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Short Note
First comprehensive abundance survey of a newly discovered Adélie penguin breeding metapopulation in the Robinson Group of islands, Mac.Robertson Land, East Antarctica

COLIN SOUTHWELL[1], MATTHEW LOW[1,2], KYM NEWBERY[1] and LOUISE EMMERSON[1]

[1]*Australian Antarctic Division, Department of Sustainability, Environment, Water, Population and Communities, 203 Channel Highway, Kingston, TAS, 7050 Australia*

[2]*Department of Ecology, Swedish University of Agricultural Sciences, Box 7044, 75007 Uppsala, Sweden*

colin.southwell@aad.gov.au

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Introduction

The Robinson Group of islands is situated 25–55 km east of Mawson Station on the Mac.Robertson Land coast of East Antarctic between longitudes 63.246°E and 64.106°E (Fig. 1). Until recently the only published information on seabird populations in this region was a count of 434 Adélie penguin (*Pygoscelis adeliae* (Hombron & Jacquinot)) chicks on one island (Horne 1983). A comprehensive survey of Adélie penguin breeding distribution in the Robinson Group in 2005 (Low *et al*. 2007) found Adélie penguins breeding on 30 islands and qualitative observations suggested the breeding population numbered in the tens of thousands. We report here the results of an abundance survey of the region in the 2006–07 breeding season. We aimed to develop a robust abundance estimate for this newly discovered metapopulation to improve estimates of current Adélie penguin breeding abundance in the broader Mac.Robertson Land region and to provide a baseline to assess future population change.

Methods

Given the unknown but expected large size of the population and time constraints for survey work, we used the new methods and technologies presented in Southwell *et al*. (2013) to estimate abundance. These methods involved: i) establishing a set of boundaries that encompassed all breeding nests in the region by walking within 5–10 m around sub-colonies or groups of sub-colonies with a hand-held GPS unit, ii) using a random sample count design, photography and virtual delineation of sample-plot boundaries in the photographs to estimate the observed abundance of occupied nests at the time of the survey, iii) estimating detectability with distance sampling techniques, and iv) using remotely operating time-lapse cameras to determine whether the survey was conducted at an optimal time to estimate the maximum number of occupied nests.

Results

We mapped breeding area boundaries in late November 2006 and took photographs at 335 sample plots from 2–4 December 2006. A count of 3447 occupied nests within the plot boundaries, when adjusted upwards by the sampling fraction of 7.1%, returned an observed abundance estimate of 48 500 (standard error = 4100) occupied nests at the time of the survey. Counts within the sample plots were relatively constant as distance from the central point of plots increased (counts of 680, 706, 711, 704 and 646 in five 1-metre distance bins), and an analysis using DISTANCE 5.0 software estimated detectability to be perfect.

Standardized time-series counts from three cameras located 20 km to the west of the survey region (Fig. 1) showed that the number of occupied nests reached a peak in mid-November and remained at a maximum level until early December (Fig. 2). The sample plot photographs were taken at the end of this peak and just before the number of occupied nests declined through December. Given that detectability was estimated to be perfect and that sample counts were made at a time when the number of occupied nests was at its peak, the estimated observed abundance of occupied nests at the time of the survey can reasonably be taken as an unbiased estimate of the maximum number of occupied nests for the breeding season.

Discussion

This survey features the integrated application of several newly developed methods including photography for sample counts, 'virtual' boundaries for delineating sample plots and remotely operating cameras for determining the time when the number of occupied nests is greatest (Southwell *et al*. 2013). Our motivation to develop new methods for this survey application recognized the conflicting demands of an expected large population and short time-window for survey work, and aimed to ensure

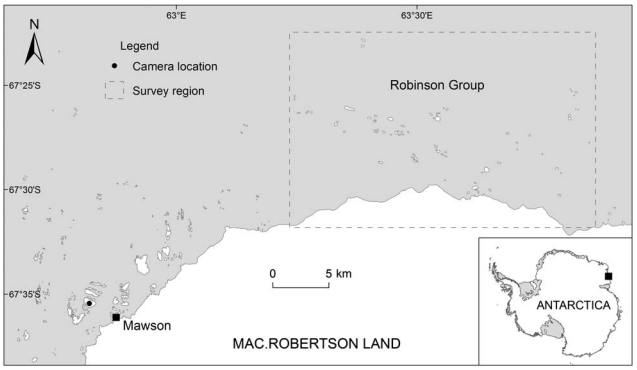

Fig. 1. Map of the Mac.Robertson Land coast showing the Robinson Group of islands and the location where three remotely operating cameras were established.

the integrated survey methods maximized efficiency and minimized disturbance without sacrificing accuracy or precision. Although we developed the methods specifically for use on Adélie penguin populations, the methods have broad application for a wide range of colonial breeding birds and mammals.

Our estimate of nearly 50 000 breeding pairs in the Robinson Group of islands is in stark contrast to the only previous published population data in this region (a count of 434 chicks on Macey Islands in 1972; Horne 1983). In reviewing the circumpolar distribution and abundance of Adélie penguins, Ainley (2002) concluded that most Adélie penguin colonies were known and that any undiscovered colonies were probably not large. Our survey result runs counter to this expectation and is surprising considering the close proximity to a research station that has been permanently occupied for over 50 years. Satellite technology is now proving useful for identifying unknown penguin colonies in remote locations of Antarctica (Fretwell & Trathan 2009, Schwaller *et al*. 2013). Fretwell *et al*. (2012) have also used satellite technology to provide the first synoptic estimate of ice-breeding emperor penguin breeding populations, although they note a number of caveats and potential biases in the estimates and indicate that more ground truthing is required for these to be addressed. Similar application of satellite technology for estimating land-breeding penguin populations, such as Adélie penguins, over large scales may be possible in the future (Schwaller *et al*. 2013), but this is likely to be more challenging than for the ice-breeding emperor penguin because of the more complex substrate that these species breed on, and reliable application will necessarily rely on ground truthing for verification. Whether satellite technology can be used to monitor population change over time with sufficient precision and sensitivity for management or scientific purposes remains uncertain, and is likely to take some time and further assessment to resolve. Regardless of such advances in satellite technology, the use of efficient, rigorous, direct survey designs and methods, such as those used in this study, will continue to be important for assessing and monitoring penguin population status.

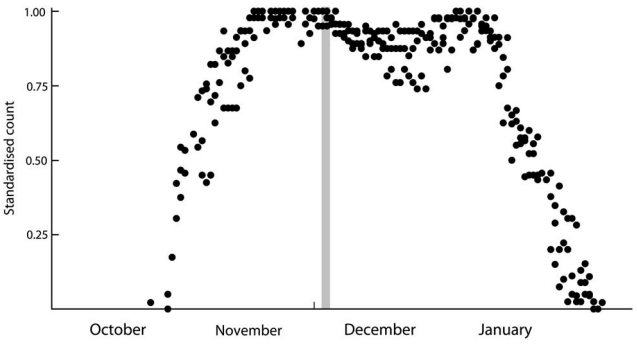

Fig. 2. Standardized time-series counts of occupied nests through the 2006–07 breeding season from three cameras located 20 km west of the Robinson Group of islands. Time-series counts have been standardized to the maximum number of occupied nests at each camera site. The grey shaded area shows the date range when plot photographs were taken for sample counts.

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