CENSUSES OF PENGUIN, BLUE-EYED SHAG *PHALACROCORAX ATRICEPS* AND SOUTHERN GIANT PETREL *MACRONECTES GIGANTEUS* POPULATIONS ON THE ANTARCTIC PENINSULA, 2001–2007

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SUMMARY

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Here, we report census results for Adélie Penguin *Pygoscelis adeliae,* Gentoo Penguin *P. papua,* Chinstrap Penguin *P. antarctica,* Blue-eyed Shag *Phalacrocorax atriceps,* and Southern Giant Petrel *Macronectes giganteus* collected as part of the Antarctic Site Inventory project during 2001–2007. We report on new breeding populations of Gentoo Penguins in the Yalour Islands, Galindez Island and Cape Tuxen (Antarctic Peninsula), which reflect the southernmost known breeding colonies of this species. We also document range expansion and population increases for Gentoo Penguins throughout the Antarctic Peninsula. Further, we report on the continuing population decline of Adélie Penguins in the Antarctic Peninsula, and present records of all three pygoscelid penguins breeding at Booth Island, the fifth known site where these species nest contiguously on the Antarctic Peninsula.

Key words: Censuses, Antarctic Peninsula, penguins, Blue-eyed Shag, Southern Giant Petrel

INTRODUCTION

Fieldwork by the Antarctic Site Inventory (ASI) began in November 1994, examining whether opportunistic visits can be used to

- effectively and economically detect possible visitor-caused changes in the physical features, flora and fauna of sites on the Antarctic Peninsula being visited repeatedly by ship-based tourists;
- collect baseline information necessary to detect possible changes in the physical and biologic variables being monitored; and
- determine how best to minimize or avoid the potentially negative effects of tourism and governmental and non-governmental activities in the Antarctic Peninsula area.

The ASI has collected information on Antarctic Peninsula visitor sites frequently and cost-effectively, relying opportunistically on expedition tour vessels and, occasionally, the United Kingdom ice patrol vessel *HMS Endurance* for logistics support. Well-timed visits by trained researchers have proved an effective means of characterizing sites and collecting relevant biologic data (Naveen 1997, Naveen *et al.* 2001, Naveen 2003).

Data collected by the Inventory are intended to assist the implementation of the 1991 Protocol on Environmental Protection to the Antarctic Treaty, which, among other things, requires *a priori* environmental impact assessments for all human activities, including tourism, and monitoring to assess and verify predicted environmental impacts. The goal is to develop a baseline against which changes in the ecosystem can be assessed and, if possible, determine whether any detected changes are naturally occurring or are anthropogenic, perhaps caused by tourism or other human activities (Naveen 1996). Potential impacts may be short-term or long-term, immediate or cumulative (Benninghoff & Bonner 1985, Abbott & Benninghoff 1990, Emslie 1997, Hofman & Jatko 2002).

In this paper we report on the last six years' worth of census data collected to update earlier efforts reported in Naveen *et al.* (2000). The ASI is conducted by researchers placed on tour ships, and site censuses are taken during zodiac landings or, occasionally, during zodiac tours. The advantages of this approach include wide spatial coverage of the western Antarctic Peninsula, and a negligible "footprint" on the landscape. The disadvantage is that the timing of censuses is opportunistic, and census counts are not always timed with the peak of egg laying or chick crèching as required by the Commission for the Conservation of Antarctic Marine Living Resources Ecosystem Monitoring Program (SCCAMLR 2004). Off-peak bias corrections are currently being developed (Lynch *et al.* in prep.), but even uncorrected census counts, as reported in this paper, add tremendous spatial and temporal coverage to existing census records and can be used in population analyses (e.g. Woehler *et al.* 2001, Sander *et al.* 2007).

STUDY AREA

As reported elsewhere (Naveen *et al.* 2000), the Inventory divides the Antarctic Peninsula into six subareas (Fig. 1), designations that are followed here.

- South Orkneys (SO), including Laurie, Coronation, and Signy Islands

- Elephant Island and nearby islands (EI)
- South Shetland Islands (SH), including Deception, Low, and Smith Islands (see Fig. 2)
- Northeast Antarctic Peninsula (NE), from Cape Dubouzet (63°16′S, 64°00′W) and Joinville Island (63°15′S, 55°45′W) to James Ross Island (64°10′S, 57°45′W) (see Fig. 3)
- Northwest Antarctic Peninsula (NW), from Cape Dubouzet (63°16′S, 64°00′W) to northern end of the Lemaire Channel (65°04′S, 63°57′W) (see Fig. 4)
- Southwest Antarctic Peninsula (SW), from the northern end of the Lemaire Channel to the northern part of Marguerite Bay (68°18′S, 67°11′W) (see Fig. 5)

In 13 seasons from November 1994 through February 2007, the Inventory has made 758 visits and collected data at 115 Antarctic Peninsula locations. Inventory researchers have repeatedly visited all those sites that are most heavily visited by expedition tourists, and all sites that exhibit high species diversity or are especially prone to environmental disturbance from human visitors (Naveen 1997, Naveen *et al.* 2001, Naveen 2003).

The present paper provides new census data from each of the six subareas for Adélie Penguin *Pygoscelis adeliae,* Gentoo Penguin *P. papua,* Chinstrap Penguin *P. antarctica,* Blue-eyed Shag *Phalacrocorax atriceps,* and Southern Giant Petrel *Macronectes giganteus.* These long-term data are particularly important now that Antarctic Treaty parties have begun to adopt site specific management guidelines for key visitor locations.

CENSUS DATA

The census data reported in Tables 1–5 have been reported in a manner consistent with the census compilations of Woehler (1993) and Woehler and Croxall (1997):

N1 Nests individually counted, accurate to better than ±5%
N2 Nests counted in a known area, and then extrapolated over total colony area, accurate to 5%–10%
N3 Accurate estimate, accurate to 10%–15%
N4 Rough estimate, accurate to 25%–50%
C1 Chicks individually counted, accurate to better than ±5%
C2 Chicks counted in a known area, and then extrapolated over total area, accurate to 5%–10%

