SURVEYS OF BREEDING CHINSTRAP PENGUINS IN THE SOUTH SHETLAND ISLANDS, ANTARCTICA

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ABSTRACT. Surveys in 1987 provide data on the number, size and location of chinstrap penguin colonies in the South Shetland Islands (62–64° S, 57–63° W) Antarctica. The minimum estimate of about 1620000 breeding chinstraps, the most abundant penguin in this area, is about 2.5 times greater than the previous estimate. Although there appears to have been about a 40% overall increase in the chinstrap population in the last 20–30 years, about three-quarters of the difference between our counts and previous ones is apparently due to more complete coverage of available nesting habitat in 1987.

INTRODUCTION

Data on the distribution and abundance of breeding penguins of the Antarctic Peninsula and the islands of the Scotia Sea have been summarized recently (Watson and others, 1971; Croxall and Kirkwood, 1979; Wilson, 1983; Croxall and others, 1984), but information is incomplete. To fill data gaps, we have carried out censuses of breeding penguins and other seabirds (Shuford and Spear, 1988) along most of the ice-free shoreline of the South Shetland Islands from 29 January to 12 February 1987. We report here our estimates of the number of breeding chinstrap penguins (*Pygoscelis antarctica*), the most numerous penguin in the region.

STUDY AREA AND METHODS

Censuses

Our work in the South Shetland Islands (Fig. 1) was conducted in conjunction with surveys of seals, primarily Antarctic fur seals (*Arctocephalus gazella*) and southern elephant seals (*Mirounga leonina*). We surveyed the ice-free shorelines of King George, Nelson, Robert, Greenwich, Livingston, Deception, Snow, Smith and Low Islands, and other small offshore islands in the vicinity (Figs 2–4). Censuses were not carried out on offshore islands on the north coast of King George Island from Cape Melville to False Round Point and from Stigant Point to Fildes Strait (Fig. 2); the inside of Admiralty Bay, King George Island, from Sphinx Hill on the west to Chabrier Rock on the east (Fig. 2); and offshore islands on the north coast of Nelson and Robert islands as far west as Dee Island off the north-east corner of Greenwich Island (Fig. 3). Information for some of these areas was obtained from observers who primarily censused seals. So as not to bias our censuses, we refrained from consulting previous penguin colony-size estimates for this region (Croxall and Kirkwood, 1979; Jabloński, 1984) until after the completion of our work.

Surveys were conducted primarily from two inflatable boats deployed from the Polish research ship, *Profesor Siedlecki*. Seabirds were viewed through 8–10× binoculars from the stationary boats or while we cruised at approximately 1–3 kts, usually 50–300 m from shore. We occasionally went ashore to obtain overviews of very large penguin colonies which were not completely visible from the water.

