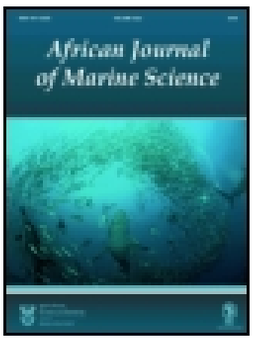

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TRENDS OF AFRICAN PENGUIN *SPHENISCUS DEMERSUS* POPULATIONS IN THE 20TH CENTURY

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The entire nesting population of African penguins *Spheniscus demersus* was about 575 000 adults at the start of the 20th century. Numbers halved by the 1950s and continued to fall to about 220 000 by the late 1970s and about 180 000 by the early 1990s. In Namibia, there has been a 30% reduction since the late 1970s, the most severe declines being in the south, where colonies continue to decrease. Populations at Mercury, Ichaboe and Halifax islands now appear to be stable. In South Africa, numbers fell by 17% between the late 1970s and early 1990s, with especially severe decreases near Saldanha Bay and at Dassen and Dyer islands. These decreases have been arrested, except at Dyer Island. Three new colonies were established in the Western Cape in the early 1980s and supported about 10 000 adult birds in 1994. At islands in Algoa Bay, numbers of adults increased by nearly 30 000 between the late 1970s and the early 1990s, with large increases at St Croix and Bird islands. Ongoing deterioration in the status of the species is being driven by the trends at Dyer Island and off southern Namibia, the causes of which must be investigated.

Daar was waarskynlik sowat 575 000 volwasse, nesmakende Afrika-pikkewyne *Spheniscus demersus* aan die begin van die 20ste eeu. Teen die 1950s het getalle gehalveer en bly daal tot sowat 220 000 teen die laat 1970s en sowat 180 000 vroeg in die 1990s. In Namibië was die vermindering 30% sedert die laat 1970s en die ergste afnames was in die suide waar die kolonies steeds krimp. Die bevolkings op Mercury-, Ichaboe- en Halifaxeiland is tans blykbaar stabiel. In Suid-Afrika het die getal met 17% tussen die laat 1970s en die vroeë 1990s gedaal en die afnames was veral erg naby Saldanhabaai en op Dassen- en Dyereiland. Hierdie afnames is gestuit, behalwe op Dyereiland. Drie nuwe kolonies het hul in die vroeë 1980s in die Wes-Kaap gevestig en het in 1994 sowat 10 000 volwasse voëls gedra. Op die eilande in Algoabaai het die getal volwassenes met bykans 30 000 toegeneem tussen die laat 1970s en die vroeë 1990s, met groot toenames op St Croix- en Birdeiland. Die voortskrydende verslegting van die status van die spesie word aangedryf deur die neigings op Dyereiland en teenoor suidelike Namibië waarvan die oorsake ondersoek moet word.

African or jackass penguins *Spheniscus demersus* are endemic to southern Africa, where they breed at 27 localities between Hollams Bird Island off central Namibia and Bird Island, Algoa Bay, South Africa (Fig. 1, Shelton *et al.* 1984). The total population has decreased markedly this century (Shelton *et al.* 1984, Crawford *et al.* 1990). Breeding no longer occurs at 10 localities where it was previously recorded or suspected, although some colonies have increased in size since the last reported census (Crawford *et al.* 1995a).

This paper documents recent population trends at the most important colonies, and uses historical information to place them in a longer-term perspective.

METHODS

Census methods applied to the African penguin have been reviewed by Randall *et al.* (1986), including counts from aerial photographs (Rand 1963a, b), ground counts of chicks, adults, breeding pairs or nests (Berry *et al.* 1974, Shelton *et al.* 1984), ground counts of moulting birds (Randall *et al.* 1986) and the combination of measurements of colony area and densities of birds in subareas of the colony (Ross 1971). Recent assessment of trends in the adult population of African penguins has been based on two of these methods: counts of moulting birds and of active nest sites (Crawford *et al.* 1990).

Counts of moulting adults need to be undertaken at intervals of approximately two weeks, during the feather-shedding phase of the moult (Randall *et al.* 1986). The date of peak numbers of moulting birds varies at different localities along southern Africa (Crawford *et al.* 1995b) and is unknown for some colonies. The large number of colonies has precluded counts of moulting birds at most colonies at the frequency required to determine the peak moult period and to estimate population size.

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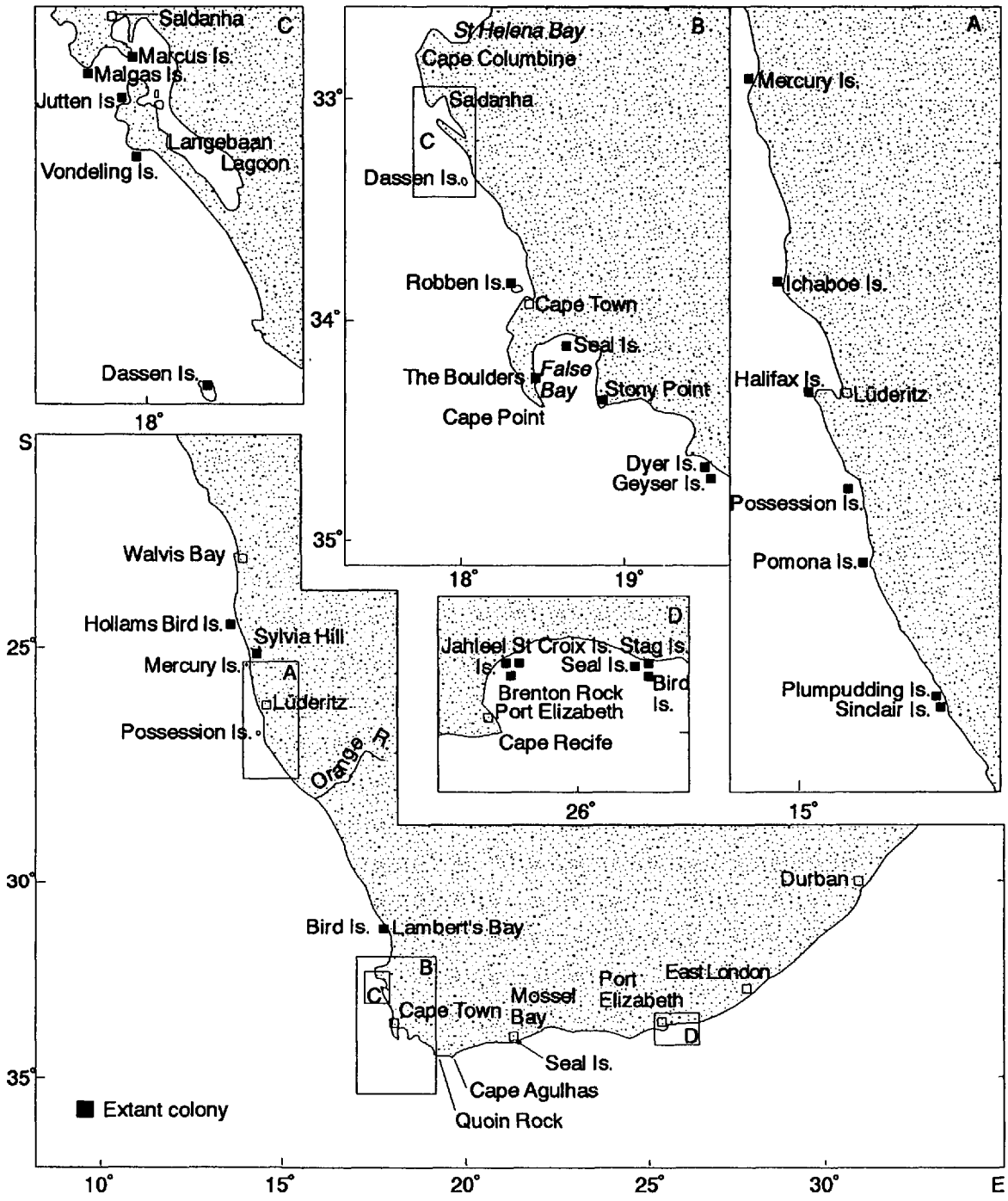

Fig. 1: Locations of African penguin breeding colonies extant in the early 1990s

Active nest sites need to be counted during the main breeding season. The disadvantages of this technique include inter-season variation in the proportion of birds that breed (Crawford and Dyer 1995) and under-counting as a result of breeding birds being absent from nest sites for various reasons (Randall *et*

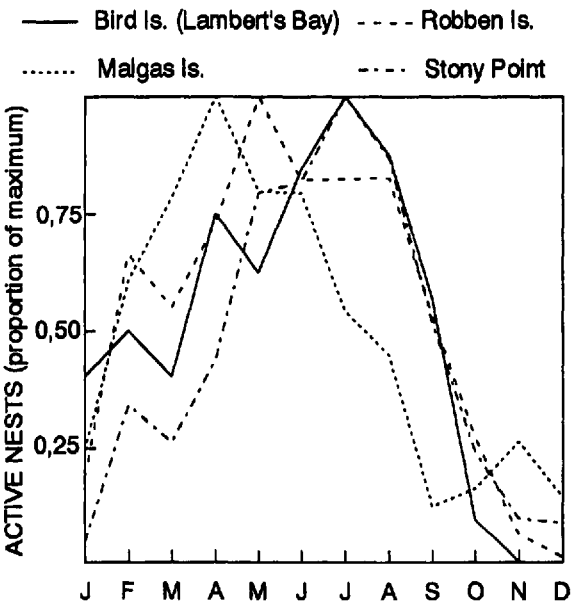

Fig. 2: Monthly trends in active nest sites, expressed as a proportion of the maximum, at Bird (Lambert's Bay) and Malgas islands and Stony Point during the period 1991–1994, compared with the seasonal trend in breeding activity at Robben Island (Crawford *et al.* 1995b)

al. 1986). Over a five-year period at Robben Island, the counts of moulting adults were significantly positively correlated with counts of active nest sites of African penguins during peak breeding, especially when the maximum nest count made during a breeding season was used (Crawford and Boonstra 1994). On average, the number of moulting adults was 3,2 times greater than the maximum count of nests (Crawford and Boonstra 1994).

