

## Distribution, population size and conservation of the jackass penguin *Spheniscus demersus*

P. A. Shelton , R. J. M. Crawford , J. Cooper & R. K. Brooke

To cite this article: P. A. Shelton , R. J. M. Crawford , J. Cooper & R. K. Brooke (1984) Distribution, population size and conservation of the jackass penguin *Spheniscus demersus* , South African Journal of Marine Science, 2:1, 217-257, DOI: [10.2989/02577618409504370](https://doi.org/10.2989/02577618409504370)

To link to this article: <https://doi.org/10.2989/02577618409504370>



Published online: 08 Apr 2010.



Submit your article to this journal [↗](#)



Article views: 592



Citing articles: 38 [View citing articles](#) [↗](#)

## DISTRIBUTION, POPULATION SIZE AND CONSERVATION OF THE JACKASS PENGUIN *SPHENISCUS DEMERSUS*

P. A. SHELTON\*, R. J. M. CRAWFORD\*, J. COOPER† AND R. K. BROOKE†

The jackass penguin, endemic to southern Africa, is the only member of the Sphenisciformes now breeding in Africa. Its breeding distribution extends from Sylvia Hill, South West Africa (Namibia), to Bird Island, Algoa Bay, South Africa. The non-breeding range extends from Sette Cama, Gabon, to Inhaca Island, Moçambique. Jackass penguins do not usually occur far off shore. The minimum total breeding population in 1978/79 was estimated to be approximately 134 000 birds. Numbers halved between 1956 and 1978 alone as a result of collapses in the South and South West African pilchard populations. Numerical decreases at Possession and Dassen Islands were particularly severe. Prior to 1956 numbers had also decreased, primarily because of large collections of eggs. Sealing activities and guano harvests may also have influenced trends. Only colonies at the periphery of the breeding distribution have increased numerically in recent times, and such increases appear to be related to the availability of suitable prey. Although the species breeds in captivity and is unlikely to become extinct, its continued survival in the wild probably relies on the continued good state of the pelagic fish resources.

Die Kaapse pikkewyn, endemies in suider-Afrika, is die enigste lid van die Sphenisciformes wat tans in Afrika broei. Die broeiverspreiding van die spesie strek van Sylvia-heuwel, Suidwes-Afrika (Namibië), tot by Voëleiland, Algoabaai, Suid-Afrika. Die nie-broeiverspreiding strek van Sette Cama, Gaboen, tot by Inhaca-eiland, Mosambiek. Kaapse pikkewyne kom gewoonlik nie ver van die kus af voor nie. Die totale broeibevoelking is in 1978/79 op 'n minimum van ongeveer 134 000 geraam. Net tussen 1956 en 1978 is getalle gehalveer as gevolg van ineenstortings in die Suid- en Suidwes-Afrikaanse sardynbevolkings. Veral by Possession- en Dassen-eiland was die getalsvermindering drasties. Voor 1956 het getalle ook afgeneem, primêr vanweë grootskaalse eiersameling. Robbejagbedrywighede en ghvano skrapery kon ook 'n uitwerking op tendense gehad het. Die afgelope tyd het net kolonies aan die buiterand van die broeiverspreiding in getalle vermeerder, en sodanige vermeerderings hou blykbaar verband met die beskikbaarheid van geskikte prooi. Hoewel die spesie in gevangenskap broei en uitsterwing onwaarskynlik is, hang die voortbestaan daarvan in die natuur waarskynlik af van die voortgesette goeie stand van die pelagiese vishulpbronne.

"Birds as large as ducks, they do not fly because they do not have feathers on their wings. We killed as many of them as we desired and they Bray like asses" — Vasco da Gama in 1497.

The jackass penguin *Spheniscus demersus* (Aves: Spheniscidae) is an endemic seabird of the coastal region of southern Africa (Clancey 1980), and it is the only member of the Order Sphenisciformes breeding in Africa at present. In the Pliocene, south-western Africa had a richer penguin fauna, and four species have been described (Clancey op. cit.). Together with the Cape cormorant *Phalacrocorax capensis* (Cooper et al. 1982) and the Cape gannet *Morus capensis* (Crawford et al. 1983), the jackass penguin is one of the three most important avian predators of pelagic fish in the Benguela system (Crawford and Shelton 1978).