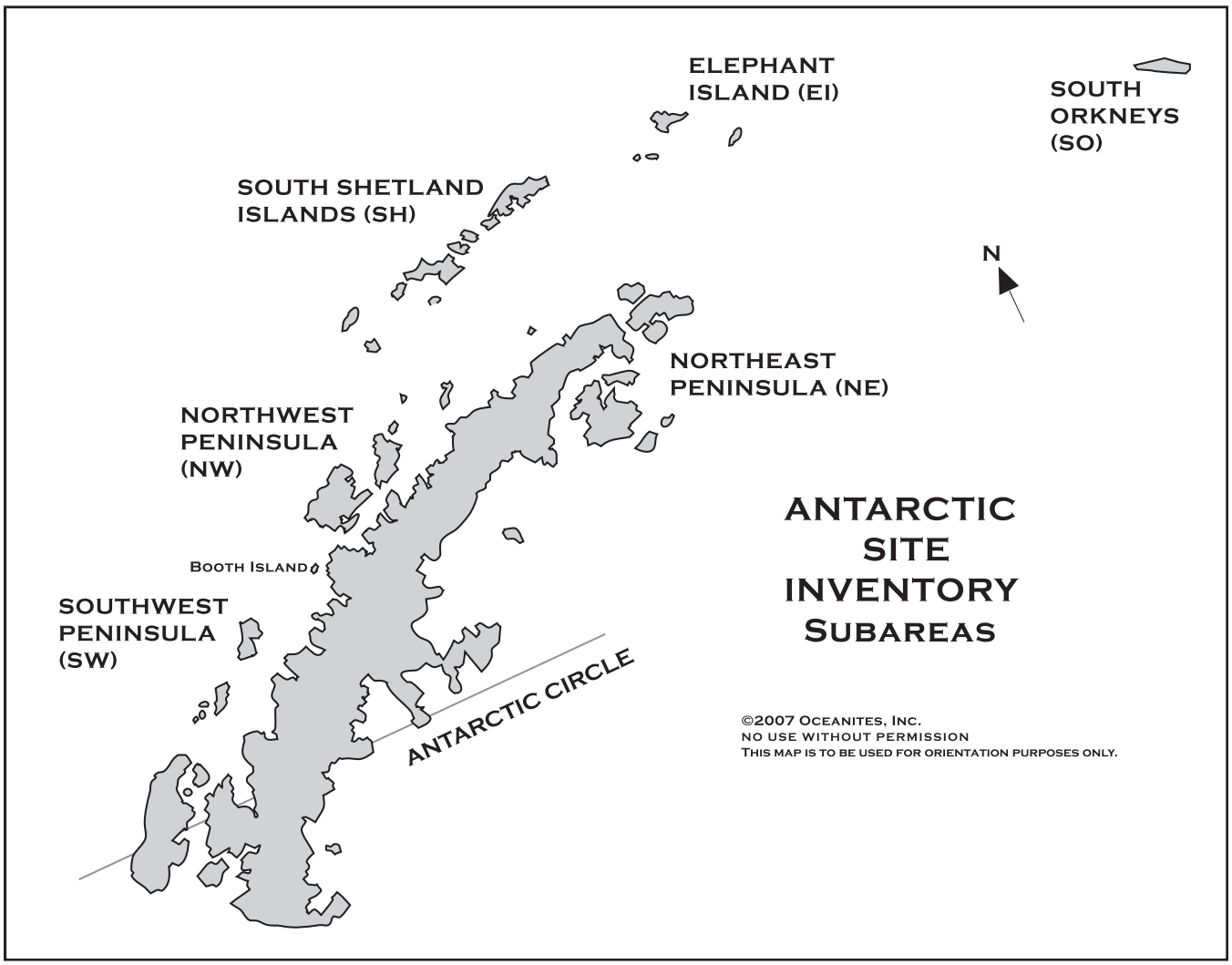

Fig.1. Map of the Antarctic Peninsula region, indicating the six subareas and their abbreviations, as divided by the Antarctic Site Inventory: the South Orkney islands, Elephant Island and nearby islands, the South Shetland Islands, the Northeast Antarctic Peninsula, the Northwest Antarctic Peninsula, and the Southwest Antarctic Peninsula.

C3 Accurate estimate, accurate to 10%–15%

C4 Rough estimate, accurate to 25%–50%

A1 Estimates based on counts of total birds or adults individually counted, accurate to better than ±5%

A2 Estimates based on counts of total birds or adults individually counted, accurate to 5%–10%

A3 Estimates based on counts of total birds or adults individually counted, accurate to 10%–15%

A4 Estimates based on counts of total birds or adults individually counted, accurate to 25%–50%

The site censuses represent all the birds at a particular site, except where indicated by a map. Where multiple nest or chick censuses (or both) are available for a site in any given year, we report the largest December nest count and the largest January chick count available. If no December nest count is available, we give January nest counts priority over November nest counts, and February chick counts priority over December chick counts.

We report on 81 censuses taken at 52 different sites. Among these are 24 census reports that are new to the ASI project. In addition, we note changes from the most recent available census before 2001, and use census that to estimate the annual rate of population change λ between the "baseline" count in year t_1 and the most recent count in year $t_1 + T$ (Ebert 1999),

$$\lambda = \left(\frac{N_{t1+T}}{N_{t1}} \right)^{1/T}, \quad [1]$$

and its error δλ (see Taylor 1982),

$$\delta\lambda = \frac{\lambda}{T} \sqrt{\left(\frac{\delta N_{t1}}{N_{t1}} \right)^2 + \left(\frac{\delta N_{t1+T}}{N_{t1+T}} \right)^2}, \quad [2]$$

where $\delta N/N$ represents the fractional error of the census (e.g. 0.05 for N1, 0.10 for N2) and T represents the time difference between the two censuses.

RESULTS AND DISCUSSION

With respect to Adélie Penguins (Table 1), the Inventory continues to document the population decline of this species in the western Antarctic Peninsula region, most strikingly in the southwestern region subarea (Fig. 6). Inventory data suggest population declines at the Berthelot Islands (65°20′S, 64°09′W), Booth Island (65°05′S, 64°00′W), Petermann Island (65°10′S, 64°10′W), and the Yalour Islands (65°14′S, 64°10′W).

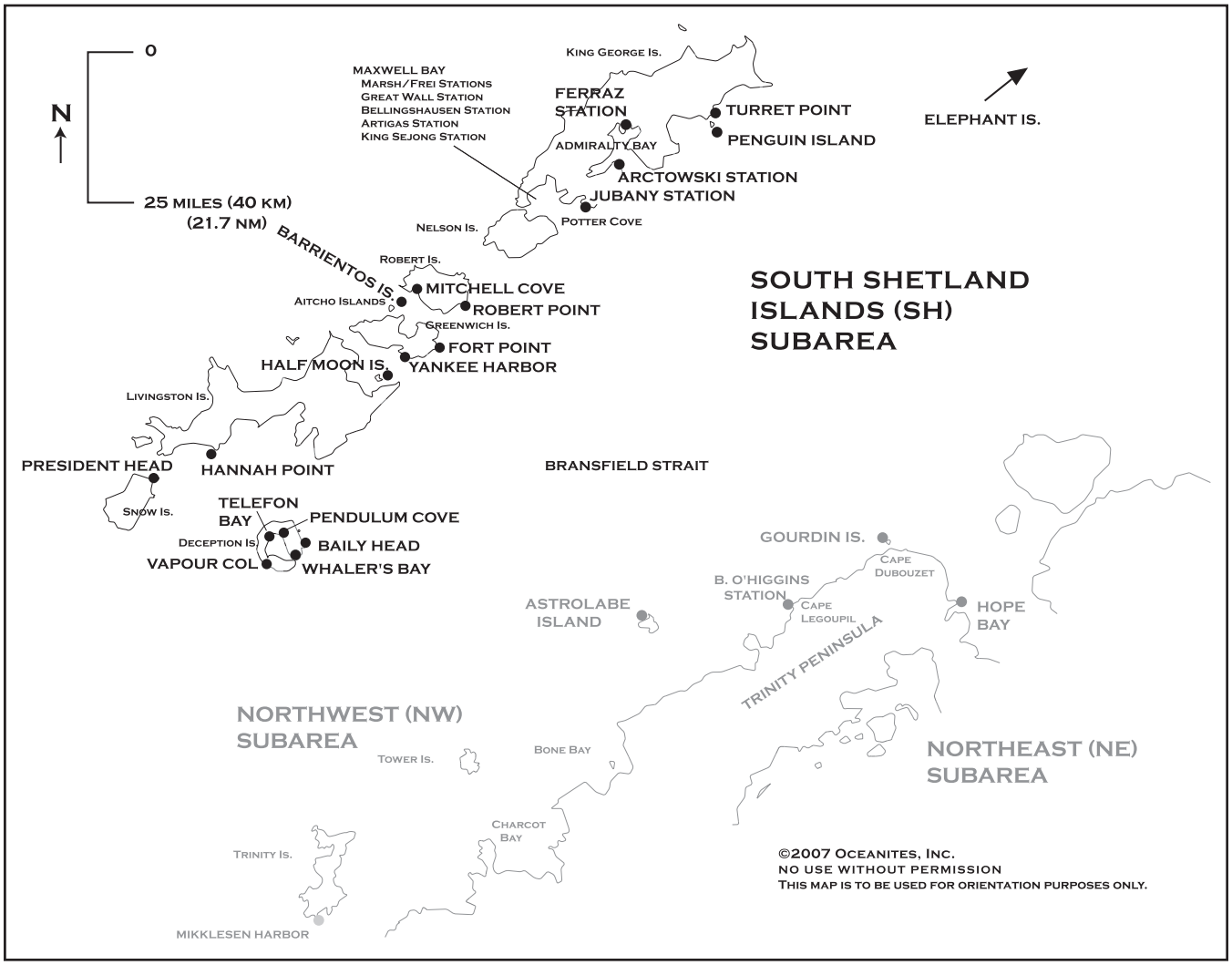

Fig. 2. Map of the South Shetland Islands and parts of the Northwest Antarctic Peninsula region.

With respect to Gentoo Penguins, the Inventory continues to document the population increase of this species in the Antarctic Peninsula (Naveen *et al.* 2000), and for the first time we report the expansion of this species south of their historic range into the Yalour Islands (65°14′S, 64°10′W), Galindez Island (65°15′S, 64°15′W), and Cape Tuxen (65°16′S, 64°08′W). Previously, the southern end of this species' breeding range was believed to be Petermann Island (65°10′S, 64°10′W) (Croxall & Kirkwood 1979). In 2005, one pair of Gentoos made an unsuccessful attempt to breed at Vernadsky Station on Galindez Island (A. Zalizovsky, pers. comm.), and in November 2007, the ASI recorded 21 Gentoo nests at this location. In 2006/07, the Inventory documented 15 Gentoo nests at the Yalour Islands, and in November 2007, there were approximately 100 Gentoo nests at Cape Tuxen (V. Timofeev & V. Trohymets, pers. comm.), which is currently the southernmost known breeding location for Gentoo penguins. This southward expansion of the Gentoo range is consistent with the rapid population growth reported here and elsewhere (Naveen *et al.* 2000), particularly at the southern end of the range (see Fig. 6).