Most colonies have not been monitored as intensively as that at Robben Island, owing to the difficulty of access to several colonies, which has meant that they have been seldom visited, and the time necessary to count some of the larger colonies. For example, a census of active nests at Dassen Island takes about 20 man-days.

Between 1976 and 1994, many counts of active nest sites of African penguins at breeding colonies were conducted (Appendix). In this period the number of counts at breeding localities ranged between one and 103 (Appendix). A site was considered active if it contained eggs or chicks, or if it was defended by an adult bird (Crawford *et al.* 1990). Creching chicks were divided by two to estimate the number of nest sites they represented, with remainders taken to represent an additional site — for example creches of five and six chicks would both be taken to represent three nests (Shelton *et al.* 1984).

At Bird Island (Lambert's Bay), Malgas Island and Stony Point (Betty's Bay) during the period 1991–1994, there was at least one count of active nest sites for each calendar month. The mean count for each month was used to indicate the seasonal trend in breeding at these sites. At Mercury Island, nests that contained live eggs or chicks were counted in all months between March 1994 and January 1995, except in May and October 1994. At Stony Point, in addition to counts of active nest sites in particular months, records were kept of the overall number of sites at which breeding occurred each year.

To compensate for the fact that some counts of active nest sites may have missed substantial numbers of breeding birds, as a result of counts being conducted outside the main breeding season or because of absenteeism of breeders, the counts were grouped into four periods: 1976–1980, 1981–1985, 1986–1990 and 1991–1994. A preliminary assumption was made that the maximum nest count in each period was representative of the population size. That maximum count was then multiplied by 3,2 (Crawford and Boonstra 1994) to estimate the number of adult birds at the colony in that period.

When counts of active nest sites were not available, but there were counts of moulting birds (Randall *et al.* 1986) or counts of adults (RMR unpublished data), the latter were used as an estimate of the population. For colonies where no estimates of population size existed for some periods, the population was assumed to be the mean of the estimates made in adjacent periods. The overall population in any period was calculated by summing the estimates for individual colonies.

The present trend in numbers of African penguins was determined from estimates of the overall population for the periods 1976–1980, 1986–1990 and 1991–1994. The estimate for 1981–1985 was rejected because it became clear that some larger colonies off western South Africa were probably severely underestimated; few counts of nest sites were conducted and many of them fell outside the main breeding season.

RESULTS AND DISCUSSION

Seasonal pattern of breeding off western South Africa

At Bird Island (Lambert's Bay), Malgas Island and Stony Point, the mean number of active nests sites increased markedly between January and the middle of the year, but it decreased sharply after September (Fig. 2). This trend is similar to the seasonal pattern of breeding at Robben Island (Fig. 2, Crawford *et al.* 1995b). At all four localities, peaks in mean counts

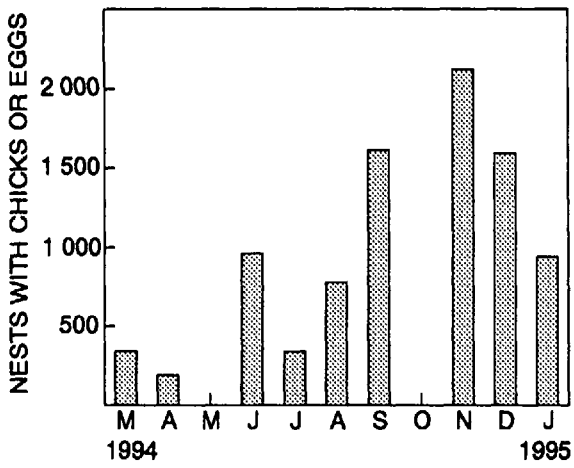

Fig. 3: Counts of nests at Mercury Island containing eggs or chicks, March 1994–January 1995

of active nests were obtained between April and July, whereas from October to January mean counts were fewer than 50% of the maximum. The pattern is the same at other breeding localities in the Western Cape (Duffy *et al.* 1984). Therefore, nest counts undertaken between September and March in that region may often underestimate the breeding population.

At Mercury Island, numbers of nests with eggs and chicks increase after May to peak in November and then decrease again (Fig. 3). The decrease in nests with eggs and chicks between June and July resulted from the loss of nests to rain and heavy swells (YC pers. obs.). Off central Namibia, the peak breeding season appears to be from September to December, which is when most counts of nests were undertaken.

At Robben Island, most birds moult in December (Crawford *et al.* 1995b). At St Croix Island, the majority of penguins moult in November (Randall *et al.* 1986), whereas at Mercury Island most birds moult in April (YC and AJW unpublished data). Therefore, breeding in Algoa Bay is likely to be about one month earlier than in the Western Cape, and 5–7 months before that off central Namibia.

Recent population trends

NAMIBIA

Since 1976 there has been only one count of active nest sites at the northernmost breeding locality of African penguins (Hollams Bird Island) and only four at Sylvia Hill in central Namibia. This lack of data precludes any assessment of population trends at those two localities. However, both localities support small colonies (Appendix) that will not influence overall trends to any great extent. At Hollams Bird Island there is severe competition with South African fur seals *Arctocephalus pusillus* for space (Williams and Dyer 1990). At Sylvia Hill there is a record of 230 adults and immatures present at the colony in February 1984 (Shelton *et al.* 1984), but it is not known what proportion of those birds were visiting. Only 20 nests were active then (Loutit and Boyer 1985). In December 1994, R.E. Simmons (Ministry of Wildlife, Conservation and Tourism, Namibia, pers. comm.) counted 234 adult and immature penguins and 26 active nest sites, suggesting a stable colony.

At Mercury Island, seals displaced more than 1 000 pairs of penguins from their nests in the mid 1980s (Crawford *et al.* 1989). Measures were implemented to reverse this trend, and by the late 1980s the numbers of penguins breeding at Mercury Island had recovered to the level of the late 1970s (Crawford *et al.* 1994, Table I). In 1993, Mercury Island supported about 12 000 adult African penguins and was the largest colony in Namibia (Table II).

Numbers of penguins at Ichaboe Island are estimated to have decreased from 11 500 in the late 1970s to between 6 000 and 7 000 in the early 1980s, and then to have increased to more than 9000 in the early 1990s (Table II). The drop in the 1980s was more severe than at Mercury Island, and the subsequent recovery has been less pronounced. There was no displacement of birds by seals, but harvesting of guano before 1986 probably caused substantial disturbance to penguins (AJW pers. obs.). In the early 1990s there were about 20% fewer penguins than in the late 1970s.

At Halifax Island, near Lüderitz (see Fig. 1), numbers of nest sites fell by 46% between the late 1970s and the early 1990s, but they have been stable since 1985 (Table I). Farther south on the Namibian coast, penguins no longer breed at North Reef Island, where there were 151 active nests in the late 1970s (Table I, Crawford *et al.* 1995a). At Possession Island, the number of nests fell from about 2 550 in 1978 to only 750 in 1993 (Appendix). This decrease of 70% amounts to a loss of almost 6 000 adults (Table II). Over the same period, losses at Pomona (93%), Plumpudding (94%) and Sinclair (74%) islands were relatively even more severe. At both Possession and Plumpudding islands only one count was conducted during the period 1981–1985, that at Plumpudding Island probably outside the main breeding period. It is more likely that the populations at these localities were underestimated in this period (Tables I, II) than that they had decreased to levels lower than those that were subsequently recorded in 1987 and 1988.

