FIRST POPULATION COUNTS AT NEWLY DISCOVERED ADÉLIE PENGUIN *PYGOSCELIS ADELIAE* BREEDING SITES ALONG THE WILHELM II, QUEEN MARY AND WILKES LAND COASTLINES, EAST ANTARCTICA

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Knowledge of seabird populations in east Antarctica is sparse. The Adélie Penguin *Pygoscelis adeliae* is one of the most visible and intensively studied Antarctic seabirds, but basic knowledge of breeding distribution and abundance along large sections of eastern Antarctica is uncertain (Barbraud *et al.* 1999, Southwell *et al.* 2009). Until recently, only eight Adélie Penguin breeding sites were known along the Wilhelm II, Queen Mary and Wilkes Land coastlines between longitude 89°E and 110°E (six sites in the Haswell Islands and two sites in the Davis Islands reported in Pryor 1968 and Melick et al. 1995 respectively, Fig. 1). However, a recent comprehensive survey of potential Adélie Penguin breeding habitat along this stretch of coastline (Southwell and Emmerson 2013) found an additional five breeding sites in this region that had not been previously reported (Fig. 1). We present here the first population counts of Adélie penguins at these five newly discovered breeding sites, and in doing so substantially improve knowledge of Adélie Penguin breeding abundance in the region.

METHODS

We took advantage of Australian Antarctic Program logistic flights by CASA 212 fixed wing aircraft between Casey and Davis stations in the 2009/10 and 2010/11 field seasons to obtain aerial photographs of Adélie Penguin populations at the five newly discovered breeding sites. These flights were scheduled for other purposes and, consequently, did not occur at the optimal time for Adélie Penguin population estimation. Whereas the optimal time in east Antarctica is late November to early December when the number of penguins present at breeding sites is similar to the number of incubating nests (Taylor *et al*. 1990, Woehler *et al.* 1991, Watanuki and Naito 1992, Southwell *et al.* 2010), these flights occurred between late December and early February (Table 1).

Flight operations near the sites were in accordance with the Australian Antarctic Division's guidelines for aerial operations near wildlife breeding populations (minimum altitude 750 m, Australian Antarctic Division 2011). Oblique photographs were taken with a hand-held Nikon D200 digital SLR camera fitted with 75–300 mm zoom lens. Overlapping photographs were taken on both low- and high-zoom settings from several vantage points. The entire breeding site was covered in a single photograph at two sites (Adams Island and Mallory Point), but several photographs were required to cover all of the three larger sites (Merritt Island, Cape Nutt and Ivanoff Head). Image quality (clarity and sharpness of focus, contrast between penguins and background) varied between sites. The best images were chosen for counting, but image quality still varied (Table 1). It was not possible to stitch the overlapping photographs of the larger sites together using appropriate software because the photographs were taken on different zoom settings and angles from the moving aircraft. Instead, where necessary, we used features in the low-zoom photographs such as guano, snow and rock patterns to delineate adjoining sections of the site on the high-zoom photographs, and then made counts from the high-zoom photographs. The extent and overlap of photographic coverage was sufficient to include all penguin sub-colonies at Adams Island, Merritt Island, Mallory Point and Ivanoff Head, and most or all sub-colonies at Cape Nutt.

We independently counted all penguins present at the sites and distinguished between penguins located on guano-covered rock and those on bare rock. Both adults and chicks would have been present at the sites when the flights occurred. However, chicks would have been very small and closely guarded by the parents on the earlier flights (27 December and 5 January for Ivanoff Head and Cape Nutt, respectively, Table 1) and so would not have been visible at a

TABLE 1
Number of Adélie Penguins counted from aerial photographs on guano-covered rock at five newly discovered breeding sites along the Wilhelm II, Queen Mary and Wilkes Land coastlines, east Antarctica

Site	Latitude	Longitude	Date	Image quality	Count Mean (SE) from two independent counts	Population object
Adams Island	66.5459°S	92.5486°E	21 Jan 2011	Excellent	425 (2)	Adults and unguarded chicks
Merritt Island	66.4588°S	107.1565°E	1 Feb 2010	Poor	532 (48)	Adults and unguarded chicks
Cape Nutt	66.6352°S	108.2127°E	5 Jan 2010	Fair	1 971 (58)	Adults
Mallory Point	66.8299°S	108.6432°E	21 Jan 2011	Good	4 621 (302)	Adults and unguarded chicks
Ivanoff Head	66.8803°S	109.1275°E	27 Dec 2009	Fair	6 130 (166)	Adults

distance from the air. We are therefore confident that all penguins counted at these sites would have been adults. The dates of flights for Adams Island, Mallory Point and Merritt Island (21 January and 1 February) were late enough in the breeding season for some chicks to be unguarded and physically independent of the parents, so both adults and unguarded chicks were visible. While many adults could be clearly distinguished from unguarded chicks by the presence of white plumage or rigid, outstretched flippers, these distinguishing features were not obvious if an adult had its back to the aircraft or was holding its flippers close to the body. As we were often unable to confidently distinguish adults from unguarded chicks at these sites, we have conservatively presented counts for adults and unguarded chicks combined.

