the status of each island

was determined (surveyed/unsurveyed). Because of this systematic approach, there was confidence that all islands with ice-free areas on them were visited.

The survey of the Robinson Group was conducted by navigating to each island sub-Group and systematically moving across the sub-Group in one direction until all islands in that location had been visited. Each island was climbed, and a GPS waypoint recorded (on a Garmin 12XL GPS receiver) at the island's approximate geographical centre. Satellite coverage was very good during the survey, with an estimated position error of  $\sim 5$  m achieved for all waypoints. In cases where the entire island could not be seen from the summit, it was systematically searched for evidence of Adélie penguins. An island was recorded as being a breeding site for Adélie penguins if there was at least one penguin on a nest at the time of the survey. Thus, our definition of 'breeding site' follows Ainley (2002) who also uses the term 'breeding locality'. This is a convenient geographical label describing where penguins breed (in our case, an island), with each site potentially containing multiple subcolonies, or itself being a part of a larger penguin colony (see Ainley 2002 for a discussion of these terms). While endeavours were made to plot a separate waypoint for each island, because of the topography of snow and ice it was sometimes difficult to know if two rocks separated by ice were one island or two. Also, in some instances difficulty was experienced in locating islands of low elevation because they were completely covered in ice.

Table 1. Position (in decimal degrees) of the 30 surveyed islands where breeding Adélie penguins were found. Names of individual islands or island sub-Groups are given if known. See the text for information on the definitions of population size categories

Island or sub-Group name	Latitude °S	Longitude °E	Population size category
Un-named island, Douglas Islands sub-Group	67.38025	63.38933	10's
Un-named island, Douglas Islands sub-Group	67.38493	63.38954	100's
Un-named island, Auster Islands sub-Group	67.41969	63.82447	100's
Un-named island, Auster Islands sub-Group	67.42047	63.83377	100's
Andersen Island	67.43528	63.35721	1000's
Un-named island, Child Rocks Islands sub-Group	67.43771	63.27494	100's
Un-named island, Child Rocks Islands sub-Group	67.43797	63.28240	1000's
Un-named island, Child Rocks Islands sub-Group	67.43865	63.27154	100's
Macey Island	67.43885	63.81928	1000's
Un-named island	67.43935	63.53110	1000's
Un-named island	67.44019	63.54346	<10
Un-named island, Macey Islands sub-Group	67.44133	63.81940	1000's
Un-named island	67.44172	63.54655	<10
Thorgaut Island	67.44250	63.54329	1000's
Un-named island	67.44515	63.41144	10's
Un-named island	67.44526	63.41297	100's
Un-named island	67.44751	63.33359	1000's
Un-named island	67.45288	63.41424	100's
Un-named island	67.45430	63.45958	1000's
Un-named island	67.45518	63.46922	<10
Un-named island	67.47405	63.49854	1000's
Un-named island	67.47489	63.49563	100's
Un-named island	67.47558	63.50072	10's
Un-named island	67.47656	63.49673	100's
Un-named island	67.47747	63.67317	10's
Macklin Island	67.48305	63.64677	1000's
Un-named island	67.49390	63.62470	100's
Kirton Island	67.49798	63.62296	1000's
Un-named island	67.49924	63.62624	1000's
Un-named island	67.50095	63.61104	1000's

Thus, it is possible that some small islands were missed because of complete ice cover, and it is also possible that two rocks counted as separate islands were, in fact, joined. Regardless of these minor concerns, in such cases no penguins would breed on these ice-covered rocks and so the survey still comprehensively assessed all potential breeding sites for Adélie penguins in the region.

On each island where penguins were found, a rough estimate of the size of that population was recorded as a future reference for allocating resources should a more precise abundance survey be undertaken in the future. The categories employed (10's, 100's, 1000's) may range up to an order of magnitude and should not be relied upon for population estimates.

## Results

149 islands were surveyed and a GPS location was recorded at the approximate centre of 142 of them. The seven islands for which a central GPS location was not recorded were small ice-covered islands, usually no more than 50 m across. In these instances the state of the sea ice surrounding them or the smooth ice covering them prevented access, and it was possible to obtain a GPS location only for the closest visited point on

the surrounding sea ice. Because these seven islands were completely covered by ice in November, there was confidence that none of these islands were occupied by breeding Adélie penguins. Of the 142 islands to which access was possible, 30 islands were occupied by breeding Adélie penguins (Table 1) and 112 had no evidence of breeding Adélie penguins (Table 2). The number of nests on each occupied island ranged from fewer than 10 (for example 67.44019°S, 63.54346°E) to several thousand (for example Macklin Island). With the exception of the area to the south and east of the Macey Islands, in which there were no breeding penguins, the islands containing breeding Adélies were located throughout the Robinson Group.