The Namibian population of African penguins in the late 1970s was about 39 000 adults (Table II). By the early 1990s, it was about 27 000, a decrease of more

Table I: Maximum nest counts of African penguins at breeding localities during four periods, 1976–1994 (values in parenthesis are used where there are no data and are assumed the same as, or intermediate between, earlier or later counts)

Locality	Nest counts			
	1976–1980	1981–1985	1986–1990	1991–1994
Hollams Bird Island	(1)	(1)	1	(1)
Sylvia Hill	6	20	(23)	26
Mercury Island	3 218	2 092	3 552	3 659
Ichaboe Island	3 598	2 070	2 427	2 858
Halifax Island	1 750	1 007	1 050	981
Central Namibia	8 573	5 190	7 053	7 525
North Reef	151	58	2	0
Possession Island	2 568	638	946	751
Pomona Island	123	20	15	8
Plumpudding Island	438	100	228	26
Sinclair Island	246	124	44	63
Southern Namibia	3 526	940	1 235	848
Bird Island, Lambert's Bay	50	(40)	30	25
Malgas Island	1 022	129	142	99
Marcus Island	1 243	115	214	207
Jutten Island	2 878	755	(1 052)	1 349
Vondeling Island	1 028	79	196	229
Dassen Island	12 646	2 757	8 428	9 389
Robben Island	–	103	1 278	2 799
Western South Africa	18 867	3 978	11 340	14 097
Boulders	–	2	54	359
Seal Island, False Bay	82	55	83	95
Stony Point	–	4	89	77
Dyer Island	22 655	13 074	18 481	8 349
Geyser Island	318	(304)	291	328
South-western South Africa	23 055	13 439	18 998	9 208
West Coast	54 021	23 547	38 626	31 678
Jahleel Island	(578)	578	(564)	549
Brenton Island	(38)	(38)	38	31
St Croix Island				19 478
Seal Island	>102		510	375
Stag Island	45	23	50	24
Bird Island, Algoa Bay	345	572	3 703	3 784
South Coast				24 241
Total				55 919

than 30%, but at least from 1990 to 1993, numbers appeared to be stable. Only at Mercury Island, the most northern colony for which a trend can be gauged, was there no decrease between the late 1970s and early 1990s, and then only because management measures to prevent seals displacing penguins from nest sites were implemented (Crawford *et al.* 1989). At Ichaboe and Halifax islands decreases stopped in the 1980s, but at localities farther south numbers continue to fall. The populations at Pomona and Plumpudding islands are now small (Table II), and could soon follow North Reef to extinction. Management should aim to establish reasons for the rapid declines at Pomona and Plumpudding islands, as well as at Possession Island, with a view to stopping and reversing the trends.

SOUTH AFRICA

Off South Africa, the most northern breeding colony is at Bird Island (Lambert's Bay), where the number of penguins halved between the late 1970s and the early 1990s (Table I).

For each of Malgas, Marcus, Jutten, Vondeling

Table II: Estimated number of adult African penguins during four periods, 1976-1994. Values in parenthesis are used where there are no data and are assumed the same as, or intermediate between, earlier or later counts

Locality	Number of adult penguins			
	1976–1980	1981–1985	1986–1990	1991–1994
Hollams Bird Island	3	3	3	3
Sylvia Hill	19	64	74	83
Mercury Island	10 298	6 694	11 366	11 709
Ichaboe Island	11 514	6 624	7 766	9 146
Halifax Island	5 600	3 222	3 360	3 139
Central Namibia	27 434	16 607	22 569	24 080
North Reef	483	186	6	0
Possession Island	8 218	2 042	3 027	2 403
Pomona Island	394	64	48	26
Plumpudding Island	1 402	320	730	83
Sinclair Island	787	397	141	202
Southern Namibia	11 284	3 009	3 952	2 714
Bird Island, Lambert's Bay	160	128	96	80
Malgas Island	3 270	413	454	317
Marcus Island	3 978	368	685	662
Jutten Island	9 210	2 416	3 366	4 317
Vondeling Island	3 290	253	627	733
Dassen Island	40 467	8 822	26 970	30 045
Robben Island	–	330	4 090	8 957
Western South Africa	60 375	12 730	36 288	45 111
Boulders	–	6	173	1 149
Seal Island, False Bay	262	176	266	304
Stony Point	–	13	285	246
Dyer Island	72 496	41 836	59 139	26 717
Geyser Island	1 018	973	931	1 050
South-western South Africa	73 776	43 004	60 794	29 466
West Coast	172 869	75 350	123 603	101 371
Jahleel Island	(1 850)	1 850	(1 805)	1 757
Brenton Island	(122)	(122)	122	99
St Croix Island	44 781*	48 113*	(55 221)	62 330
Seal Island	789†	(1 210)	1 632	1 200
Stag Island	144	74	160	77
Bird Island, Algoa Bay	1 104	1 830	11 850	12 109
South Coast	48 790	53 199	70 790	77 572
Total	221 659	128 549	194 393	178 943

* Randall *et al.* (1986)
† RMR (unpublished total count made on 18 January 1977)

and Dassen islands, there was just one count of active nest sites during the period 1981–1985. Those counts were all conducted in late October or early November, outside the main breeding season in the region (Fig. 2), and are therefore likely to have substantially underestimated the breeding population.

The populations at the three islands in Saldanha Bay, which in 1985 were incorporated into the West Coast National Park, all decreased between the late 1970s and early 1990s — at Malgas Island by 90%, at Marcus Island by 83% and at Jutten Island by 53%. At nearby Vondeling Island there was a decrease of 78% (Table I). The estimated decreases at Malgas, Marcus and Vondeling islands were similar, but that at Jutten Island was less. The reason for this is not clear. At Malgas Island, where the decrease was relatively most severe, some penguins may have been displaced from breeding sites by Cape gannets *Morus*

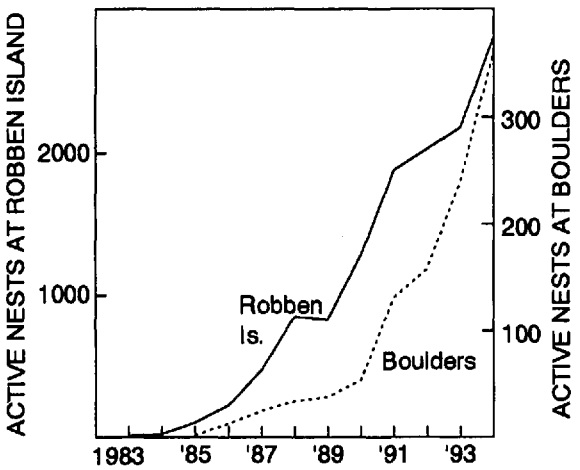

Fig. 4: Annual maximum counts of active nest sites at Robben Island and Boulders, 1983–1994

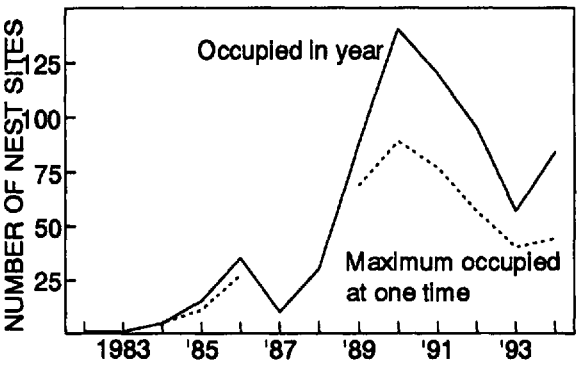

Fig. 5: Maximum counts of nest sites at Stony Point active at any one time, and overall number of nest sites occupied in the year, 1982–1994

capensis. The area occupied by breeding gannets increased from 1,13 ha in 1978 to 2,02 ha in 1989 (Crawford and Dyer 1995), and it now extends over areas where about 250 pairs of penguins nested in the late 1970s (Sea Fisheries Research Institute, unpublished records). These penguins may have moved to other areas on Malgas Island. It is also possible that some of them relocated to Jutten Island, which is just 3,6 km to the south-east. However, adults have not, to date, been recorded breeding at more than one island (Randall *et al.* 1987).

At Jutten Island, the count of nests in June 1994 was the highest since July 1979, indicating that the downward trend may have been reversed. Overall numbers of penguins at Malgas, Marcus, Jutten and Vondeling islands were approximately equivalent in the late 1980s and early 1990s (Table I).

At Dassen Island, the number of active nest sites fell from about 12 600 in 1979 to about 8 400 in 1989 (Appendix). In intervening years there was only one count of active nests in the main breeding season — 4 588 in July 1987. As the colony is unlikely to have doubled in size in the next two seasons, it can be concluded that substantial numbers of breeders were probably absent during the 1987 count. In 1994, there were about 9 400 active nests at Dassen Island. Numbers of nests between April and June of 1989–1994 varied between 7 200 and 9 400 (Appendix), i.e. by an amount greater than the increase between the late 1980s and the early 1990s (Table I). Therefore, no recent increase can be concluded. However, the population at Dassen Island appears to have been constant in the six years 1989–1994, following a decrease of about 26% since the late 1970s.