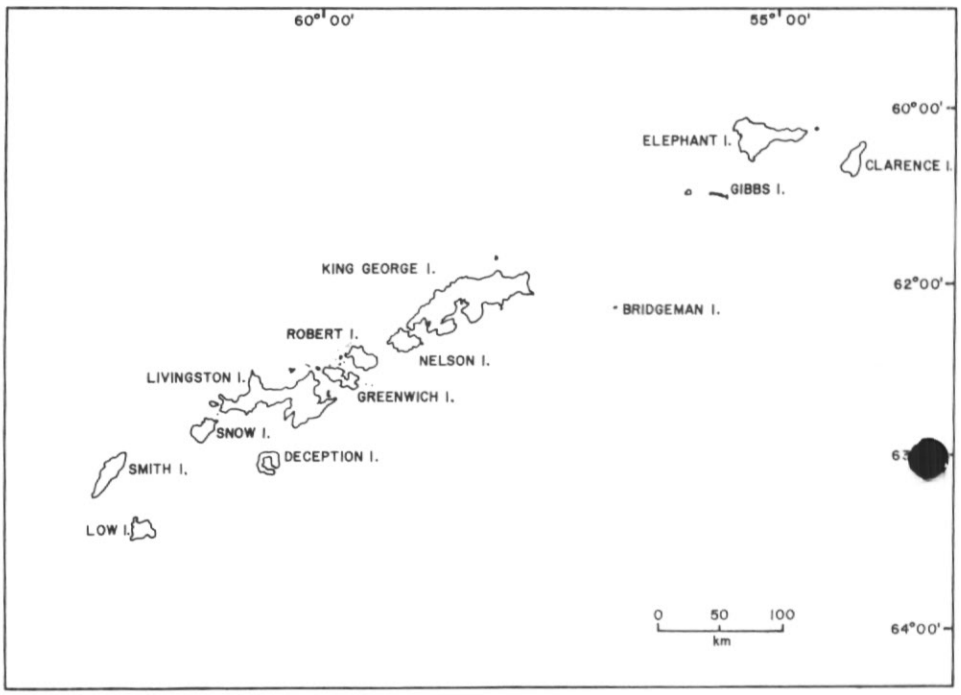

Fig. 1. South Shetland Islands, Antarctica study area.

At all chinstrap penguin colonies we counted only adults associated directly with nests or young, excluding peripheral birds such as those roosting nearby or on beaches or walking to and from the colonies. At the time of our censuses, adults and chicks were still closely associated with their nest sites.

Accuracy of censuses

Our censuses of penguins were dependent on the schedule and priorities of the seal investigators, and thus we were able to obtain careful counts at only a few sites. Additionally, between-site differences existed in census conditions (e.g. diverse topography, boat versus land vantage points, and time available for conducting the census) and, thus, the accuracy of our censuses varied considerably. Accordingly, we assigned each estimate (total number of adults) to one of four categories of approximate accuracy:

1. *Detailed counts* of individuals in small colonies (< 500 birds) or *estimates* of individuals by blocks of 10, 50, of 100 in larger colonies. These were made from the land by walking along colony boundaries, and we guess accuracy to be ±5–10% (see Jehl and Todd, 1985).

2. *Rough estimates* by blocks of 100s or 1000s, from a moving boat, or by walking around major portions of extensive colonies making partial counts and mental extrapolations from these. The accuracy of estimates under 5000 is probably ±10–20%, between 5000 and 25000 ±20–30% and over 25000 ±30–50%.

3. *Educated guesstimates* were guesses based on mental comparison with detailed counts of other penguin colonies or prior experience with known-sized colonies of

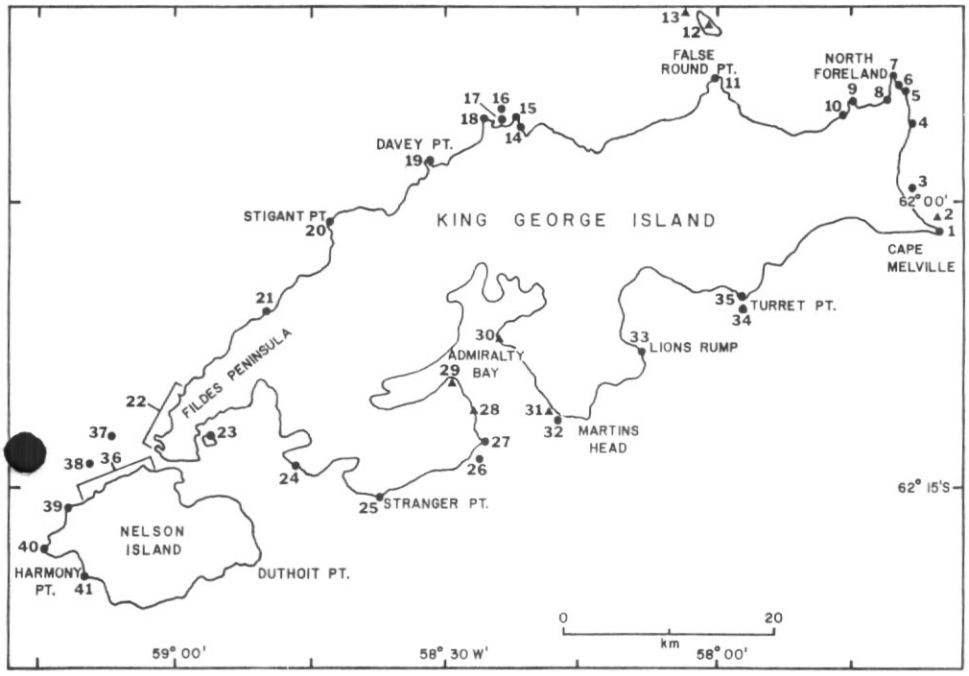

Fig. 2. King George and Nelson islands, South Shetland Islands. Survey sites in 1987 indicated by numbered dots or bracketed stretches of coastline; additional prior survey sites reported in the literature indicated by triangles (Table I).