Chinstrap Penguins declined at all sites for which data were available to assess change, with the sole exception of a small increase on Booth Island. Unlike the Adélie Penguins, which are declining principally in the southwestern region subarea, Chinstraps declined significantly throughout their range. We report declines at Cecilia Island (62°25′S, 59°43′W), Entrance Point (63°00′S, 60°33′W), Georges Point, Ronge Island (64°40′S, 62°40′W) and Hydrurga Rocks (64°08′S, 61°37′W).

Several authors have noted that sea-ice loss, with subsequent effects on krill recruitment, is likely to affect the three pygoscelid species differentially, leading to range expansions and contractions, and a reorganization of the relative proportion of each of these species (Fraser *et al.* 1992, Smith *et al.* 1999, Forcada *et al.* 2006). In years of abundant prey availability, sympatrically breeding species are able to forage and breed successfully; in years of low prey availability, interspecific competition and differential foraging success favors some species over others (Lynnes *et al.* 2002).

Our results are largely consistent with the most recent literature on pygoscelid population dynamics which, taken collectively, report on widespread and long-term Adélie declines along the Antarctic Peninsula, recent but significant declines in Chinstrap populations, and a stable or increasing population of Gentoos in all but the northwestern region of the Peninsula. Sander *et al.* (2007) report a decline in both Adélies and Chinstraps at Penguin Island in the South Shetland Islands. Forcada *et al.* (2006) report on Adélie and Chinstrap declines coincident with significant increases in the Gentoo

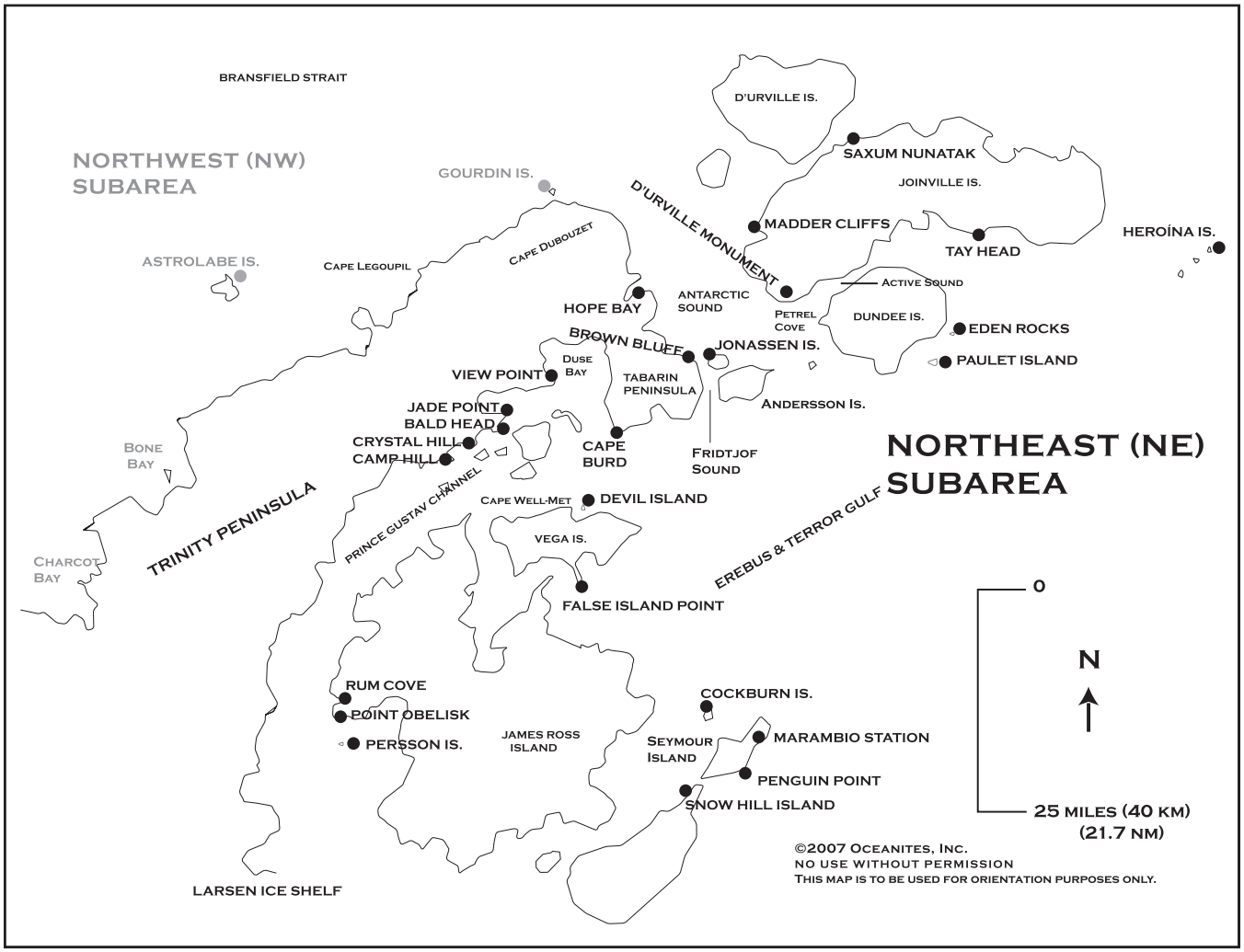

Fig. 3. Map of the Northeast Antarctic Peninsula region subarea, as defined by the Antarctic Site Inventory.

population at the South Orkney Islands (see also Woehler *et al.* 2001). Hinke *et al.* (2007) report significant declines in the breeding population of Adélie and Chinstrap penguins at Admiralty Bay, King George Island, since the early 1980s, and declines in breeding Chinstraps at Cape Shirreff, Livingston Island, since the late 1990s. Hinke *et al.* (2007) find no trend in the Gentoo populations of either site, and our results indicate a mix of zero and positive trends in the Gentoo populations we monitored in the South Shetland Islands.

High site-to-site variability in population trends makes it difficult to synthesize the Chinstrap Penguin population data from the last two decades. Poncet and Poncet (1987) report increasing populations in the South Orkneys and the South Shetlands, and a mix of increasing (e.g. Georges Point, Orne Island) and decreasing [e.g. Waterboat Point, Cuverville Island] populations on the Peninsula. Fraser *et al.* (1992) report increases in Chinstraps—citing, among others, an increase by a factor of five at Signey Island, South Orkneys, reported by Rootes (1988). Woehler and Croxall (1997) report a general downward trend in Chinstrap populations on the Peninsula since 1990, with Livingston Island and the Palmer Station area cited as two exceptions. In an earlier report of data from the ASI Project, we reported several declining Chinstrap populations on the Peninsula and no increasing populations (Naveen *et al.* 2000). The available data, although complex and difficult to interpret, suggest a shift in Chinstrap populations over the last two decades from generally increasing to generally decreasing populations. Smith *et al.* (1999) note that optimum sea ice conditions no longer exist in the western Antarctic Peninsula for Adélie Penguins, but it may be that conditions are also becoming less optimum even for their less ice-dependent counterpart, the Chinstrap Penguin.

With respect to Blue-eyed Shags, the Inventory identified a downward population trend during the 1990s throughout the Antarctic Peninsula, regardless of whether sites experienced many or few tourist visits (Naveen *et al.* 2000). That observation was consistent with other studies showing that increases up to the mid-1980s had peaked and that many populations (e.g. Signy Island, Cuverville Island, Half Moon Island) experienced significant declines throughout the late 1980s and 1990s (Woehler & Croxall 1997). The Blue-eyed Shag population in the Palmer area also experienced significant declines during this period, although it is difficult to disentangle long-term declines from those that may have resulted from the *Bahia Paraiso* oil spill in 1989 (Woehler & Croxall 1997).

The downward trend of the Blue-eyed Shag population on the Antarctic Peninsula appears to have leveled off, with Shag populations stabilizing throughout the Peninsula. In fact, several sites saw population increases during the seven years reported in this paper.