Robben Island was recolonized by African penguins in 1983, after which numbers of breeding birds increased steadily, except in 1989 (Fig. 4, Crawford and Boonstra 1994, Crawford and Dyer 1995, Crawford *et al.* 1995b). In 1994, the maximum count of nests was about 2 800 (Appendix). The mainland colony at Boulders was first observed in 1985, when two breeding pairs were present (Cooper 1985). The colony increased steadily and there were more than 350 active nests in July 1994 (Fig. 4, Appendix).

At Seal Island in False Bay, there was only one count of nest sites between 1981 and 1985; it was undertaken in October, late in the breeding season for the region (Fig. 2). The population appears to have been stable since the late 1970s (Table I). Breeding space for penguins at this island is severely restricted by South African fur seals, and penguins readily relocate to artificial sites when they are introduced (Crawford *et al.* 1994).

Stony Point at Betty's Bay was colonized by African penguins in 1982 (Broni 1982). The highest count of active nest sites in any one month was 89 in 1990, after which the colony has decreased (Fig. 5, Appendix). The overall number of nests occupied rose to 140 in 1990, but it dropped to 84 by 1994 (Fig. 5). This is thought to be due to predation of adults by caracal *Felis caracal* and of eggs by small grey mongoose *Galerella pulverulenta*, water mongoose *Atilax paludinosus* or large-spotted genet *Genetta tigrina*. All these predators are common in the area (JHH pers. obs.). According to records of the Town Clerk of Betty's Bay, leopards *Panthera pardus* have also killed penguins at Stony Point on at least five occasions. In December 1986, 65 penguins were killed by a leopard, and in August and September 1990 a further 50.

At Dyer Island, the two counts of nest sites in the

period 1981–1985 were outside the main breeding season (Appendix). Counts of active nests fell from about 22 700 in June 1979, to about 18 500 in October 1986 (late in the breeding season) and about 8 350 in April 1991 (Appendix), a total decrease of 63%, representing an estimated 46 000 adults (Table II). Counts indicate that numbers at Dyer Island may have decreased even more by 1994 (Appendix). Based on an analysis of band recoveries (Randall *et al.* 1987), it is reasonable to conclude that young penguins from Dyer Island were mainly responsible for establishing the new colonies at Stony Point (1982) and Boulders (1985). Limited resightings at Robben Island indicate that most of the birds that established the colony there originated from Dyer Island, suggesting some limiting factor at Dyer Island (Crawford *et al.* 1995b).

In 1991, several thousand nests at Dyer Island were abandoned, probably because of a scarcity of food (Crawford and Dyer 1995). Additionally, penguins at Dyer Island recently have become exceptionally nervous, which may have arisen from the method used at the island to capture oiled birds for rehabilitation. A large "butterfly"-type net is brought down on top of the oiled penguins in breeding colonies, with considerable disturbance to birds breeding nearby (pers. obs.). Contrasting with the large decrease of penguins at Dyer Island, numbers at neighbouring Geyser Island have been stable since 1978 (Table II, Appendix). This suggests that the cause of the decrease at Dyer Island is to some extent site-specific, as would be the case from disturbance.

At St Croix Island in Algoa Bay, 19 478 active nests were counted in May 1993 which, using the factor of 3,2 obtained at Robben Island (Crawford and Boonstra 1994), suggests a population of some 62 000 adults. Counts of moulting birds during 1993/94 indicated that 57 500 adults frequented St Croix Island (NTWK, unpublished data), which is in good agreement with the estimate based on counts of nests. From 1979 to 1981, there were about 45 000 adult penguins at St Croix Island (Randall *et al.* 1986). Therefore, the population has increased by 30–40% since then. At Jahleel and Brenton islands, in the St Croix Island group, the relatively scant information suggests that the populations have been stable since the late 1970s (Table II).

The numbers of penguins at Bird Island in Algoa Bay increased substantially between the late 1970s and the early 1990s (Table II). Construction of a jetty at Bird Island between April and October 1983 displaced breeding penguins from a portion of the island, but it appears to have had no long-term effect. At neighbouring Stag Island the counts suggest a stable population. At Seal Island the scanty information since 1976 is equivocal. However, a count of 607 active nests in March 1975 (A. F. de Villiers 1975, unpublished) reveals that the population has decreased by about 40% since then. There is no evidence to support the probability that the Bird Island population was augmented by individuals from Seal Island.

The South African population of African penguins decreased from about 183 000 in the late 1970s to some 152 000 in the early 1990s (17%). This decrease is less than the loss of birds at Dyer Island in the same period. The substantial decreases between Lambert's Bay and Dassen Island have been more than offset by establishment of the three new colonies at Robben Island, Boulders and Stony Point, and by the increase in numbers of penguins at St Croix and Bird islands in Algoa Bay. The decreases at colonies between Lambert's Bay and Dassen Island have slowed or stopped, but that at Dyer Island continues. A priority for management of the African penguin in South Africa is to halt the downward trend at Dyer Island.

OVERALL

Overall numbers of African penguins decreased from some 220 000 adults in the late 1970s to about 190 000 in the late 1980s and to about 180 000 in the early 1990s (Table II), i.e. an annual loss of about 2 850 adults, or 1,3% of the population of the late 1970s.

The deteriorating status of the African penguin continues despite increases in numbers at some breeding localities, and the halting of decreases at others. The overall decrease is at present being driven by substantial losses of birds at islands off southern Namibia and especially at Dyer Island. If these trends can be stopped, the overall population should stabilize and perhaps even increase. However, the probable loss of 5 000 adults and an equivalent number of chicks after oil from the *Apollo Sea*, which sank between Dassen and Robben islands in June 1994, reached these two islands indicates the potential of catastrophic events to rapidly worsen the status of the species. Understanding the causes of the decreases at Dyer Island and the islands off southern Namibia, with a view to stabilizing these colonies, is a priority for research.

Longer-term population trends

Earlier estimates of numbers of African penguins are available from records of eggs collected at certain localities, counts of occupied burrows (Frost *et al.*

1976), aerial photographs (Rand 1963a, b), measurements of breeding area and density of nesting birds (Ross 1971), counts of individuals (Berry *et al.* 1974) and extrapolation from partial nest counts (Cooper 1977). These estimates, summarized in Appendix 1 of Shelton *et al.* (1984), are not strictly comparable with values presented in Table II, but they nevertheless permit the more recent trends to be placed in a longer-term perspective.

NAMIBIA

At Mercury Island, the population appears to have remained relatively stable since the mid 1950s, the only major trend being the displacement of penguins by seals during the 1980s and the subsequent recovery of the penguin population (Fig. 6a, Crawford *et al.* 1989). Similarly, at Ichaboe Island the population appears to have been relatively stable over the past 40 years (Fig. 6a).

Farther south along the Namibian coast, the decreases in numbers of penguins recorded since the late 1970s (Tables I, II) were a continuation of earlier trends (Figs 6b, c, d, Crawford and Shelton 1981). Seals displaced many penguins from Sinclair Island after the mid 1950s (Shaughnessy 1980). Some of the displaced birds may have moved to nearby Plumpudding Island (Crawford *et al.* 1994).

The large decrease in numbers of penguins at Possession Island, which supported about 100 000 adult penguins in the mid 1950s, but only about 26 000 in the early 1990s (Fig. 6e), has had the dominant impact on the population in Namibia.

SOUTH AFRICA

At Bird Island, Lambert's Bay, an estimated 2 700 adult penguins were present in the first decade of the 20th century. Numbers have since decreased to fewer than 100 (Fig. 7a, Table II).

At the four islands in or near Saldanha Bay (Malgas, Marcus, Jutten and Vondeling), the numbers of penguins decreased from about 115 000 at the start of the 20th century to about 6 000 in the 1990s, i.e. by about 95% (Fig. 7a). At Dassen Island, numbers decreased from about 300 000 to about 30 000 (90%) in the same period (Fig. 7b).

In the late 19th century at Seal Island, False Bay, there were about 5 000 adult penguins (Shelton *et al.* 1984), compared to a stable population of some 300 at present (Table II). However, three new colonies that now total about 10 000 adults (Robben Island, Boulders and Stony Point) were established nearby in the 1980s.

At Dyer Island, the numbers of African penguins fell from some 40 000 at the start of the 20th century to about 8 000 in the 1950s, but then increased to more than 70 000 in the 1970s (Fig. 7b). The present population is estimated to be about 25 000 adults (Table II). Therefore, there have been large oscillations in numbers of penguins at Dyer Island, in contrast to steady changes observed at most of the other major colonies. In November 1948, oil spilt by the *Esso Wheeling* washed onto the shores of Dyer Island and " ... thousands died ... at least one third of the penguin population died ..." (Kruger 1949, p. 602). This is likely to have been partially responsible for the very low numbers recorded in the 1950s (Rand 1963a).

Rand (1963a, p. 10) observed that " ... few penguins are known to use ..." Geyser Island. Since 1978, Geyser Island has probably supported about 1 000 African penguins (Table II), indicating an increase after the 1950s.