other seabirds. These were made for very large and extensive colonies when time or vantage points were limited, and were the least reliable of all; accuracy likely ±50–100%.

4. *Casual observations* were verbal descriptions from observers concerned with other work, or our own for localities where it was not possible to see a substantial proportion of the colony due to time and vantage point limitations.

Results

We recorded chinstrap colonies at 91 sites in the South Shetland Islands (Table I, Figs 2–4). Although the species occurred throughout the study area, most of the breeding sites and population resided on the northern or western sides of the islands (Table I). Our censuses provide an estimate of 1.6–2.1 million breeding chinstraps in the South Shetlands (Table I). Our minimum estimate is likely to be conservative due to breeding failure before our arrival, the lack of quantitative population estimates for several large colonies, and the fact that 1986/87 was a year when sea ice was extensive and fewer chinstraps were breeding at least in Admiralty Bay, King George Island (W. L. Trivelpiece, pers. comm.). Even so, our minimum estimate is about 2.5 times greater than Croxall and others' (1984) estimate of about 660000 birds nesting at 45 sites in the South Shetland Islands. Although we clearly conducted censuses at many more sites than did previous workers, comparisons with other estimates for individual islands shed light on how much of the difference between our

Table I. Censuses of breeding chinstrap penguins on the South Shetland Islands in 1987 (Figs 1–4), and comparisons to the most recent censuses reported by Croxall and Kirkwood (1979) and Jabloński (1984); numbers in parentheses indicate the colony number designation reported in the respective papers. Penguin colony size expressed as total adults. Accuracy of penguin colony estimates for 1987: 1 = detailed counts; 2 = rough estimate; 3 = guesstimate; 4 = casual observations (see Methods); * = sites where adequate data exists for comparison in text of 1987 counts and those reported by Croxall and Kirkwood (1979)

Location	*1987 Date*	*Estimates*	*Jabloński*	*Croxall and Kirkwood*
King George Island				
*1. Cape Melville	1/31	8000–9000[2]	19940 (12)	6500 (73)
2. Ornen Rocks	–	–	0	2200 (74)
3. Trowbridge Island	1/31	2000[2]	12616 (13)	–
4. Taylor Point	1/31	0	1196 (14)	–
5. Carolyn Bluff & hillside to North	1/31	5000–6000[2]	–	–
*6. South-east corner North Foreland	1/31	10000[2]	46572 (15)	27600 (75)
*7. North Foreland proper	1/31	50000[3]		
8. Emerald Cove	1/31	200[2]	–	–
9. Brimstone Peak	1/31	10000[1]	26040 (16)	–
10. Brimstone Peak to next point west	1/31	5000–7000[2]	8260 (17, 18)	–
*11. False Round Point	1/31	100000–175000[3]	100652 (19, 20, 21, 24, 25)	26000 (76)
12. Ridley Island	–	–	8070 (22)	–
13. World's End	–	–	432 (23)	–
14. Small point just east of Pottinger Point	1/31	500–600[2]	111722 (26)	–
15. Pottinger Point	1/31	150000–200000[3]		~100000 (77)
16. Kellick Island	1/31	30000–50000[3]	53780 (28)	–
17. Owen Island	1/29	25000+[2]	43102 (27)	–
*18. Tartar Island/Round Point	1/29	30000–40000[2]	40988 (29, 30)	59600 (77)
19. Vicinity of Davey Point	1/29	25000[2]	45850 (31–36)	–
20. Stigant Point	1/29	13550[1]	19316 (37)	–
21. Offshore rocks, Bell Point	2/1	3000–5000[2]	21908 (38–41)	–
22. Northwest side of Fildes Peninsula	2/1	150[2]	~180 (42–46)	–
*23. Ardley Island	2/11	0	420 (47)	100 (63)
*24. Barton Peninsula	2/12	3500[2]	12596 (48)	4200 (64)
25. Stranger Point	2/12	150–200[2]	990 (49)	~400 (65)
26. North-west Tele[illegible]Rocks	2/12	2000[2]	2996 (1)	~2000 (66)