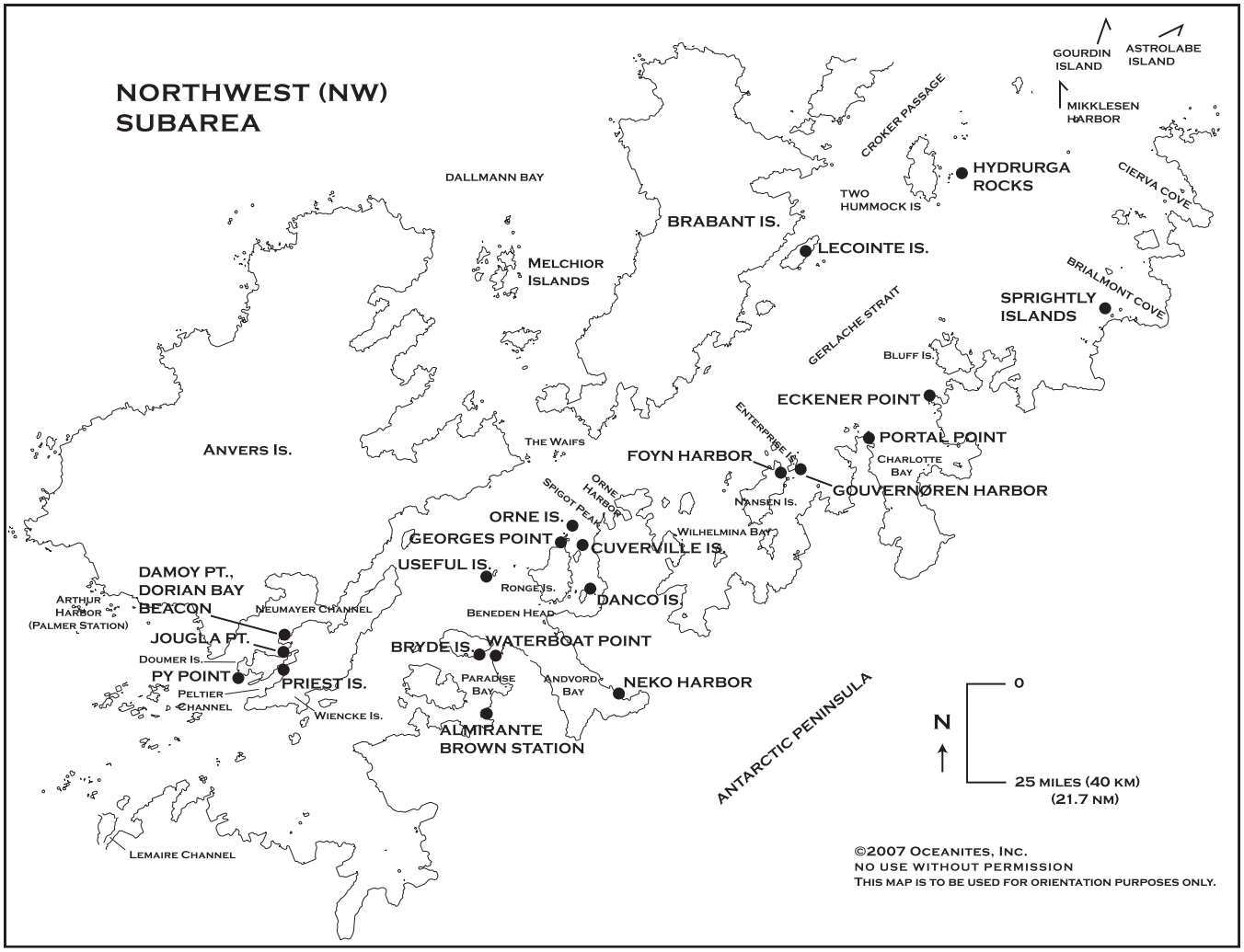

Fig. 4. Map of the Northwest Antarctic Peninsula region subarea, as defined by the Antarctic Site Inventory.

The population of Blue-eyed Shags roughly doubled at Cuverville Island (64°41′S, 62°38′W) between December 2001 and December 2004 and at Pléneau Island (65°06′S, 64°04′W) between January 2000 and January 2006, and more than doubled at Paulet Island (63°35′S, 55°47′W) between November 1999 and November 2007.

With respect to Southern Giant Petrels, we report increasing populations at two sites in the South Shetland Islands (Barrientos Island [Aitcho Islands] 62°24′23″S, 59°45′00″W, and Hannah Point [Livingston Island] 62°39′S, 60°37′W). These trends are consistent with reports of stable or increasing Southern Giant Petrel populations elsewhere on the Peninsula (Woehler & Croxall 1997), but with only two sites at which we can assess changes, we are unable to assess overall trends for this species. We note, however, that at the 2006 and 2007 Antarctic Treaty Consultative Meetings, there was vigorous discussion about listing this species as a Specially Protected Species under Annex II of the Protocol on Environmental Protection to the Antarctic Treaty (λXth Antarctic Treaty Consultative Meeting 2006, XXXth Antarctic Treaty Consultative Meeting 2007). The International Union for Conservation of Nature (IUCN) has expressed concern about this species because of longline fishing in the Southern Ocean, but the status of Southern Giant Petrels in the Antarctic Peninsula remains unclear. The Inventory is uniquely positioned to monitor this species and will continue to do so.

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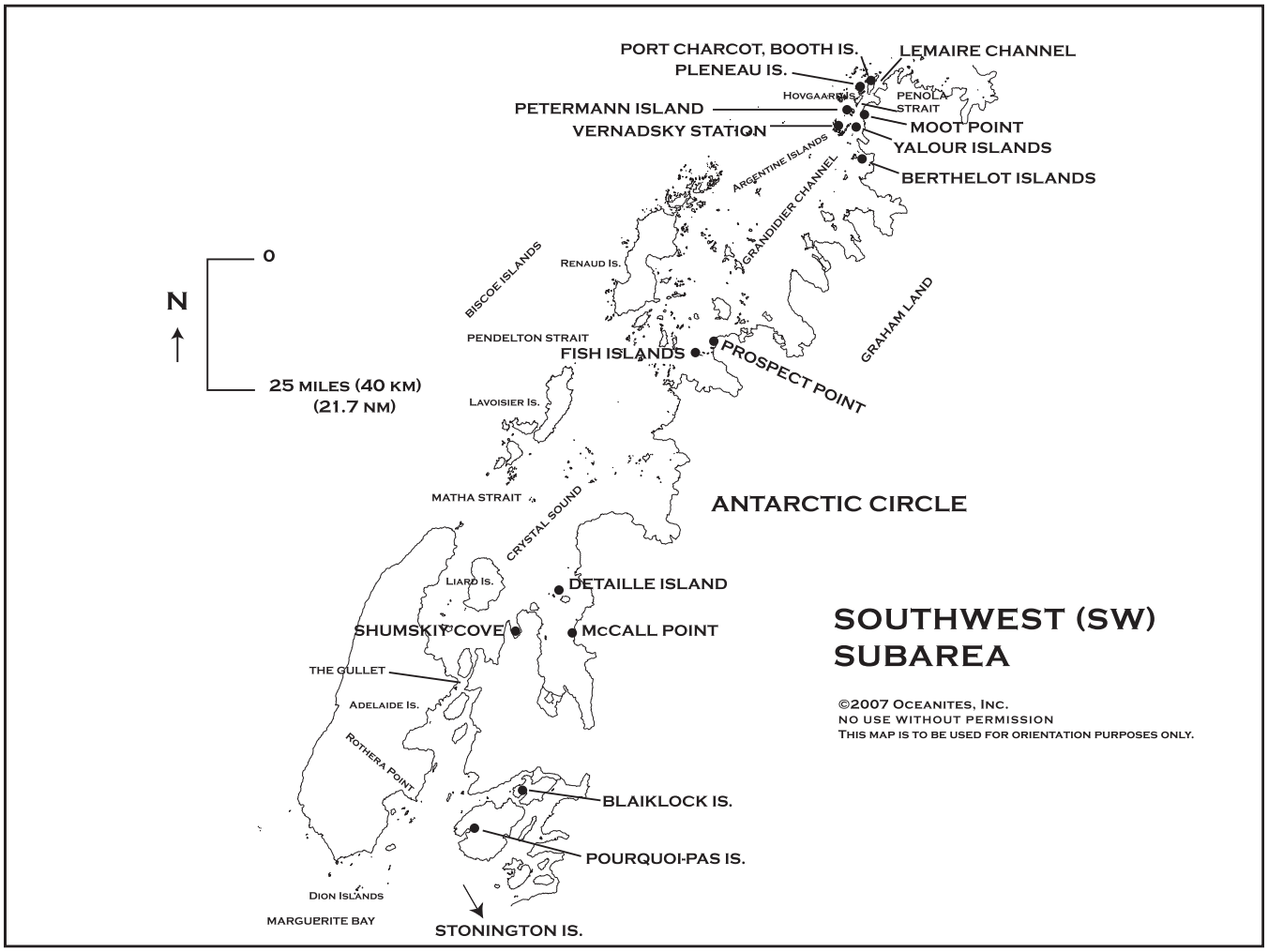

Fig. 5. Map of the Southwest Antarctic Peninsula region subarea, as defined by the Antarctic Site Inventory.