For Algoa Bay in the 1950s, Rand (1963a) estimated about 12 000 penguins at St Croix Island and 500 at the Bird Island group, a group including Seal and Stag islands. Aerial photographs of St Croix Island yielded counts of 7470 penguins on 26 November 1956 (Rand 1963a), 17 696 on 25 November 1969, 11 053 on 23 November 1978 (Shelton *et al.* 1984) and 25 205 on 25 November 1985 (Crawford *et al.* 1990). The up-and-down nature of these counts may have arisen from a lower proportion of moulting birds being ashore when the 1956 and 1978 photographs were taken. Rand (1963a, p. 9) noted of St Croix Island "Penguins overrun the whole island", which is unlikely if there were only 12 000 penguins. His estimate was probably too small. Nevertheless, there appear to have been large increases at both St Croix and Bird (Algoa Bay) islands in the second half of the 20th century (Table II, Fig. 7c). There is no information on numbers of penguins at Jahleel and Brenton islands prior to the 1970s.

The population of penguins off western South Africa fell by some 250 000 birds in the first half of the 20th century. There is no information on trends elsewhere in South Africa. Between the 1950s and 1970s the South African population was stable (Fig. 7d), because continued large decreases between Lambert's Bay and Dassen Island (about 115 000 birds) were approximately balanced by increases at Dyer Island (about 65 000) and in Algoa Bay (about 46 000). More recently the population has again been decreasing.

OVERALL

Estimates made from egg harvests suggest that colonies off western South Africa supported about

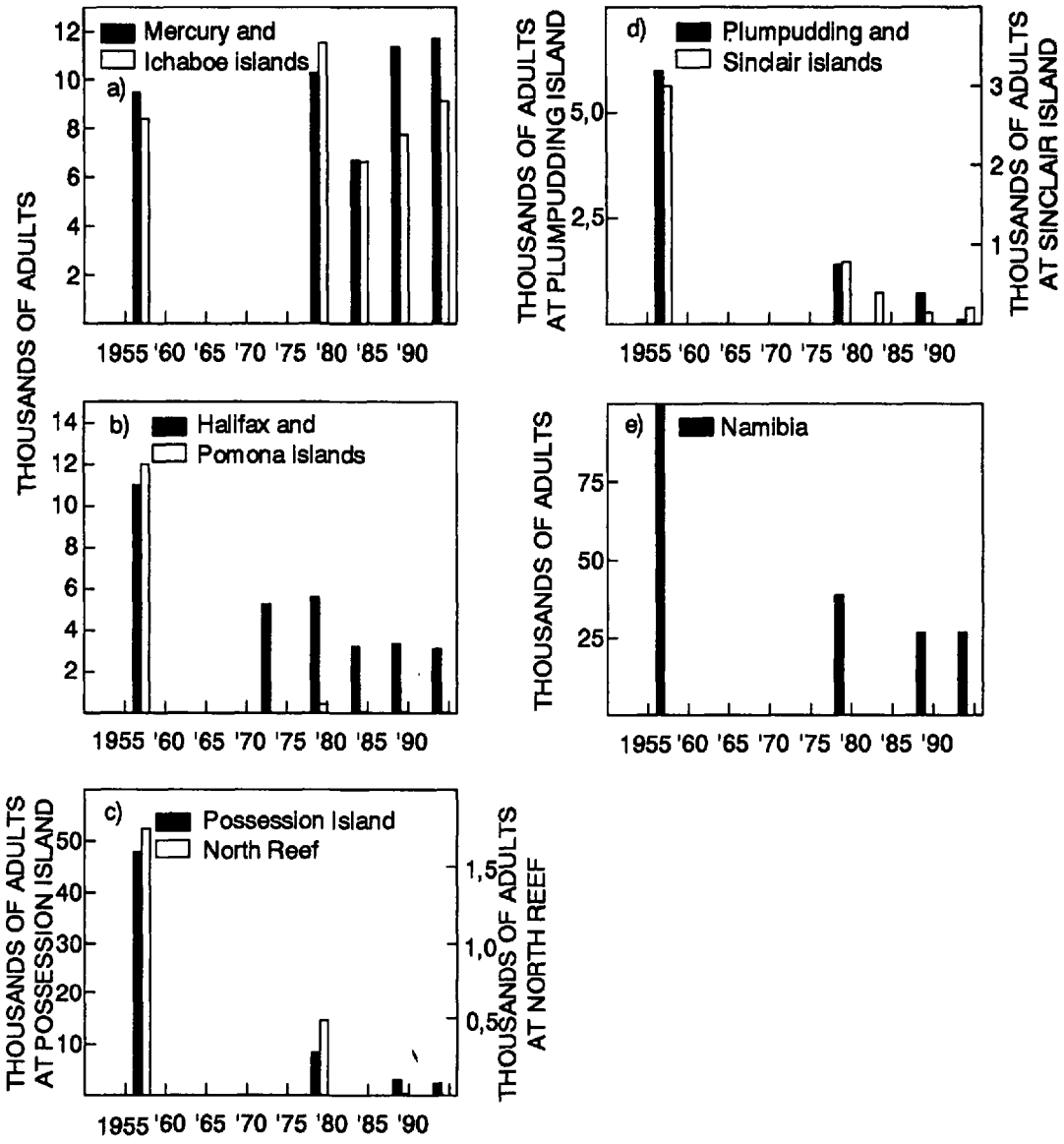

Fig. 6: Trends in the populations of African penguins at (a) Mercury and Ichaboe islands, (b) Halifax and Pomona islands, (c) Possession Island group of islands, (d) Plumpudding and Sinclair islands, and (e) off Namibia in the latter half of the 20th century. Each histogram represents an observation in one year

464 000 penguins at the start of the 20th century (Frost *et al.* 1976, Shelton *et al.* 1984). There is no information on numbers in Namibia or at islands in Algoa Bay at that time. In the 1950s, there were an estimated 99 000 penguins in Namibia (Rand 1963b) and some 12 000 in Algoa Bay (Rand 1963a). This latter value was probably an underestimate. As these colonies were not subject to the large collections of eggs that were made off western South Africa in the first half of the 20th century (Shelton *et al.* 1984), an assumption can be made that numbers of penguins off Namibia and in Algoa Bay changed little between

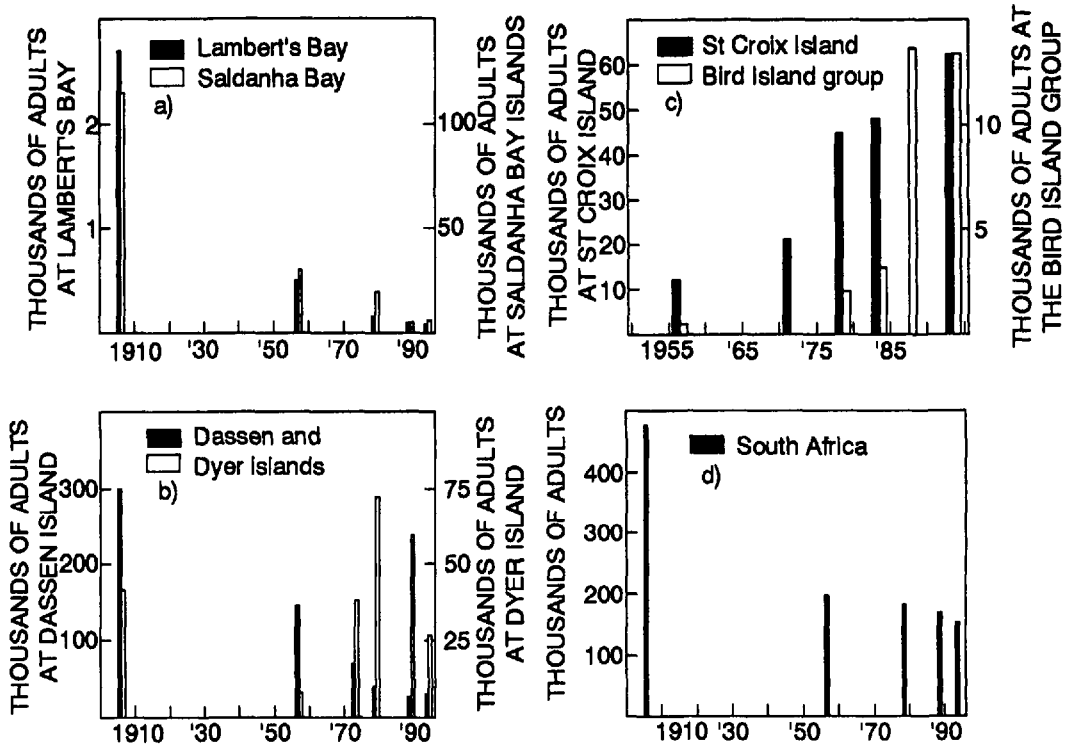

Fig. 7: Trends in the populations of African penguins at (a) Bird Island (Lambert's Bay) and islands in or near Saldanha Bay (Malgas, Marcus, Jutten and Vondeling), (b) Dassen and Dyer islands, (c) islands in Algoa Bay, and (d) off South Africa in the 20th century. Each histogram represents an observation in one year

1900 and 1950. If this was the case, the African penguin population at the beginning of the 20th century would have been about 575 000 birds. By the 1950s, the decreases off western South Africa had reduced numbers to 296 000 (Rand 1963a, b), i.e. by about half. By the late 1970s, the overall population had fallen to about 222 000, and by the early 1990s to about 179 000 (Table II).