27. Demay Point	2/12	3000[2]	4316 (2, 3)	~4000 (66)
28. Sphinx Hill	–	–	698 (4)	580 (67)
29. Point Thomas	–	–	1052 (5)	1500 (68)
30. Point Hennequin	–	–	–	'colony' (66)
31. Shag Island	–	–	718 (6)	–
32. Chabrier Rock	2/12	2500[2]	3448 (6)	–
*33. Lions Rump	2/12	400[2]	20 (7)	0 (70)
34. Penguin Island	2/12	>1000[4]	15162 (10, 11)	10310 (72)
*35. Turret Point	2/12	300[2]	1834 (8)	800 (71)
Nelson Island				
36. Vicinity Rip Point	2/1	a 500–1000[2] b 100[2] c 15000–20000[2]	–	~20000 (62)
37. Nancy Rock	2/1	'Covered with penguins'[4]	–	–
38. Withen Island	2/1	'Covered with penguins'[4]	–	–
39. Pt 3–4 km east of Harmony Point	2/1	1500–2000[2]	–	–
40. Harmony Point	2/1	~300000[3]	–	~100000 (60)
41. The Toe	2/11	20000–25000[2]	–	~30000 (61)
Robert Island				
42. Newell Point	2/1	15000–20000[2]	–	–
43. Heywood Island	2/1	'Almost as many as Harmony Pt, Nelson I.'[4]	–	46000 (58)
44. Jorge Island	–	–	–	'Rookery' (57)
*45. Edwards Point	2/11	40[2]	–	94 (59)
46. Robert Point	2/11	5000[2]	–	–
47. Kitchen Point	2/11	2500[2]	–	–
Greenwich Island				
48. Large I. North of Dee I.	2/1	'Large colony'[4]	–	7000 (56)
49. Dee Island	–	–	–	3000 (55)
50. Romeo Island	2/2	500[2]	–	–
51. Fort Point	2/10	3500[2]	–	–
Livingston Island				
52. Zed Island	2/2	8000[2]	–	–
53. Desolation Island	2/2	18000[2]	–	–
54. Wood Island	2/2	5000–6000[2]	–	–
*55. Cape Shirreff	2/2	20800[1]	–	4000 (46)

Table 1. (*cont.*)

Location	1987 Date	Estimates	Jabloński	Croxall and Kirkwood
*56. Lair Point	2/3	50[1]	–	312 (47)
*57. Robbery Beach	2/3	0	–	100 (48)
58. Window Island	2/3	50–100[2]	–	–
*59. Devils Point	2/4	5000–6000[2]	–	10600 (49)
60. Pt north-west of Vietor Rock	2/9	100[2]	–	–
61. Vietor Rock	2/9	200[2]	–	–
*62. Elephant Point	2/9	1500[2]	–	400–600 (50)
63. Island just off Elephant Pt	2/9	500[2]	–	–
*64. Hannah Point	2/9	2500[2]	–	2000 (51)
65. 1–2 km north-west Miers Bluff	2/9	80[2]	–	–
66. Miers Bluff	2/9	5000[2]	–	–
67. Cove 3–4 km north-east Miers Bluff	2/9	200[2]	–	–
68. Barnard Point west	2/10	750[2]	–	16520 (52)
69. Barnard Point east	2/10	Several thousand?[4]	–	
70. Rugged Rocks off Renier Point	2/10	3000[2]	–	'Colony' (53)
*71. Half Moon Island	2/10	6000[2]	–	2394 (54)
Deception Island				
*72. Bailey Head	2/8	100000–150000[3]	–	100000–150000 (45)
73. Macaroni Point	2/8	> 1000[4]	–	10400 (43, 44)
*74. Bluff just west of Macaroni Point	2/8	400[1]	–	900–1200 (42)
*75. Pt north-east of New Rock	2/8	15000[2]	–	20000 (41)
*76. Pt 5–6 km north-west of South Point	2/8	15000[2]	–	800–1000 (40)
*77. First bluff west of South Point	2/8	4000–5000[2]	–	600–800 (39)
*78. Entrance Point	2/8	4000[2]	–	
*79. Pt north-west of Entrance Point	2/8	250[2]	–	4100 (36–38)