Adventures; Hapag–Lloyd Kreuzfahrten; Hurtigruten Group ASA; and Polar Star Expeditions).

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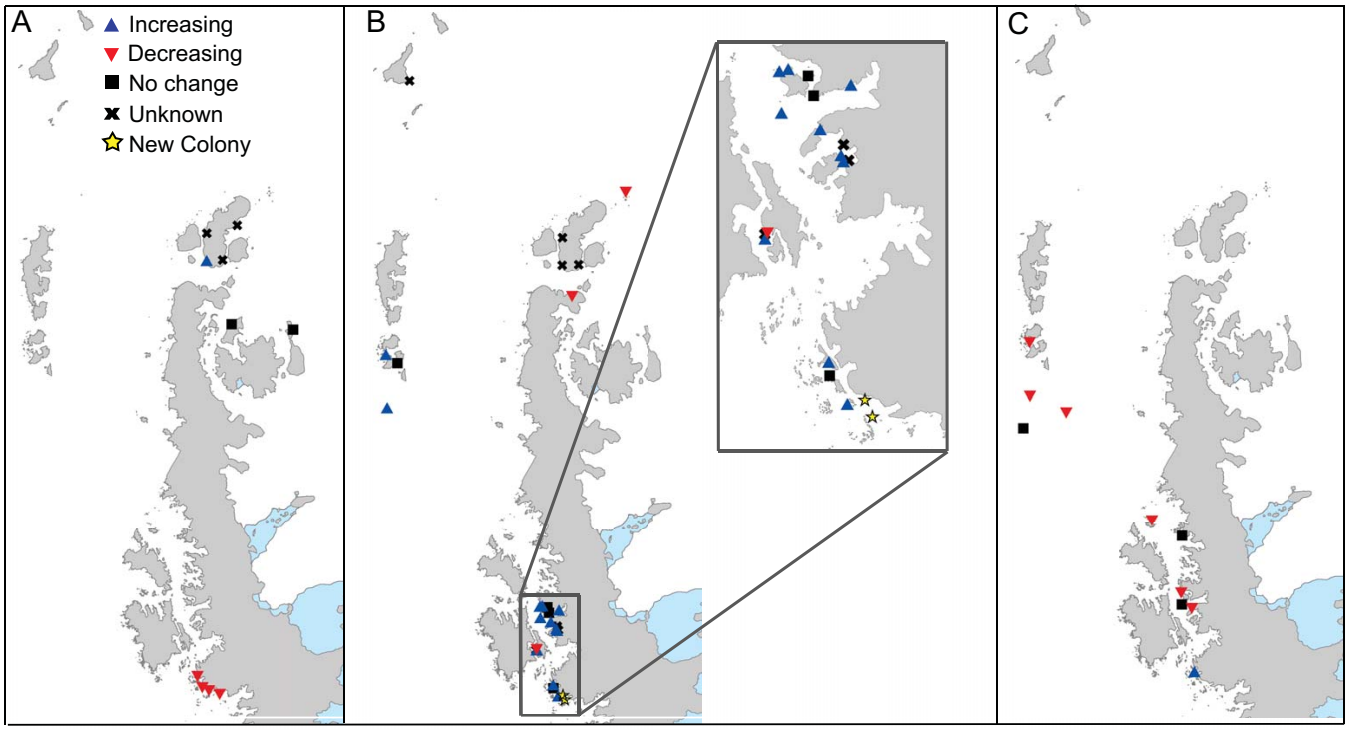

Fig. 6. (A) Changes in Adélie Penguin *Pygoscelis adeliae* populations. (B) Changes in Gentoo Penguin *Pygoscelis papua* populations. The southwestern region has been expanded in the inset to provide greater detail. (C) Changes in Chinstrap Penguin *Pygoscelis antarctica* populations. Filled triangle = increasing; filled inverted triangle = decreasing; filled square = no change; cross = unknown; filled star = new colony.

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TABLE 1
Antarctic Site Inventory (ASI) censuses for the Adélie Penguin *Pygoscelis adeliae,* 2001–2007

Census[a]		Date	Notes	Annual rate of change (λ)[b]
Marshall Bay, Coronation Island (SO)			To be confirmed. New site for the ASI. Appears to be the first reported census at this site.	NA
60°39′S, 45°38′W				
13 381	N3	17 Dec 2003		
Shingle Cove, Coronation Island (SO)			No change since N4 count of 3000 in 1978 (Woehler 1993). New site for the ASI.	1.0±0.02
60°39′S, 45°34′W				
3205	N1	17 Dec 2003		
3041	N1/N2/N3	9 Dec 2006		
Devil Island (NE)			No clear trend since C3 count of 10 320 in 1996 (Naveen, unpub. data; reported in Woehler & Croxall 1997).	NA
63°48′S, 57°17′W				
5880	C3	12 Jan 2002		
8500	C3	20 Jan 2003		
8802	N1/N2/N3	31 Dec 2004		
18 000	C3	13 Jan 2007		
d'Urville Monument (NE)				NA
63°25′S, 56°18′W				
10 000	N4	24 Jan 2006		
Penguin Point, Seymour Island (NE)			No change since N2 count of 21 954 in 1985 (Woehler 1993). New site for the ASI.	1.01±0.02
64°17′42″S, 56°41′24″W				
26 400	N4	22 Dec 2006		
Saxum Nunatak (NE)			To be confirmed. New site for the ASI. Appears to be the first reported census at this site.	NA
63°10′S, 56°02′W				
150	N4	22 Dec 2005		
Tay Head, Joinville Island (NE)			New site for the ASI. Appears to be the first reported census at this site.	NA
63°21′S, 55°33′W				
6450	N4	21 Dec 2006		
Berthelot Islands (SW)			N1 count of 402 is down 69% since N1 count of 1300 in 1982 (Woehler 1993).	0.952±0.003
65°20′S, 64°09′W				
402	N1	25 Dec 2006		
548	C1	16 Jan 2007		
Booth Island (SW)			Down >95% from estimate of >1208 (A5,C1,C3,B) in 1903–1909 (Woehler 1993). (We assume a C4 count of 1208 in 1906 to estimate λ.)	0.961±0.005
65°05′S, 64°00′W				
18	N1	14 Jan 2001		
34	N1	24 Dec 2001		
17	N1	4 Jan 2006		
23	C1	26 Jan 2006		
Detaille Island (SW)			No change between C3 count of 925 and C1 count of 900 in 1986 (Woehler 1993). New site for the ASI.	1.00±0.01
66°52′S, 66°48′W				
925	C3	13 Jan 2003		
Fish Islands (SW)			Down 59% from C3/C4 count of 4000 in 1984 (Woehler 1993).	0.95±0.03
66°02′S, 65°25′W				
1634	C1/C2	13 Jan 2003		
Pléneau Island (SW)			Further monitoring of this site is required to determine if this stray nesting pair represents a new colony of Adélie penguins at this site.	N/A
65°06′S, 64°04′W				
1	N1	3 Jan 2003		
1	N1	4 Jan 2004		
Petermann Island (SW)			N1 count of 410 is down 52% from N1 count of 862 in 1997 (Naveen *et al.* 2000).	0.921±0.007
65°10′S, 64°10′W				
485	N1	10 Dec 2002		
553	N1	21 Nov 2003		
731	C1	24 Jan 2004		
532	N1	21 Nov 2004		
580	C1	4 Feb 2005		
505	N1	16 Nov 2005		
589	C1	27 Jan 2006		
410	N1	21 Nov 2006		
458	C1	4 Feb 2007		
Yalour Islands (SW)			N1 count of 4246 is down 47% from N1 count of 8000 in 1982 (Woehler 1993).	0.970±0.003
65°14′S, 64°10′W				
4246[c]	N1	30 Nov 2003		
5558	C1	27 Jan 2004		

[a] Codes: N1 = nests individually counted, accurate to better than ±5%; N2 = nests counted in a known area, and then extrapolated over total colony area, accurate to 5%–10%; N3 = accurate estimate, accurate to 10%–15%; N4 = Rough estimate, accurate to 25%–50%; C1 = chicks individually counted, accurate to better than ±5%; C2 = chicks counted in a known area, and then extrapolated over total area, accurate to 5%–10%; C3 = accurate estimate, accurate to 10%–15%; C4 = rough estimate, accurate to 25%–50%; A1 = estimates based on counts of total birds or adults individually counted, accurate to better than ±5%; A2 = estimates based on counts of total birds or adults individually counted, accurate to 5%–10%; A3 = estimates based on counts of total birds or adults individually counted, accurate to 10%–15%; A4 = estimates based on counts of total birds or adults individually counted, accurate to 25%–50%.