Therefore, the present-day population is about 400 000 birds fewer than at the start of the 20th century, a decrease of some 70%. It should be borne in mind that the earlier figures were rough estimates only and the more recent values are also subject to limitations. The Namibian population probably decreased by about 75 000 birds this century, and that between Lambert's Bay and Dassen Island by about 380 000. Between Robben Island and Dyer Island there was an overall decrease of about 8 000 birds. At Seal Island in Mossel Bay, breeding ceased in the 20th century (Shaughnessy and Shaughnessy 1978, Shelton *et al.* 1984). In Algoa Bay, numbers of penguins possibly increased by about 65 000, although this is probably an overestimate.

The main cause of the decrease off western South Africa in the early part of the 20th century is likely to have been excessive egg harvests (Frost *et al.* 1976, Shelton *et al.* 1984), with an oil spill also having an impact at Dyer Island (Kruger 1949). Subsequent persistent decreases off western South Africa and off Namibia may have resulted from a scarcity of food (Crawford and Shelton 1981), although several other factors have also influenced trends, including oiling (Randall and Randall 1986), predation by feral cats *Felis catus* (Berruti 1986), competition for space with seals (Shaughnessy 1980, Crawford *et al.* 1989) and human disturbance (Hockey and Hallinan 1981). Of the overall decrease in the 20th century, approximately 70% probably resulted from harvesting of penguin eggs by man and 30% from indirect influences, with food scarcity likely to have been the

main indirect influence. Harvesting of eggs was most important in the first half of the century, whereas indirect influences have dominated subsequently.

In the early part of the 20th century, the main threats to the African penguin were at its breeding localities, especially from excessive harvesting of eggs, but also from disturbance caused by exploitation of guano (Frost *et al.* 1976). These threats have now been eliminated or reduced. New threats at breeding localities, such as displacement of penguins from breeding sites by seals, are being managed satisfactorily at most colonies. However, concern remains that disturbance at colonies off southern Namibia and at Dyer Island may be excessively high and contributing to the decreases at those localities. As the 20th century draws to its close, the main threats to African penguins have shifted away from the breeding localities to the sea — a scarcity of food resulting from far greater extractions from the oceans by man and seals (Crawford *et al.* 1992) and loss of birds to oiling.

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APPENDIX

Counts of active nest sites of African penguins at breeding localities, 1976–1994

Locality	Date	Count of active nest sites
	Namibia	
Hollams Bird Island	9 May 1988	1[1]
Sylvia Hill	Jun. 1980	6[2]
	Jun. 1983	15[2]
	28 Feb. 1984	20[2]
	18 Dec. 1994	26[3]
Mercury Island	20–23 Nov. 1978	3 218[4]
	27–28 Nov. 1985	2 092[5]
	8–10 Nov. 1986	1 126[5]
	2–3 Dec. 1986	1 112[5]
	Aug. 1987	2 181[6]
	25 Nov. 1987	2 175[7]
	Nov. 1989	3 394[6]
	Nov. 1990	3 552[6]
	20–21 Jan. 1993	3 576[7]
	25 Nov. 1993	3 659[6]
	16 Dec. 1994	3 605[8]
Ichaboe Island	24–28 Nov. 1978	3 598[4]
	24 Nov. 1985	2 070[9]
	25 Nov. 1986	739[7]
	29 Aug. 1987	1 372[7]
	2 Dec. 1987	827[7]
	Jun. 1990	2 427[6]
	28–29 Nov. 1990	1 937[6]
	Apr. – Aug. 1991	2 858[6]
	26–28 Jan. 1993	2 418[7]
	22–24 Nov. 1993	2 605[6]
Halifax Island	30 Nov. 1978	1 750[4]
	14 Dec. 1981	1 007[4]
	2 Dec. 1985	334[9]
	16 Dec. 1986	259[7]
	30 Jan. 1987	389[7]
	26 Aug. 1987	678[7]
	2 Dec. 1990	1 050[6]
	16 Mar. 1991	981[7]
	Dec. 1992	690[6]
	1 Feb. 1993	537[7]
	27 Nov. 1993	709[6]
	23 Oct. 1994	681[8]
North Reef	1 Dec. 1978	151[4]
	26 Jan. 1980	58[4]
	18 Mar. 1980	16[7]
	4 Dec. 1985	0[9]
	11 Apr. 1986	2[10]
	2 Nov. 1986	1[7]
	4 Sep. 1987	2[7]
	28 Nov. 1987	1[7]
	5 Dec. 1988	0[7]
	27 Mar. 1990	0[10]
	5 Dec. 1990	0[6]
	21 Mar. 1991	0[7]
	29 Jan. 1993	0[7]
	30 Nov. 1993	0[6]
Possession Island	2–4 Dec. 1978	2 568[4]
	7–8 Dec. 1985	638[9]
	10 Apr. 1986	735[10]
	30 Oct. – 2 Nov. 1986	327[7]
	4 Sep. 1987	442[7]
	28–29 Nov. 1987	454[7]
	25–26 Feb. 1988	613[7]
	4–5 Dec. 1988	946[7]
	5–7 Dec. 1990	702[6]
	29–31 Jan. 1993	669[7]
	1 Dec. 1993	751[6]
Pomona Island	7 Dec. 1978	123[4]
	23 Jan. 1980	20[4]
	6 Dec. 1985	13[9]
	30 Oct. 1986	15[7]
	29 Nov. 1987	8[7]
	11 Mar. 1988	13[7]
	3 Dec. 1988	13[7]
	3 Dec. 1990	2[6]
	21 Mar. 1991	8[7]
Plumpudding Island	8 Dec. 1978	438[4]
	23 Jan. 1980	100[4]
	5 Dec. 1985	92[9]
	30 Nov. 1987	228[7]
	3 Dec. 1988	90[7]
	3 Dec. 1990	1[6]
	27 Nov. 1991	2[7]
	6 Dec. 1993	26[6]
Sinclair Island	8 Dec. 1978	246[4]
	23 Jan. 1980	124[4]
	5 Dec. 1985	51[9]
	30 Nov. 1987	29[7]
	3 Dec. 1988	44[7]
	3 Dec. 1990	27[6]
	27 Nov. 1991	38[7]
	6 Dec. 1993	63[6]
	South Africa	
Bird Island, Lambert's Bay	20 Dec. 1977	7[4]
	8 Jan. 1978	7[4]
	24 Feb. 1978	5[4]
	11 Mar. 1978	6[4]
	13 May 1978	24[4]
	5 Jun. 1978	37[4]
	14 Jul. 1978	31[4]
	29 Aug. 1978	22[4]
	4 Jan. 1979	10[4]
	16 Feb. 1979	12[4]
	16 Mar. 1979	19[4]
	19 Apr. 1979	46[4]
	21 May 1979	50[4]
	27–28 Jun. 1979	36[4]
	24–25 Jul. 1979	33[4]
	23 Aug. 1979	41[4]