The jackass penguin is considered to be vulnerable (Frost et al. 1976, King 1981, Brooke in press) because of the large decrease in population size, a

decrease estimated to be more than 50 per cent for the period 1956—1978 alone by Crawford and Shelton (1981). Earlier decreases also occurred (Frost et al. op. cit.). A number of causes for these trends have been given in literature. The commercial collection of penguin eggs for food ceased in 1968, but as many as 500 000 were collected from Dassen Island alone in 1925 (Siegfried and Crawford 1978, Appendix 3) and more than 700 000 were collected from a number of localities in 1897 (Appendix 3). Oiling at sea may have accounted for mortality of as much as 10 per cent of the population in a single incident in 1968 (Westphal and Rowan 1971), and subsequent attempts to clean the birds are thought to have had little conservation value (Frost et al. op. cit.), though Morant et al. (1981) give good grounds for a more

\* Sea Fisheries Research Institute, Private Bag X2, Rogge Bay 8012, Cape Town

† Percy FitzPatrick Institute of African Ornithology, University of Cape Town, Rondebosch 7700, Cape Town

optimistic view. Although on a number of islands jackass penguins breed in burrows in guano or sand, or in clefts between rocks, surface nesting also occurs. On these islands penguins are susceptible to human disturbance, which facilitates egg predation by kelp gulls *Larus dominicanus* (Berry *et al.* 1974, Hockey and Hallinan 1981), and to competition for breeding space with Cape fur seals *Arctocephalus pusillus* (Shaughnessy 1980). Access to islands by humans is strictly controlled by government legislation and, although guano collection is permitted on a number of islands, it is no longer allowed within penguin colonies. The construction of walls on some islands has created enclosures which reduce competition with Cape fur seals (Shaughnessy *op. cit.*).

By far the most telling cause for the decrease in the numbers of jackass penguins subsequent to 1960 is thought to be the collapses of populations of the South West African and South African pilchard *Sardinops ocellata*, collapses brought about by overfishing in the 1960s and early 1970s (Crawford and Shelton 1981). Prior to these collapses pilchard was the most frequently recorded item in the diet of penguins (Davies 1955, 1956, Rand 1960, Matthews 1961). Although there has been a large overall decrease in the population of penguins, colonies at both the northern and eastern extremities of the breeding distribution have increased since 1956 (Crawford and Shelton *op. cit.*). In the north this may have been related to an increase in abundance of pelagic goby *Sufflogobius bibarbatatus*, a species which has been reported from acoustic surveys as being most abundant north of Lüderitz (Cruickshank *et al.* 1980). Further, commercial fishing grounds for pilchard off South West Africa have recently contracted to the north (Crawford *et al.* 1983). The eastern colonies may also have benefited from a shift in the centre of distribution of the reduced South African pilchard population (Crawford and Shelton *op. cit.*).

Anchovy *Engraulis capensis*, which has to a large extent replaced pilchard in commercial catches off the west coast of South and South West Africa (Crawford and Shelton 1981), has a less regular seasonal distribution than pilchard, and its availability is especially uncertain off the South African coast west of Cape Point during summer and early autumn (Crawford 1981). The jackass penguin relies on a predictable temporal and spatial distribution pattern of prey (Frost *et al.* 1976) and has decreased alarmingly at a number of West Coast colonies despite an apparent abundance of anchovy.

This report considers the overall and breeding distributions of the jackass penguin, as well as the population trends at breeding colonies. An estimate of the spring/summer breeding population of

1978/79 is presented and, in the light of the large total population decrease, suggestions for conservation of the jackass penguin are made.

## METHODS

Methods used to count jackass penguins between 1978 and 1981 have been discussed in detail by Shelton *et al.* (1982). As far as possible the census techniques were chosen to provide results comparable with a comprehensive survey conducted in 1956 (Rand 1960, 1963a, b). Because the jackass penguin nests in burrows, in crevices between rocks and under bushes, as well as in surface colonies, aerial techniques do not have universal applicability. Where aerial photographs were used to obtain population estimates, all birds, including peripheral non-breeders, were counted. Replicate counts of penguins on aerial photographs had a standard deviation that was nine per cent of the mean (Shelton *et al. op. cit.*).

Ground estimates of penguin numbers were made by counting all occupied nest sites, defined as sites defended by adult birds, sites showing evidence of recent nest building activity, and sites with eggs or chicks. In some instances penguin chicks were found in groups or creches, and the number of associated nest sites was then estimated to be half the number of chicks, with remainders taken to represent further sites (e.g. a count of 11 chicks was taken to represent 6 sites). Moulting jackass penguins frequently return to their nest sites (Cooper 1978), and sites with moulting birds present or with a large accumulation of feathers were included in the counts. Occupied nest sites of penguins were counted by walking tightly spaced grids or by counting sectors which were divided by natural or artificial markers. Nests in burrows in sand were marked off after being checked, to avoid recounting. Closely packed colonies were counted from a distance of up to 20 m, sometimes through binoculars, in order to avoid disturbance, especially when predatory kelp gulls were in the vicinity.