[b] Where census error is larger than the difference between two censuses, we assume no change in population size. The annual rate of population change λ (and its error) is calculated as described in the text.

[c] Does not include approximately 25 nests on Island 11.

SO = South Orkney islands; NA = not applicable; NE = Northeast Antarctic Peninsula; SW = Southwest Antarctic Peninsula.

TABLE 2
Antarctic Site Inventory censuses for the Gentoo Penguin *Pygoscelis papua,* 2001–2007

Census[a]		Date	Notes	Annual rate of change (λ)[b]
Barrientos Island, Aitcho Islands (SH)			Up 39% since N1 count of 1177 in Dec 1999 (Naveen *et al.* 2000).	1.05±0.01
62°24′23″S, 59°45′00″W				
1236	C1	11 Jan 2002		
1486	N1	20 Dec 2003		
1998	N1	18 Nov 2005		
2483	C1/C2	22 Jan 2006		
1639	N1	20 Dec 2006		
Hannah Point, Livingston Island (SH)			Up 40% since N1 count of 1350 in Dec 1997 (Naveen *et al.* 2000).	1.05±0.01
62°39′S, 60°37′W				
1885	N1	23 Dec 2004		
Yankee Harbor, Greenwich Island (SH)			No change since N1 count of 4751 in 1999 (Naveen *et al.* 2000).	1.01±0.02
62°32′S, 59°47′W				
3974	N1	24 Dec 2000		
3804	N1	29 Dec 2002		
4918	N1	20 Dec 2003		
Point Lookout (EI)				NA
61°17′S, 55°13′W				
313	C1	22 Jan 2007		
Brown Bluff, Tabarin Peninsula (NE)			N1 count of 444 is down 28% from N1 count of 617 in 1999 (Naveen *et al.* 2000).	0.95±0.01
63°32′S, 56°55′W				
756	N1	11 Dec 2000		
511	C1	9 Jan 2001		
450	N1	11 Dec 2001		
409	C1	24 Jan 2002		
490	N1	31 Dec 2002		
764	C1	10 Jan 2003		
200	N1	29 Nov 2003		
370	N1	24 Dec 2004		
589	C1	11 Jan 2005		
247	N1	22 Dec 2005		
118	C1	13 Jan 2006		
444	N1	19 Nov 2006		
d′Urville Monument (NE)				NA
63°25′S, 56°18′W				
671	C1/C2	24 Jan 2006		
Heroina Island, Danger Islands (NE)			Probably down from N1 count of 215 in 1996 (Naveen *et al.* 2000).	N/A
63°24′S, 54°36′W				
142	C1	3 Feb 2006		
Madder Cliffs, Joinville Island (NE)			To be confirmed. New site for the ASI. Appears to be the first reported census at this site.	NA
63°18′S, 56°29′W				
304	N1	12 Jan 2005		
455	C1	12 Jan 2005		
Saxum Nunatak (NE)			New site for the ASI. Appears to be the first reported census at this site.	NA
63°10′S, 56°02′W				
540	N4	22 Dec 2005		
Almirante Brown Station Vicinity (NW)				NA
64°53′S, 62°52′W				
111	N1	16 Jan 2006		
121	C1	6 Feb 2006		
128	N1	19 Nov 2006		
Beneden Head (NW)			No change since C1/C3 count of 500 in 1986 (Woehler 1993). New site for the ASI.	NA
64°46′S, 62°42′W				
640	N3	13 Dec 2006		
Bryde Island (NW)				
64°52′S, 63°02′W				
See Bryde Island East and South below				
Bryde Island South is actually a small island off the coast in the region indicated by the red box.				NA
Bryde Island East (NW)				1.036±0.006
64°53′21″S, 62°55′31″W				
486	N1/N2	24 Dec 2006	Up 103% since N1 count of 240 in 1986 (Woehler 1993). New site for the ASI.	
Bryde Island South (NW)			Possibly up from C1 count of 500 in 1987 (Woehler 1993). New site for the ASI.	NA
64°54′3″S, 62°57′2″W				
818	N1	24 Dec 2006		
Cuverville Island (NW)			N1 count of 6294 is up 31% since N1 count of 4818 in 1994 (Woehler and Croxall 1997).	1.025±0.007
64°41′S, 62°38′W				
5990	N1	21 Dec 2003		
6294	N1	2 Dec 2005		
4420	N3	4 Jan 2007		
Dorian Bay/Damoy Point (NW)			N1 count of 2273 is up 37% since N1 count of 1658 in 1990 (Woehler 1993).	1.021±0.005
64°49′S, 63°32′W				
1928	N1	12 Dec 2002		
2022	N1	4 Jan 2005		
2273	N1	26 Dec 2005		
2990	C1	5 Feb 2006		
Danco Island (NW)			No change since N2 count of 2300 in Nov 1999 (Naveen *et al.* 2000).	1.01±0.02
64°44′S, 62°37′W				
2506	N1	8 Dec 2006		

Census[a]		Date	Notes	Annual rate of change (λ)[b]
Dori Beacon (NW)			New site for the ASI. Appears to be the first reported census at this site.	NA
64°48′42″S, 63°30′42″W				
132	N1	15 Jan 2005		
181	N1	26 Dec 2005		
257	C1	5 Feb 2006		
Georges Point, Rongé Island (NW)			N1 count of 2464 is up 41% since N2 count 1752 in 1994 (Woehler and Croxall 1997).	1.03±0.01
63°12′S,57°18′W				
1995	N1	20 Dec 2004		
2464	N1	26 Dec 2005		
Jougla Point/Port Lockroy (NW)			N1 count of 1282 is down 24% since N1 count of 1681 in 1999 (Naveen *et al.* 2000).	0.96±0.01
64°49′S, 63°30′W				
1556	N1	9 Dec 2002		
1621	C1	25 Jan 2003		
1540	N1	5 Jan 2004		
2043	C1	16 Feb 2004		
1306	N1	20 Dec 2004		
1409	N1	26 Dec 2005		
1925	C1	27 Jan 2006		
1282	N1	22 Nov 2006		
1684	C1	28 Jan 2007		
Neko Harbor, Andvord Bay (NW)			N1/N2/N3 count of 1153 is up 37% since N1 count of 844 in 1999 (Naveen *et al.* 2000).	1.05±0.02
64°50′S, 62°33′W				
1072	N1	11 Dec 2002		
1088	N1	21 Dec 2003		
1096	N1	14 Dec 2004		
1301	N1	3 Dec 2005		
1726	C1	28 Jan 2006		
1153	N1/N2/N3	13 Dec 2006		
Paradise Harbor Beacon, Paradise Bay (NW)			New site for the ASI. Appears to be the first reported census at this site.	NA
64°54′40″S, 62°55′52″W				
3	N1	24 Dec 2006		
Useful Island (NW)			Up >1500% over N3N/4 count of 150 in 1984 (Woehler 1993). New site for the ASI.	1.13±0.03
64°43′S, 62°52′W				
1861	N1	3 Jan 2005		
Waterboat Point, Paradise Bay (NW)			This represents a significant increase since C1 count of 750 in 1986 (Woehler 1993).	NA
64°49′S, 62°51′W				
2122	N2	4 Dec 2004		
Port Charcot, Booth Island (SW)			N3 count of 1200 is up 300% since N1 count of 400 in 1983 (Woehler 1993).	1.063±0.009
65°05′S, 64°00′W				
1200	N3	13 Jan 2001		
1151	N1/N3	4 Jan 2006		
Moot Point (SW)			This represents a new breeding colony of Gentoos. New site for the ASI. Appears to be the first reported census at this site.	NA
65°12′S, 64°06′W				
74	N1	24 Nov 2005		
101	N1	25 Dec 2006		
Pléneau Island (SW)			No change since N1 count of 1577 in 1999 (Naveen *et al.* 2000).	1.00±0.01
65°06′S, 64°04′W				
1579	N1	13 Dec 2000		
1639	N1	3 Jan 2003		
2170	N1	22 Dec 2003		
2135	N1	4 Jan 2005		
1574	N1	5 Jan 2007		
Petermann Island (SW)			N1 count of 2293 is up 47% since N1 count of 1224 in 1997 (Naveen *et al.* 2000).	1.072±0.008
65°10′S, 64°10′W				
2212	N1	17 Jan 2004		
3260	C1	24 Jan 2004		
2301	N1	4 Dec 2004		
2781	C1	23 Jan 2005		
2438	N1	2 Dec 2005		
3453	C1	25 Jan 2006		
2293	N1	24 Nov 2006		
3344	C1	2 Feb 2007		
Yalour Islands (SW)			This represents a new breeding colony of Gentoos and the southernmost location ever reported for Gentoos along the Antarctic Peninsula.	NA
65°14′S, 64°10′W				
15	N1	25 Dec 2006		