Appendix *(continued)*

Locality	Date	Count of active nest sites
	27 Sep. 1979	10[4]
	27 Nov. 1979	c.20[4]
	21 Dec. 1979	7[4]
	8 Jan. 1980	2[4]
	12 May 1987	21[9]
	25 Jan. 1988	0[7]
	23 Feb. 1988	3[7]
	28 Mar. 1988	23[7]
	25 Jul. 1988	23[7]
	29–30 Aug. 1988	11[7]
	28 Sep. 1988	0[7]
	25 Oct. 1988	4[7]
	19 Sep. 1989	5[7]
	24 Oct. 1989	0[7]
	11–13 Dec. 1989	1[7]
	16 Jan. 1990	11[7]
	9 Feb. 1990	9[7]
	19–21 Mar. 1990	6[7]
	23–24 Apr. 1990	17[7]
	19 May 1990	9[7]
	4–6 Jun. 1990	26[7]
	17 Jul. 1990	30[7]
	14 Aug. 1990	14[7]
	10–12 Sep. 1990	21[7]
	15–17 Oct. 1990	0[7]
	28 Nov. 1990	0[7]
	17–18 Dec. 1990	0[7]
	2 Jan. 1991	6[7]
	21 Feb. 1991	11[7]
	29 Mar. 1991	8[7]
	17 Apr. 1991	18[7]
	23 May 1991	11[7]
	18 Jun. 1991	20[7]
	16 Jul. 1991	25[7]
	19–21 Aug. 1991	14[7]
	16–18 Sep. 1991	15[7]
	15 Oct. 1991	2[7]
	12 Nov. 1991	0[7]
	17 Dec. 1991	0[7]
	24 Jan. 1992	5[7]
	21 Feb. 1992	11[7]
	31 Mar. 1992	8[7]
	24 Apr. 1992	6[7]
	5 May 1992	12[7]
	28 Jun. 1992	10[7]
	20 Jul. 1992	14[7]
	25 Aug. 1992	18[7]
	10 Sep. 1992	9[7]
	5–6 Oct. 1992	2[7]
	26 Nov. 1992	0[7]
	8–9 Dec. 1992	0[7]
	12 Jan. 1993	11[7]
	11 Feb. 1993	9[7]
	25 Mar. 1993	3[7]
	24 Apr. 1993	15[7]
	12 May 1993	8[7]
	8 Jun. 1993	15[7]
	20 Jul. 1993	22[7]
	9 Aug. 1993	18[7]
	6 Sep. 1993	7[7]
	12 Oct. 1993	1[7]
	9 Nov. 1993	0[7]
	13 Dec. 1993	0[7]
	13 Jan. 1994	7[7]
	4 Feb. 1994	5[7]
	10 Mar. 1994	10[7]
	18 Apr. 1994	15[7]
	3 May 1994	14[7]
	8 Jun. 1994	16[7]
	13 Jul. 1994	11[7]
	4 Aug. 1994	13[7]
	6 Sep. 1994	10[7]
	5 Oct. 1994	2[7]
	10 Nov. 1994	4[7]
	13 Dec. 1994	1[7]
Malgas Island	29 Dec. 1978	576[4]
	18 Jul. 1979	1 022[4]
	22 Aug. 1979	303[4]
	23 Oct. 1979	739[4]
	26 Nov. 1979	>375[4]
	20 Dec. 1979	113[4]
	6 Nov. 1985	129[9]
	1 Apr. 1987	142[7]
	29 Sep. 1988	31[7]
	14–15 Nov. 1988	19[7]
	20 Jan. 1989	0[7]
	20 Feb. 1989	71[7]
	7 Mar. 1989	58[7]
	30 Apr. 1989	101[7]
	16 May 1989	95[7]
	19–21 Jun. 1989	83[7]
	24–26 Jul. 1989	56[7]
	20 Sep. 1989	7[7]
	26 Oct. 1989	0[7]
	12–15 Dec. 1989	36[7]
	17–19 Jan. 1990	97[7]
	7 Feb. 1990	109[7]
	23–26 Mar. 1990	118[7]
	30 Apr. 1990	104[7]
	17 May 1990	43[7]
	6–8 Jun. 1990	84[7]
	18–20 Jul. 1990	41[7]
	15–17 Aug. 1990	28[7]
	17–19 Sep. 1990	14[7]
	16 Oct. 1990	15[7]
	26–28 Nov. 1990	20[7]
	20 Dec. 1990	40[7]
	23 Jan. 1991	21[7]
	20 Feb. 1991	49[7]
	19 Mar. 1991	41[7]
	19 Apr. 1991	80[7]
	21 May 1991	46[7]
	20 Jun. 1991	75[7]
	17 Jul. 1991	67[7]
	22 Aug. 1991	34[7]
	24 Sep. 1991	10[7]
	20 Jan. 1992	18[7]
	17 Feb. 1992	42[7]
	9–10 Mar. 1992	64[7]
	13–16 Apr. 1992	88[7]
	12 May 1992	99[7]
	28 Jun. 1992	61[7]
	23 Jul. 1992	48[7]
	27 Oct. 1992	8[7]
	12 Dec. 1992	5[7]
	23 Mar. 1993	65[7]
	20 Apr. 1993	70[7]
	11 May 1993	43[7]
	10 Jun. 1993	41[7]

Appendix *(continued)*

Locality	Date	Count of active nest sites
	22 Jul. 1993	37[7]
	12 Aug. 1993	44[7]
	20 Oct. 1993	16[7]
	25 Nov. 1993	21[7]
	15 Dec. 1993	18[7]
	15 Feb. 1994	54[7]
	10 Mar. 1994	80[7]
	20 Apr. 1994	62[7]
	4 May 1994	66[7]
	6 Jun. 1994	76[7]
	21 Jul. 1994	21[7]
	3 Aug. 1994	29[7]
	5 Oct. 1994	15[7]
	7 Nov. 1994	37[7]
	14 Dec. 1994	5[7]
Marcus Island	29 Apr. 1976	717[4]
	26 Dec. 1978 – 7 Jan. 1979	374[4]
	17–18 Jul. 1979	1 243[4]
	3 Nov. 1985	115[9]
	2 Apr. 1987	214[7]
	21 Mar. 1990	119[7]
	21 Jun. 1991	207[7]
	18 Oct. 1991	91[7]
	26 Feb. 1992	50[7]
	4 Mar. 1993	62[7]
	21 Oct. 1993	22[7]
	11 Mar. 1994	88[7]
	16 Jun. 1994	204[7]
	25 Oct. 1994	15[7]
Jutten Island	29 Dec. 1978	712[4]
	10–15 Feb. 1979	2 397[4]
	25–26 Jul. 1979	2 878[4]
	4–5 Nov. 1985	755[9]
	10 May 1991	806[7]
	13 May 1992	991[7]
	2–3 Mar. 1993	526[7]
	19–21 Oct. 1993	199[7]
	8–10 Jun. 1994	1 349[7]
Vondeling Island	26 Apr. 1976	1 028[4]
	27 Oct. 1978	276[4]
	8 Jun. 1979	495[4]
	2 Nov. 1985	79[9]
	31 Mar. 1987	196[7]
	13 Apr. 1989	109[7]
	11 May 1991	229[7]
	2 Oct. 1991	36[7]
	24 Feb. 1992	133[7]
	17 Mar. 1992	125[7]
	5 Mar. 1993	141[7]
	25 Oct. 1993	21[7]
	15 Feb. 1994	169[7]
	23 Oct. 1994	31[7]
Dassen Island	23–30 Oct. 1978	11 220[4]
	1–12 Jun. 1979	12 646[4]
	26–31 Oct. 1985	2 757[9]
	7–10 Jul. 1987	4 588[7]
	31 Oct. – 3 Nov. 1988	1 674[7]
	26–30 May 1989	8 428[7]
	11–15 May 1991	9 012[7]
	10–13 Jun. 1992	7 563[7]
	17–21 May 1993	7 199[7]
	8–13 Apr. 1994	9 389[7]
	13–26 Aug. 1994	3 110[6]
Robben Island	Oct. 1983	c.9[11]
	Apr. 1984	12[4]
	30 May 1984	24[4]
	4 May 1985	86[12]
	24 Oct. 1985	103[11]
	27 Mar. 1986	227[11]
	24 Sep. 1986	225[11]
	29 Oct. 1986	197[11]
	26 Nov. 1986	25[11]
	31 Dec. 1986	13[11]
	28 Jan. 1987	125[11]
	26 Feb. 1987	300[11]
	26 Mar. 1987	298[11]
	30 Apr. 1987	421[11]
	25 May 1987	476[9]
	29 Jun. 1987	425[11]
	27 Jul. 1987	397[11]
	24 Aug. 1987	418[11]
	28 Sep. 1987	414[11]
	9 Oct. 1987	92[11]
	26 Nov. 1987	57[11]
	21 Dec. 1987	3[11]
	31 Jan. 1988	140[11]
	25 Feb. 1988	506[11]
	14 Apr. 1988	613[11]
	30 May 1988	849[11]
	16 Jun. 1988	741[11]
	25 Jul. 1988	773[11]
	22 Aug. 1988	509[11]
	22 Sep. 1988	369[11]
	20 Oct. 1988	215[11]
	21 Nov. 1988	53[11]
	19 Dec. 1988	7[11]
	13 Feb. 1989	609[11]
	13 Mar. 1989	647[11]
	22 May 1989	802[11]
	1 Aug. 1989	829[11]
	14 Sep. 1989	502[11]
	26 Oct. 1989	272[11]
	14 Feb. 1990	648[11]
	14 Mar. 1990	1 211[11]
	28 May 1990	1 278[11]
	22 Aug. 1990	977[11]
	26 Sep. 1990	558[11]
	5 Nov. 1990	277[11]
	11 Feb. 1991	478[11]
	12 Mar 1991	953[11]
	27 May 1991	1 879[11]
	28 Aug. 1991	1 342[11]
	25 Sep. 1991	1 026[11]
	29 Oct. 1991	427[11]
	27 Feb. 1992	942[11]
	25 Mar. 1992	967[11]
	26 May 1992	2 027[11]
	29 Sep. 1992	711[13]
	2–5 Nov. 1992	276[7]
	24–26 Feb. 1993	1 699[7]
	17–19 Mar. 1993	1 241[7]
	26–28 May 1993	2 176[7]
	23–25 Aug. 1993	1 517[7]
	22–24 Sep. 1993	741[7]
	21–23 Feb. 1994	1 269[7]