Snow Island				
80. Byewater Point	2/4	700[2]	–	–
81. Pt 2–3 km south of Byewater Point	2/4	2350–2850[2]	–	–
82. Castle Rock	2/4	5000[2]	–	–
83. Monroe Point	2/4	2000[2]	–	–
84. Cape Conway	2/8	400[2]	–	–
85. Pt 1–2 km east of Cape Conway	2/8	2000–2500[2]	–	–
86. Hall Pen. west/South Pt	2/8	2000[2]	–	–
87. Hall Pen. east/North Pt	2/8	3000[2]	–	–
88. Presidents Head	2/8	100[2]	–	–
Smith Island				
89. Cape Smith	2/4	4500[1]	–	–
90. Cape James	2/5	10000[2]	–	–
Low Island				
91. Large I. off northeast pt of Cape Wallace	2/5	50000[3]	–	–
92. Other offshore rocks/islands Cape Wallace	2/5	8100[2]	–	–
93. Cape Wallace	2/5	150000–300000[3]		~10000 (22)
94. First bluff south of Cape Wallace	2/5	50000–100000[3]	–	–
95. Vicinity Jameson Point	2/5	40000–70000[3]	–	–
96. Pt South of Jameson Pt	2/5	1500[2]	–	–
97. Islands, Jameson Point to Cape Gary	2/5	2750[2]	–	–
98. Cape Gary	2/5	200000[3]	–	–
99. Pt 2–3 km east of Cape Gary	2/5	6000[2]	–	–
100. Rock 1 km south of Cape Hooker	2/5	4500[2]	–	–
101. Cape Hooker	2/5	15000–20000[2]	–	~20000–30000 (22)
102. Two pts north of Cape Hooker	2/5	100[2]	–	–
103. Promontories on north-central coast	2/5	100[2]	–	–