RESULTS AND DISCUSSION

Our counts of penguins on guano-covered rock ranged from several hundred adults and unguarded chicks at Adams and Merritt Islands to several thousand adults at Ivanoff Head (Table 1). There were only a small number of penguins on bare rock (approximately 300 across all sites). The opportunistic nature of the counts, particularly with respect to the stage of the breeding season and the difficulty of distinguishing adults and unguarded chicks at some sites, precluded precise estimation of the number of breeding pairs at the beginning of the breeding season. Nevertheless, our results, in combination with published population count data from the other eight breeding sites along this section of Antarctic coastline (44 986 breeding pairs in the Haswell Islands in 1962/63 [Pryor 1968]; 8 730 breeding pairs in the Davis Islands in 1993/94 [Melick *et al.* 1995]), provide for the first time population data from all 13 occupied breeding sites in this region and indicate that the breeding abundance of Adélie Penguins, while substantial, is smaller than regional populations in Prydz Bay to the west (325 000 breeding pairs in 1981/82, Whitehead and Johnstone 1990) and the Windmill Islands to the east (93 000 breeding pairs in 1989/90, Woehler *et al.* 1991). The lower abundance is likely to be due in part to the relative scarcity of potential Adélie Penguin breeding habitat in the region (4 km^2 of potential breeding habitat in the region of this study compared with 221 km^2 and 42 km^2 in the Prydz Bay and Windmill Island regions, respectively, Southwell *et al.* 2009), but marine features may also influence abundance through the foraging requirements of breeding penguins. Our counts, in combination with data from adjacent regions, will allow updating of bio-regional scale abundance estimates and a better understanding of the environmental features driving broad-scale breeding distribution and abundance of Adélie Penguins in east Antarctica.

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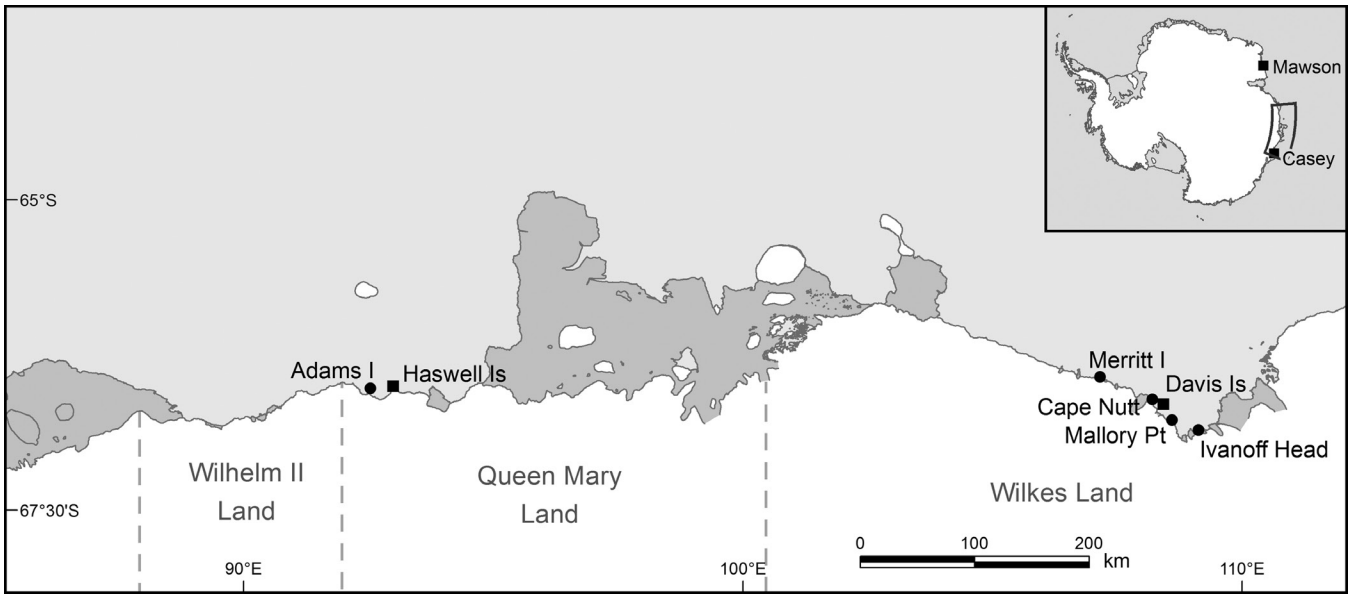

Fig. 1. Locations of five newly discovered Adélie Penguin breeding sites along the Wilhelm II, Queen Mary and Wilkes Land coasts (circles). The locations of the Haswell Islands and Davis Islands, where eight breeding sites have long been known to occur, are also shown (squares).

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