Appendix *(continued)*

Locality	Date	Count of active nest sites
	30–31 Mar. 1994	1 734[7]
	30–31 May 1994	2 799[7]
	29–31 Aug. 1994	1 160[7]
	26–27 Sep. 1994	737[7]
Boulders	3 May 1985	2[12]
	28 Aug. 1987	7[7]
	1988	34[14]
	1989	38[14]
	25 Jun. 1990	23[15]
	13 Jul. 1990	37[15]
	27 Jul. 1990	42[15]
	10 Aug. 1990	48[15]
	18 Aug. 1990	54[15]
	31 Aug. 1990	52[15]
	15 Sep. 1990	52[15]
	27 Sep. 1990	54[15]
	7 Mar. 1991	43[7]
	Apr. 1991	131[16]
	6 Mar. 1992	92[7]
	24 Apr. 1992	150[7]
	8 Jun. 1992	158[7]
	31 Aug. 1992	153[7]
	8 Oct. 1992	108[7]
	31 Mar. 1993	163[7]
	15 Apr. 1993	172[7]
	3 Jun. 1993	241[7]
	10 Oct. 1993	156[7]
	5 Apr. 1994	289[7]
	28 Jul. 1994	359[7]
Seal Island, False Bay	17 Jan. 1977	24[17]
	17 Jan. 1978	23[18]
	20 Oct. 1978	50[4]
	23 Jan. 1979	43[19]
	18 Jun. 1979	82[4]
	30 Oct. 1981	c.55[7]
	29 Oct. 1986	29[7]
	23 Jul. 1987	83[9]
	12 Oct. 1990	58[7]
	26 Feb. 1991	82[7]
	4 Jul. 1991	63[7]
	6 Aug. 1991	33[7]
	3 Apr. 1992	95[7]
	12 Jul. 1992	58[7]
	27 Oct. 1994	54[7]
Stony Point	17 Nov. 1982	1[20]
	30 Sep. 1983	1[4]
	2 Oct. 1983	1[21]
	14 Nov. 1983	1[4]
	9 Jan. 1984	1[4]
	18 Mar. 1984	0[21]
	1 Jun. 1984	4[4]
	23 Jul. 1984	5[21]
	5 Aug. 1984	4[21]
	15 Sep. 1984	5[21]
	9 Oct. 1984	1[21]
	20 Nov. 1984	1[21]
	1 Dec. 1984	1[21]
	13 Jan. 1985	1[21]
	6 Feb. 1985	0[21]
	11 Mar. 1985	0[21]
	8 Apr. 1985	4[21]
	20 Apr. 1985	7[21]
	13 Jun. 1985	10[21]
	14 Jul. 1985	11[21]
	24 Sep. 1985	8[21]
	12 Nov. 1985	4[21]
	15 Nov. 1985	5[7]
	19 Dec. 1985	1[21]
	28 Dec. 1985	0[7]
	7 Jan. 1986	0[21]
	7 Oct. 1986	27[9]
	12 Mar. 1989	36[22]
	15 Apr. 1989	60[22]
	29 Apr. 1989	50[22]
	14 May 1989	52[22]
	27 May 1989	67[22]
	10 Jun. 1989	67[22]
	1 Jul. 1989	67[22]
	22 Jul. 1989	69[22]
	19 Aug. 1989	65[22]
	10 Feb. 1990	1[22]
	17 Feb. 1990	6[22]
	24 Feb. 1990	12[22]
	3 Mar. 1990	39[22]
	25 Mar. 1990	89[22]
	6 Apr. 1990	88[22]
	24 Apr. 1990	69[22]
	24 May 1990	57[22]
	24 Jun. 1990	78[22]
	21 Jul. 1990	66[22]
	19 Aug. 1990	65[22]
	15 Sep. 1990	45[22]
	21 Oct. 1990	25[22]
	26 Jan. 1991	4[22]
	2 Feb. 1991	21[22]
	17 Feb. 1991	41[22]
	10 Mar. 1991	14[22]
	15 Apr. 1991	24[22]
	31 May 1991	47[22]
	29 Jun. 1991	67[22]
	14 Jul. 1991	77[22]
	10 Aug. 1991	53[22]
	14 Sep. 1991	37[22]
	10 Oct. 1991	17[22]
	16 Jan. 1992	1[22]
	25 Jan. 1992	1[22]
	29 Feb. 1992	6[22]
	14 Mar. 1992	7[22]
	21 Mar. 1992	7[22]
	20 Apr. 1992	31[22]
	9 May 1992	37[22]
	27 Jun. 1992	37[22]
	25 Jul. 1992	57[22]
	15 Aug. 1992	54[22]
	26 Sep. 1992	37[22]
	17 Oct. 1992	21[22]
	8 Nov. 1992	9[22]
	5 Dec. 1992	9[22]
	30 Jan. 1993	0[22]
	11 Feb. 1993	1[22]
	20 Feb. 1993	3[22]
	7 Mar. 1993	14[22]
	24 Mar. 1993	7[22]
	21 Apr. 1993	11[22]
	30 May 1993	31[22]
	2 Jul. 1993	30[22]

Appendix *(continued)*

Locality	Date	Count of active nest sites
	25 Jul. 1993	40[22]
	24 Aug. 1993	29[22]
	28 Sep. 1993	12[22]
	29 Oct. 1993	4[22]
	16 Nov. 1993	1[22]
	30 Nov. 1993	1[22]
	13 Dec. 1993	0[22]
	31 Jan. 1994	5[22]
	27 Feb. 1994	30[22]
	15 Mar. 1994	29[22]
	18 Apr. 1994	21[22]
	25 May 1994	43[22]
	30 Jun. 1994	18[22]
	29 Jul. 1994	44[22]
	17 Aug. 1994	36[22]
	30 Sep. 1994	17[22]
	30 Oct. 1994	6[22]
	5 Nov. 1994	0[22]
	14 Nov. 1994	0[22]
	30 Nov. 1994	0[22]
	8 Dec. 1994	0[22]
Dyer Island	18 Oct. 1978	18 712[4]
	14–16 Jun. 1979	22 655[4]
	14 Jan. 1980	27[4]
	9 Oct. 1981	13 074[7]
	24–26 Dec. 1985	109[7]
	14–16 Oct. 1986	18 481[9]
	5–10 Oct. 1990	4 801[7]
	23–24 Apr. 1991	8 349[7]
	6 Aug. 1991	6 115[7]
	17–19 Aug. 1991	5 263[7]
	22–24 Oct. 1991	2 028[7]
	8–9 Apr. 1992	7 579[7]
	2–3 Oct. 1992	2 882[7]
	9–12 Mar. 1993	2 374[7]
	11–12 Oct. 1993	989[7]
	28–30 Mar. 1994	4 649[7]
	12–14 Oct. 1994	639[7]
Geyser Island	19 Oct. 1978	151[4]
	11 Jan. 1979	117[4]
	17 Jun. 1979	318[4]
	14 Aug. 1987	291[9]
	4 Oct. 1990	139[7]
	23 Apr. 1991	328[7]
	2 Oct. 1992	120[7]
	9 Mar. 1993	172[7]
	13 Oct. 1993	24[7]
Jahleel Island	15 Jun. 1981	578[10]
	10 May 1993	549[7]
Brenton Island	28 Jul. 1986	38[10]
	10 May 1993	31[7]
St Croix Island	10 May 1993	19 478[7]
Seal Island, Algoa Bay	18 Jan. 1977	>102[10]
	9 Nov. 1977	45[10]
	5 Dec. 1979	26[4]
	13 Mar. 1990	510[7]
	6 Aug. 1992	372[7]
	12 May 1993	375[7]
Stag Island	2 Mar. 1977	45[10]
	31 Aug. 1977	6[10]
	5 Dec. 1979	4[4]
	4 Mar. 1981	23[10]
	13 Mar. 1990	50[7]
	12 Mar. 1991	15[7]
	6 Aug. 1992	24[7]
	12 May 1993	21[7]
Bird Island, Algoa Bay	19 Jan. 1977	42[10]
	1 Mar. 1977	333[10]
	31 May 1977	265[10]
	1 Sep. 1977	345[10]
	8 Nov. 1977	234[10]
	7 Dec. 1977	188[10]
	3 Dec. 1979	314[4]
	3 Mar. 1981	572[10]
	13–15 Mar. 1990	3 703[7]
	12–13 Mar. 1991	3 184[7]
	8 May 1991	3 194[23]
	21 Jan. 1992	2 646[23]
	13 Mar. 1992	3 784[23]
	3–7 Aug. 1992	1 145[7]
	18 Mar. 1993	1 294[23]
	11 May 1993	2 293[7]
	18 Jan. 1994	1 318[23]
	22 Mar. 1995	3 651[23]

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[21] Cooper (1986)
[22] JHH unpublished data
[23] NTWK unpublished data