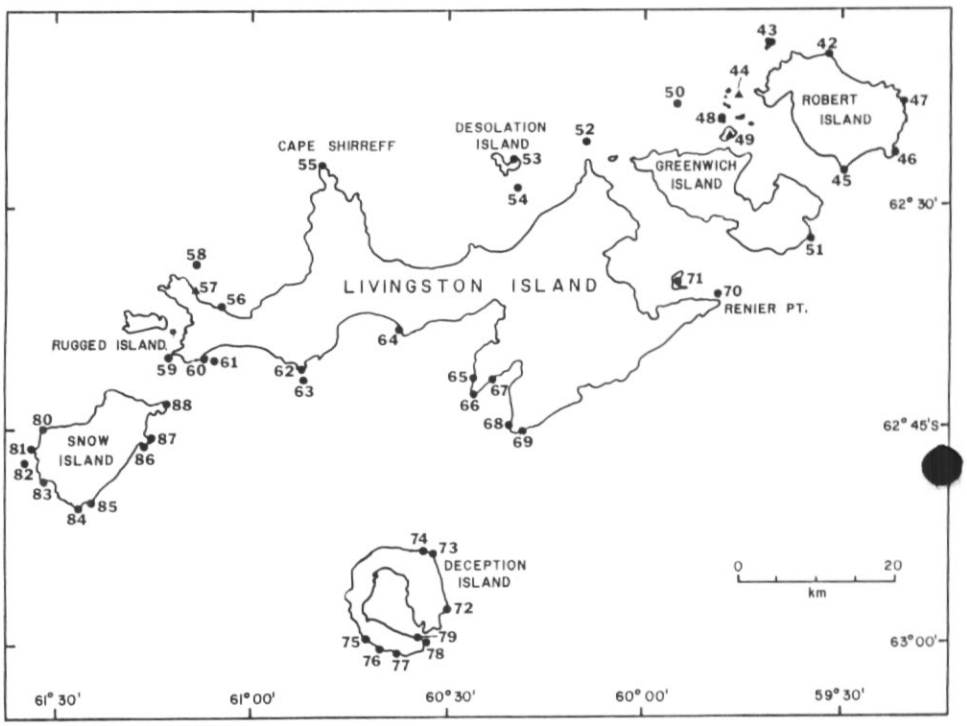

Fig. 3. Robert, Greenwich, Livingston, Deception, and Snow islands, South Shetland Islands. Survey sites in 1987 indicated by numbered dots; additional prior survey sites reported in the literature indicated by triangles (Table I).

1987 counts and prior ones can be attributed either to increased search effort or to possible increases in the populations of breeding penguins.

King George Island

Our estimate of numbers for this island of 480000–640000 chinstraps compares with Jabloński's (1984) estimate of 605000 in 1980–81 and 246000 from the assortment of previous counts summarized by Croxall and Kirkwood (1979); see Table I. Comparisons of totals for the 13 colonies that are included in all three data sets are 348000–484000 for 1987, 358000 for 1980–81, and 242000 for the earlier period (Table I). These data suggest that the chinstrap population on King George Island has probably increased at least 1.5 times since the 1950s and 1960s. However, considering all known colonies in each of the three survey periods, about two-thirds of the approximately 2.5 times greater overall estimates for the 1980s appear to be due to more complete coverage of available nesting habitat compared with prior surveys.

Nelson Island

Our estimate of 337000–348000 chinstraps on Nelson Island compares to that of ~150000 by Croxall and Kirkwood (Table I). Although on casual inspection this

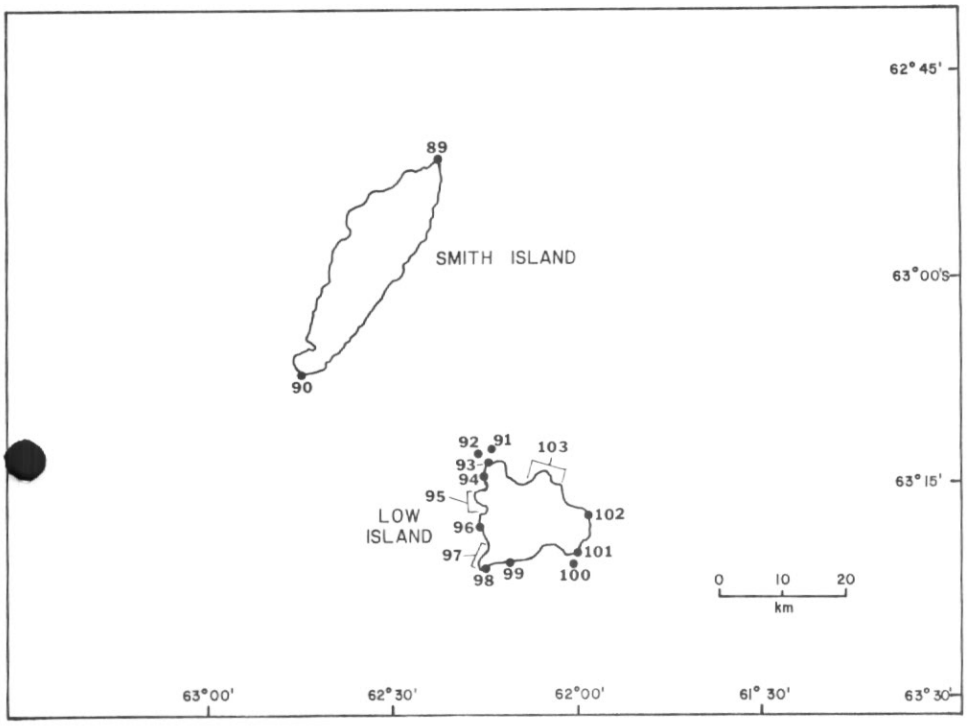

Fig. 4. Smith and Low islands, South Shetland Islands; survey sites in 1987 indicated by numbered dots or bracketed stretches of coastline (Table I).

difference might be primarily attributable to an apparent three-fold increase in the Harmony Point colony, the uncertain accuracy of the 1972 estimate of that colony (Croxall and Kirkwood, 1979) and the large potential error of our 1987 estimate both argue against drawing any conclusions about population change on Nelson, other than to consider that an increase may have occurred.