[a] Codes: N1 = nests individually counted, accurate to better than ±5%; N2 = nests counted in a known area, and then extrapolated over total colony area, accurate to 5%–10%; N3 = accurate estimate, accurate to 10%–15%; N4 = Rough estimate, accurate to 25%–50%; C1 = chicks individually counted, accurate to better than ±5%; C2 = chicks counted in a known area, and then extrapolated over total area, accurate to 5%–10%; C3 = accurate estimate, accurate to 10%–15%; C4 = rough estimate, accurate to 25%–50%; A1 = estimates based on counts of total birds or adults individually counted, accurate to better than ±5%; A2 = estimates based on counts of total birds or adults individually counted, accurate to 5%–10%; A3 = estimates based on counts of total birds or adults individually counted, accurate to 10%–15%; A4 = estimates based on counts of total birds or adults individually counted, accurate to 25%–50%.

[b] Where census error is larger than the difference between two censuses, we assume no change in population size. The annual rate of population change λ (and its error) is calculated as described in the text.

SH = South Shetland Islands; EI = Elephant Island and nearby islands; NE = Northeast Antarctic Peninsula; NW = Northwest Antarctic Peninsula; SW = Southwest Antarctic Peninsula.

TABLE 3
Antarctic Site Inventory (ASI) censuses for the Chinstrap Penguin *Pygoscelis antarctica*, 2001–2007

Census[a]		Date	Notes	Annual rate of change (λ)[b]
Sandefjord Bay (SO)			New site for the ASI. Appears to be the first reported census at this site.	NA
60°37′S, 46°03′W				
125 000	A4	28 Nov 2003		
Cecilia Island, Aitcho Islands (SH)			Down >99% from N4 count of 3500 in 1966 (Woehler 1993). New site for the ASI.	0.87±0.01
62°24′43″S, 59°43′53″W				
14	N1	11 Jan 2006		
Entrance Point (SH)			N1 count of 902 is down 55% since N3 count of 2010 in 1967 (Woehler 1993). New site for the ASI.	0.980±0.004
63°00′S, 60°33′W				
566	N1	23 Dec 2005		
736	C1	25 Jan 2006		
902	N1	21 Nov 2006		
Hannah Point, Livingston Island (SH)			Down 49% since N3 count of 1500 in 1987 (Woehler 1993).	0.961±0.009
62°39′S, 60°37′W				
759	N1	23 Dec 2004		
President Head, Snow Island (SH)			No change since A4 count of 50 in 1987 (Woehler 1993). New site for the ASI.	1.00±0.03
62°44′S, 61°12′W				
23	N1	21 Nov 2005		
Point Wild/Cape Belsham (EI)			Count includes all of Point Wild and Cape Belsham together.	NA
61°06′S, 54°52′W				
10 000	N3	10 Dec 2006		
Eckener Point (NW)			No change since N3/N4 count of 40 in 1987 (Woehler 1993). New site for the ASI.	0.98±0.02
64°26′S, 61°36′W				
30	N1	13 Dec 2006		
Georges Point, Ronge Island (NW)			N1 count of 260 is down 20% since N1 count of 327 in 1998 (Naveen *et al.* 2000).	0.972±0.009
64°40′S, 62°40′W				
356	N1	12 Jan 2001		
269	N1	20 Dec 2004		
246	N1	26 Dec 2005		
399	C1	5 Feb 2006		
260	N1	22 Nov 2006		
354	C1	26 Jan 2007		
Hydrurga Rocks (NW)			N1 count of 448 is down 15% since N1 count of 526 in 1996 (Naveen *et al.* 2000).	0.97±0.01
64°08′S, 61°37′W				
417	N1	26 Dec 2000		
448	N1	1 Jan 2003		
Orne Islands (NW) (All on island 2)			N1 count of 350 in Nov 2005 is down 17% since N1 count of 421 in Nov 1999 (Naveen *et al.* 2000).	
64°39′S, 62°40′W				
396	N1	14 Dec 2000		0.97±0.01
634	C1	23 Jan 2001		
106	N1	24 Dec 2001		
111	C1	15 Feb 2002		
338	N1	9 Dec 2002		
472	C1	14 Feb 2003		
350	N1	22 Nov 2005		
489	C1	5 Feb 2006		
447	C1	26 Jan 2007		
Useful Island (NW)			No change since N3/N4 count of 100 in 1984 (Woehler 1993). New site for the ASI.	1.02±0.03
64°43′S, 62°52′W				
160	N1	3 Jan 2005		
Waterboat Point, Paradise Bay (NW)			This represents the local disappearance of Chinstraps at this site, which recently has had a declining population over the last two decades: N1 = 4 in 1998 (Naveen, unpub. data); N1 = 28 in 1989 (Woehler 1993).	NA
64°49′S, 62°51′W				
0	N1	3 Jan 2005		
Booth Island (SW)			Generally up since C1 count of 3 in 1983 and N1 count of 3 in 1990 (Woehler 1993).	1.076±0.005
65°05′S, 64°00′W				
12	N1	13 Jan 2001		
17	C1	24 Jan 2001		
24	N1	24 Dec 2001		
9	N1	4 Jan 2006		
12	C1	26 Jan 2006		
13	C1	15 Feb 2007		

[a] Codes: N1 = nests individually counted, accurate to better than ±5%; N2 = nests counted in a known area, and then extrapolated over total colony area, accurate to 5%–10%; N3 = accurate estimate, accurate to 10%–15%; N4 = Rough estimate, accurate to 25%–50%; C1 = chicks individually counted, accurate to better than ±5%; C2 = chicks counted in a known area, and then extrapolated over total area, accurate to 5%–10%; C3 = accurate estimate, accurate to 10%–15%; C4 = rough estimate, accurate to 25%–50%; A1 = estimates based on counts of total birds or adults individually counted, accurate to better than ±5%; A2 = estimates based on counts of total birds or adults individually counted, accurate to 5%–10%; A3 = estimates based on counts of total birds or adults individually counted, accurate to 10%–15%; A4 = estimates based on counts of total birds or adults individually counted, accurate to 25%–50%.

[b] Where census error is larger than the difference between two censuses, we assume no change in population size. The annual rate of population change λ (and its error) is calculated as described in the text.

SO = South Orkney islands; NA = not applicable; SH = South Shetland Islands; EI = Elephant Island and nearby islands; NW = Northwest Antarctic Peninsula.

TABLE 4
Antarctic Site Inventory (ASI) censuses for the Blue-eyed Shag *Phalacrocorax atriceps*, 2001–2007