## Discussion

This study adds significantly to our knowledge of the distribution of breeding Adélie penguins in the Mac.Robertson Land coast between 62–64°E by more than doubling the number of known breeding sites from 21 to 51. Until now, only a single published (and, therefore, accessible) record of Adélie penguins breeding in the Robinson Group was known (Horne 1983). While the current study was restricted to a reconnaissance survey

Table 2. Position (in decimal degrees) of the 112 surveyed islands that were accessed and found to have no breeding Adélie penguins. Also shown are the approximate positions of seven ice-covered islands that could not be accessed (\*)

Latitude °S	Longitude °E	Latitude °S	Longitude °E	Latitude °S	Longitude °E
*67.37358	*63.37101	67.44831	63.47046	67.47204	63.49697
*67.37619	*63.35592	67.44906	63.47387	67.47266	63.56289
*67.37682	*63.37943	67.44937	63.40197	67.47352	63.49092
67.41025	63.82360	67.45177	63.41333	67.47408	63.68954
67.41791	63.82124	67.45189	63.41733	67.47418	63.69024
67.41933	63.82164	67.45203	63.41928	67.47427	63.68894
67.42075	63.83949	67.45286	63.46277	67.47596	63.50142
67.42287	63.82875	67.45300	63.47034	67.47721	63.50339
67.42561	63.24620	67.45303	63.47172	67.47738	63.43411
67.42774	63.24646	67.45329	63.41812	67.47748	63.42255
67.42956	63.25171	67.45331	63.43113	67.47775	63.77883
*67.43368	*63.57008	*67.45335	*63.46346	67.47842	63.42756
67.43378	63.83280	67.45340	63.48362	67.48121	63.79731
67.43401	63.83775	67.45340	63.69043	67.48505	63.80268
67.43430	63.55745	67.45353	63.69141	67.48526	63.64212
67.43521	63.56434	67.45372	63.69300	67.48530	63.63867
67.43548	63.57755	67.45379	63.68881	67.48562	63.80275
67.43760	63.55189	67.45544	63.46450	67.49167	63.56162
67.43769	63.55463	67.45545	63.44792	67.49343	63.62380
67.43785	63.82232	67.45545	63.47376	67.49677	63.63700
67.43827	63.54491	67.45554	63.73710	67.49735	63.63914
67.43828	63.54346	67.45691	63.74086	67.49918	63.65576
67.43835	63.54811	67.45776	63.74127	67.50014	63.63119
67.43877	63.25374	67.46046	63.86252	67.50043	63.61884
*67.43922	*63.27813	67.46105	63.68205	67.50085	63.63054
67.44070	63.41701	67.46108	63.71061	67.50126	63.61399
67.44094	63.41492	67.46212	63.68096	67.50217	63.64222
67.44121	63.54605	67.46457	63.54124	67.50244	63.80358
67.44151	63.54843	67.46509	63.54412	67.50300	63.80142
67.44206	63.54695	*67.46646	*63.70881	67.50322	63.62345
67.44221	63.53647	67.46647	63.71156	67.50565	63.60374
67.44254	63.40399	67.46652	63.71202	67.51205	63.91690
67.44361	63.44935	67.46740	63.54338	67.51415	63.96715
67.44411	63.41403	67.46744	63.54619	67.51694	63.90757
67.44441	63.54932	67.46835	63.54713	67.52113	64.00317
67.44574	63.33628	67.46939	63.56142	67.52187	63.90410
67.44643	63.33440	67.47006	63.76468	67.52308	64.00323
67.44674	63.33784	67.47074	63.55370	67.52542	64.00589
67.44759	63.33837	67.47115	63.49459	67.54857	64.10591
67.44824	63.46979	67.47146	63.55651		

and did not attempt to obtain accurate counts of breeding penguins, it could provide a platform for future survey work in this area.

Two important aspects of the current study should be kept in mind for future survey work. Firstly an attempt was made to survey comprehensively a pre-defined area in which there was no presupposition that penguins would be found. If reliance had been placed only on historical records of known breeding localities when designing a future survey to estimate breeding population size for this region, the resulting population estimate would have been severely biased in a negative sense. Thus, it is possible that in areas previously surveyed opportunistically, only the breeding localities that are easily accessible or are in the areas commonly traversed are found; this may, or may

not, include all populations in that region. Secondly, all islands that were visited during the survey were recorded in order to facilitate any future survey work in this area. If only those locations at which breeding populations of penguins were found, without a clear indication of where penguins were absent, it would be difficult for a reader to make a correct interpretation of the search effort, as it would be unclear whether the breeding locations that were found were the only ones in the area, or were the only ones that were visited. For future surveys the unambiguous reporting of all areas visited is encouraged with the recording of which areas did or did not contain the species of interest. From these data, a more accurate record of the distribution and abundance of species can be generated.

### Acknowledgements

We thank David Smith and Henk Brolsma from the Australian Antarctic Division Data Centre for assistance with the survey maps, Angela Bender for her help in generating Fig. 1, and David Ainley and an anonymous reviewer for comments on the manuscript. We also thank the 2005 summer crew from Mawson station for logistical support: in particular Greg Barras and Ted Mead for their assistance during the initial part of the survey.

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