Robert and Greenwich islands

Our population estimates of 23000–28000+ and 4000+, respectively, for these two islands compares with 46000+ and 10000, respectively, by Croxall and Kirkwood (1979). However, no conclusions on population changes are warranted since there were few colony sites that were investigated by both parties.

Livingston Island

We estimated 77000–79000 chinstraps on Livingston Island while Croxall and Kirkwood estimated 36000–37000 (Table I). For the seven sites for which both parties report censuses, we estimated 36000 birds and Croxall and Kirkwood estimated ~20000 (Table I). This difference is primarily attributable to an apparent large increase in the Cape Shirreff colony (Table I).

Deception Island

We estimated 140000–191000 chinstraps on Deception while Croxall and Kirkwood estimated 132000–183000 (Table I). Our estimates would probably have been somewhat higher if we had been able to climb island slopes to obtain an overview and a more accurate census of the Macaroni Point colony.

Snow and Smith islands

We estimated 18000–19000 and 15000 chinstraps on these two islands, respectively. These seem to be the first reported penguin censuses for these islands (Croxall and Kirkwood, 1979).

Low Island

We estimated 528000–763000 chinstraps on Low Island compared to the ~30000–40000 estimated by Croxall and Kirkwood (Table I). Prior census efforts appear to have been of a cursory nature and the difference between those and our estimates are apparently a function of vastly increased coverage of available nesting habitat in 1987.

Discussion

A comparison of population estimates at 24 sites in the South Shetland Islands with reliable data for both 1987 and for prior counts reported by Croxall and Kirkwood (1979) gives totals of 377000 and 271000 chinstraps, respectively (Table I, sites with *). This suggests that chinstrap populations in the South Shetlands have increased by roughly 40% in about the last 20–30 years. However, since the total estimate of breeding chinstraps in the South Shetlands in 1987 is about 2.5 times the previous estimate, it appears that about 110% of the more recent increase in the census totals is due to expanded coverage of available nesting habitat. On the other hand, it is likely that many of the colonies not previously censused have also increased to some degree historically.

The adequacy of regional coverage and accuracy of population estimates for breeding penguins of the South Shetlands Islands was previously considered 'good' compared with other areas of the Antarctic (Croxall and others, 1984). It is clear from the number of new colonies we encountered and from other recent surveys (i.e. Jabloński, 1984), however, that much still remains to be done to clarify the status of breeding penguins in this region. Although we probably now know the location of most chinstrap breeding colonies we are still lacking detailed, systematic censuses of most of the large colonies where most of the population resides. While our extensive but rough survey indicates that the South Shetland chinstrap population has in fact increased over the past few decades, we feel that variation in census methods, observers, and search effort over time, along with year-to-year variation in the number of breeding penguins under various ice conditions, makes it impossible to determine the extent of change accurately.

Much attention has been focused on the apparent increase in numbers of antarctic and subantarctic penguins and other species during this century. This change is thought to be due to increased krill availability resulting from intense harvesting of baleen whales (Sladen, 1964; Emison, 1968; Conroy and White, 1973; Conroy, 1975; Croxall and Kirkwood, 1979; Smith and Tallowin, 1979; Croxall and others, 1981,

Croxall and others, 1984). For the South Shetlands, an alternative theory suggests that chinstraps have increased in the last 20 years due to the exposure of suitable nest sites by the retreat of glacial ice cliffs (Jabloński, 1984). Population changes have been well-documented with census data at only one penguin colony (Croxall and others, 1981), however, and no adequate data exist for a broad region. Recently, penguin population monitoring programmes have gained more attention in response to increased commercial harvest of krill for human use (BIOMASS, 1983, 1984). Much of this work is focused on reproductive success and diet studies. While it is beyond the scope of this paper to suggest methods for future penguin censuses, it is clear that much more detailed work than that reported here will be needed if penguin data are to provide a sensitive tool for monitoring the Antarctic ecosystem.

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