Census[a]		Date	Notes	Annual rate of change (λ)[b]
Hannah Point, Livingston Island (SH)			Down 20% since N1 count of 5 in 1999 (Naveen *et al.* 2000).	0.96±0.0
62°39′S, 60°37′W				
3	N1	15 Dec 2000		
4	N1	23 Dec 2004	1	
Whaler's Bay, Deception Island (SH)				NA
62°59′S, 60°34′W				
10	N1	13 Jan 2005		
17	C1	13 Jan 2005		
8	N1	23 Dec 2005		
Active Reef, Active Sound (NE)			New site for the ASI.	NA
63°23′S, 55°52′W				
20	A5	21 Dec 2006		
Cockburn Island (NE)			New site for the ASI.	NA
64°12′S, 56°51′W				
800	N5	19 Nov 2006		
Almirante Brown Station Vicinity (NW)			N1 count of 75 is up 53% since N1 count of 49 in 2000 (Naveen *et al.* 2000). After declining for several years in the 1990s (Naveen *et al.* 2000), the N1 count of 45 in 2001 was the lowest point for this population, and the population has been generally increasing over the period we report here.	1.06±0.01
64°53′S, 62°52′W				
45	N1	13 Dec 2001		
63	N1	11 Dec 2002		
114	C1	25 Jan 2003		
73	N1	2 Dec 2003		
78	N1	14 Dec 2004		
104	C1	14 Jan 2005		
71	N1	2 Dec 2005		
75	N1	22 Nov 2006		
Paulet Island (NE)			N1/N2 count of 804 in Nov. 2006 is up 113% since N2 count of 377 in Nov. 1999 (Naveen *et al.* 2000).	1.11±0.02
63°35′S, 55°47′W				
291	N1	25 Dec 2000		
279	C1	9 Jan 2001		
321	N1	21 Dec 2001		
273	N1	10 Jan 2003		
524	C2	20 Jan 2003		
534	N1	24 Dec 2004		
413	N1	20 Nov 2005		
327	A1	13 Jan 2006		
804	N1/N2	19 Nov 2006		
465	C2	18 Feb 2007		
Beneden Head (NW)			New site for the ASI.	NA
64°46′S, 62°42′W				
20	N3	22 Nov 2006		
Cuverville Island (NW)			N1 count of 29 in Nov 2006 is up 141% from N1 count of 12 in Dec 2001.	1.19±0.02
64°41′S, 62°38′W				
13	N1	23 Jan 2001		
33	C1	23 Jan 2001		
12	N1	13 Dec 2001		
28	N1	2 Jan 2003		
40	C1	14 Feb 2003		
26	N1	21 Dec 2003		
21	N1	13 Dec 2004		
30	C1	14 Jan 2005		
23	N1	26 Dec 2005		
29	N1	22 Nov 2006		
Hydrurga Rocks (NW)				NA
64°08′S, 61°37′W				
11	N1	3 Jan 2002		
13	C1	3 Jan 2002		
12	N1	11 Jan 2003		
Jougla Point/Port Lockroy (NW)			No change between N1 count of 26 in Jan. 2007 and N1 count of 26 in Jan. 2000.	1.01±0.01
64°50′S, 63°30′W				
26	N1	13 Dec 2000		
43	C1	4 Feb 2001		
23	N1	25 Dec 2001		
26	C1	28 Jan 2002		
32	N1	9 Dec 2002		
62	C1	25 Jan 2003		
28	N1	1 Dec 2003		
46	C1	16 Feb 2004		
29	N1	13 Dec 2004		
43	C1	16 Jan 2005		
20	N1	26 Dec 2005		
46	C1	27 Jan 2006		
26	N1	28 Jan 2007		
44	C1	28 Jan 2007		

Census[a]		Date	Notes	Annual rate of change (λ)[b]
Lecointe Island (NW)			New site for the ASI.	NA
64°16′S, 62°03′W				
7	N1	23 Dec 2001		
4	N1	12 Dec 2002		
Orne Islands (NW)			Although there were 15 active nests in Dec 1994 (Naveen *et al.* 2000), the Blue-eyed Shag population on the Orne Islands went extinct in 1999 and, as reported here, has not been reestablished.	NA
64°39′S, 62°40′W				
0	N1	14 Dec 2000		
0	C1	23 Jan 2001		
0	N1	15 Feb 2002		
0	C1	15 Feb 2002		
0	N1	22 Nov 2005		
0	N1	22 Nov 2006		
Priest Island, Peltier Channel (NW)			New site for the ASI.	NA
64°52′S, 63°31′W				
8	N1	14 Dec 2001		
Useful Island (NW)			To be confirmed. New site for the ASI.	NA
64°43′S, 62°52′W				
17	N1	3 Jan 2005		
Berthelot Islands (SW)				NA
65°20′S, 64°09′W				
96	N1	25 Dec 2006		
Detaille Island (SW)			New site for the ASI.	NA
66°52′S, 66°48′W				
3	C1	13 Jan 2003		
3	N1	3 Jan 2004		
Fish Islands (SW)				NA
66°02′S, 65°25′W				
31	N1	13 Jan 2003		
Pléneau Island (SW)			N1 count of 58 in Dec 2006 is up 115% since N1 count of 27 in Dec 2000.	NA
65°06′S, 64°04′W				
27	N1	13 Dec 2000		
53	C1	24 Jan 2001		
18	N1	4 Jan 2002		
18	C1	15 Jan 2002		
28	N1	3 Jan 2003		
27	C1	14 Jan 2003		
38	N1	22 Dec 2003		
73	C1	15 Jan 2004		
36	N1	4 Jan 2005		
58	N1	14 Dec 2006		
Petermann Island (SW)			N1 count of 13 in Nov. 2006 is down 55% since N1 count of 29 in Nov 1997 and C1 count of 29 in Jan 2007 is down 37% since C1 count of 46 in Jan 2000 (Naveen *et al.* 2000).	0.915±0.007
65°10′S, 64°10′W				
19	N1	15 Nov 2004		
37	C1	25 Jan 2005		
11	N1	16 Nov 2005		
26	C1	16 Jan 2006		
13	N1	4 Nov 2006		
29	C1	12 Jan 2007		
Stonington Island (SW)			New site for the ASI.	N/A
68°11′S, 67°00′W				
135	C1	6 Feb 2007		
Yalour Islands (SW)				NA
65°14′S, 64°10′W				
16	N1	27 Jan 2004		
40	C1	27 Jan 2004		
18	N1	25 Dec 2006		

[a] Codes: N1 = nests individually counted, accurate to better than ±5%; N2 = nests counted in a known area, and then extrapolated over total colony area, accurate to 5%–10%; N3 = accurate estimate, accurate to 10%–15%; N4 = Rough estimate, accurate to 25%–50%; C1 = chicks individually counted, accurate to better than ±5%; C2 = chicks counted in a known area, and then extrapolated over total area, accurate to 5%–10%; C3 = accurate estimate, accurate to 10%–15%; C4 = rough estimate, accurate to 25%–50%; A1 = estimates based on counts of total birds or adults individually counted, accurate to better than ±5%; A2 = estimates based on counts of total birds or adults individually counted, accurate to 5%–10%; A3 = estimates based on counts of total birds or adults individually counted, accurate to 10%–15%; A4 = estimates based on counts of total birds or adults individually counted, accurate to 25%–50%.

[b] Where census error is larger than the difference between two censuses, we assume no change in population size. The annual rate of population change λ (and its error) is calculated as described in the text.

SH = South Shetland Islands; NA = not applicable; NE = Northeast Antarctic Peninsula; NW = Northwest Antarctic Peninsula; SW = Southwest Antarctic Peninsula.

Table 5
Antarctic Site Inventory (ASI) censuses for the Southern Giant Petrel *Macronectes giganteus*

Census[a]		Date	Notes	Annual rate of change (λ)[b]
Barrientos Island, Aitcho Islands (SH) 62°24′23″S, 59°45′00″W			N1 count of 144 is up 33% since N1 count of 108 in 1999.	1.04±0.01
153	C1	12 Dec 2001		
156	N1	11 Jan 2002		
142	N1	20 Dec 2003		
164	N1	10 Jan 2005		
143	N1	29 Nov 2005		
144	N1	18 Nov 2006		
Cecilia Island, Aitcho Islands (SH) 62°24′43″S, 59°43′53″W			New site for the ASI.	NA
100	N1	11 Jan 2006		
Hannah Point, Livingston Island (SH) 62°39′S, 60°37′W			N1 count of 142 is up 28% since N1 count of 111 in 2000 (Naveen *et al.* 2000).	1.06±0.02
123	N1	15 Dec 2000		
142	N1	2 Jan 2005		
President Head, Snow Island (SH) 62°44′S, 61°12′W			New site for the ASI.	NA
40	N4	21 Nov 2005		

[a] Codes: N1 = nests individually counted, accurate to better than ±5%; N2 = nests counted in a known area, and then extrapolated over total colony area, accurate to 5%–10%; N3 = accurate estimate, accurate to 10%–15%; N4 = Rough estimate, accurate to 25%–50%; C1 = chicks individually counted, accurate to better than ±5%; C2 = chicks counted in a known area, and then extrapolated over total area, accurate to 5%–10%; C3 = accurate estimate, accurate to 10%–15%; C4 = rough estimate, accurate to 25%–50%; A1 = estimates based on counts of total birds or adults individually counted, accurate to better than ±5%; A2 = estimates based on counts of total birds or adults individually counted, accurate to 5%–10%; A3 = estimates based on counts of total birds or adults individually counted, accurate to 10%–15%; A4 = estimates based on counts of total birds or adults individually counted, accurate to 25%–50%.

[b] Where census error is larger than the difference between two censuses, we assume no change in population size. The annual rate of population change λ (and its error) is calculated as described in the text.

SH = South Shetland Islands; NA = not applicable.