To gain insight into diel fluctuations, numbers of penguins present at surface-breeding colonies on Mercury and Ichaboe Islands were counted at intervals of 2–3 h between dawn and dusk on 23 November 1978 and 5 December 1978 respectively. The results were used to correct counts of birds on aerial photographs for the purpose of estimating the spring/summer breeding population.

Where aerial photographs indicated substantial population increases, a life table was used to compute the first-year survival necessary to achieve the ob-

served population growth. Assumptions made in the life table were that clutches comprised two eggs, that 0,377 chicks were fledged per clutch, that second-year survival was 90,5 per cent and that annual survival thereafter was 91,1 per cent, the observed parameters at St Croix Island during the period 1976—1982 (Randall 1983). Further assumptions were that age at first breeding was three years (Furness and Cooper 1982), that all pairs produced two clutches per annum (cf. Randall and Randall 1981), and that no immigration took place.

The breeding seasons at Ichaboe, Bird (Lambert's Bay) and Malgas Islands were examined by monitoring, at varying times during the period July 1978—March 1980, the contents of 10—200 nests selected at random from the periphery of colonies.

### DISTRIBUTION

The authoritative Falla and Mougín (1979) say of the jackass penguin: "Breeds on islands off the southern and southwestern coasts of southern Africa, as far north as Walvis Bay. Rather sedentary: confined at sea to south African coastal waters, mainly in the region served by the Benguela Current. Seldom occurs more than 50 kilometers from the breeding islands and more than 15 kilometers from the mainland. Stragglers observed as far north as Angola on the west coast and Mozambique on the east coast." We now give a more precise statement on these matters.

The jackass penguin at present breeds on about 24 islands and off-shore rocks and at three mainland localities between Sylvia Hill, South West Africa and Bird Island, Algoa Bay, South Africa (Fig. 1, Appendix 1). Evidence exists for a historically greater range: jackass penguins bred on Hollams Bird Island, c. 70 km north of Sylvia Hill, in 1950 (Rand 1952) and may still do so (see next section). There is no evidence that jackass penguins have ever bred as far north as Walvis Bay. Extant colonies within the present breeding range are listed with a summary of the evidence in the next section.

Appendix 2 lists all records known to the authors of jackass penguins off the West Coast of Africa to the north of Hollams Bird Island, where they possibly still breed, and to the north of the estuary of the Kei River on the East Coast c. 220 km ENE of the most easterly breeding colony (Bird Island, Algoa Bay). From Appendix 2 it appears that the most northerly record on the West Coast is Sette Cama, Gabon, and the most northerly record on the East Coast is Inhaca Island, in the extreme south of

Mozambique. We agree with Falla and Mougín (1979) that jackass penguins do not occur commonly along the coasts much more than 50 km beyond their extreme breeding localities at Sylvia Hill on the West Coast and Bird Island, Algoa Bay on the South Coast. This statement is borne out by the relatively small number of such records in Appendix 2 and the fact that most of these records refer to single birds, often juveniles. There appears to be no reason to consider that the extreme vagrant records are not natural occurrences, because there is no evidence of human assistance.

We also agree with Falla and Mougín (1979) that jackass penguins do not normally occur far off shore: 79 per cent of jackass penguins reported at sea off the South-Western Cape in the 1950s were within 12 km of land, and only one bird has been recorded as being seen more than 125 km off shore (Siegfried *et al.* 1975). Penguins may occur further off shore along the southern Cape where the off-shore extent of the distribution of prey species tends to increase (Crawford 1979). In 1960, huge "rafts" totalling about 3 000 birds were seen 16—24 km south-west of Bird Island, Algoa Bay (Liversidge and Le Gras 1981).

Elliott (1953, 1957) reported that islanders at Tristan da Cunha, in the South Atlantic Ocean, mentioned that they occasionally saw penguins "... with a white stripe on the head ..." on beaches. He attributed these sightings to the jackass penguin in his earlier paper, but in his later paper he pointed out that they were more likely to be Magellanic penguins *S. magellanicus*, because virtually all flying vagrants observed at Tristan da Cunha originated in the Americas. It is better, therefore, to regard Elliott's (1953, 1957) listing as of penguins of uncertain species.

### POPULATION TRENDS AT BREEDING LOCALITIES

#### Hollams Bird Island

According to Morell [*sic*] (1844) and Morrell (in Petrie 1844), in an entry dated 6 November 1828 an island which he called Bird island "... is resorted to by ... penguins;". He gave its position as 24° 38'S, 14° 22'E. This island is considered to be Hollams Bird Island (24° 38'S, 14° 32'E) by Best and Shaughnessy (1979).

Breeding and moulting jackass penguins were present on Hollams Bird Island in 1845 (Eden 1846). Capt. John Spence believed that penguins did not occur on this island later in the 19th Century (Angra

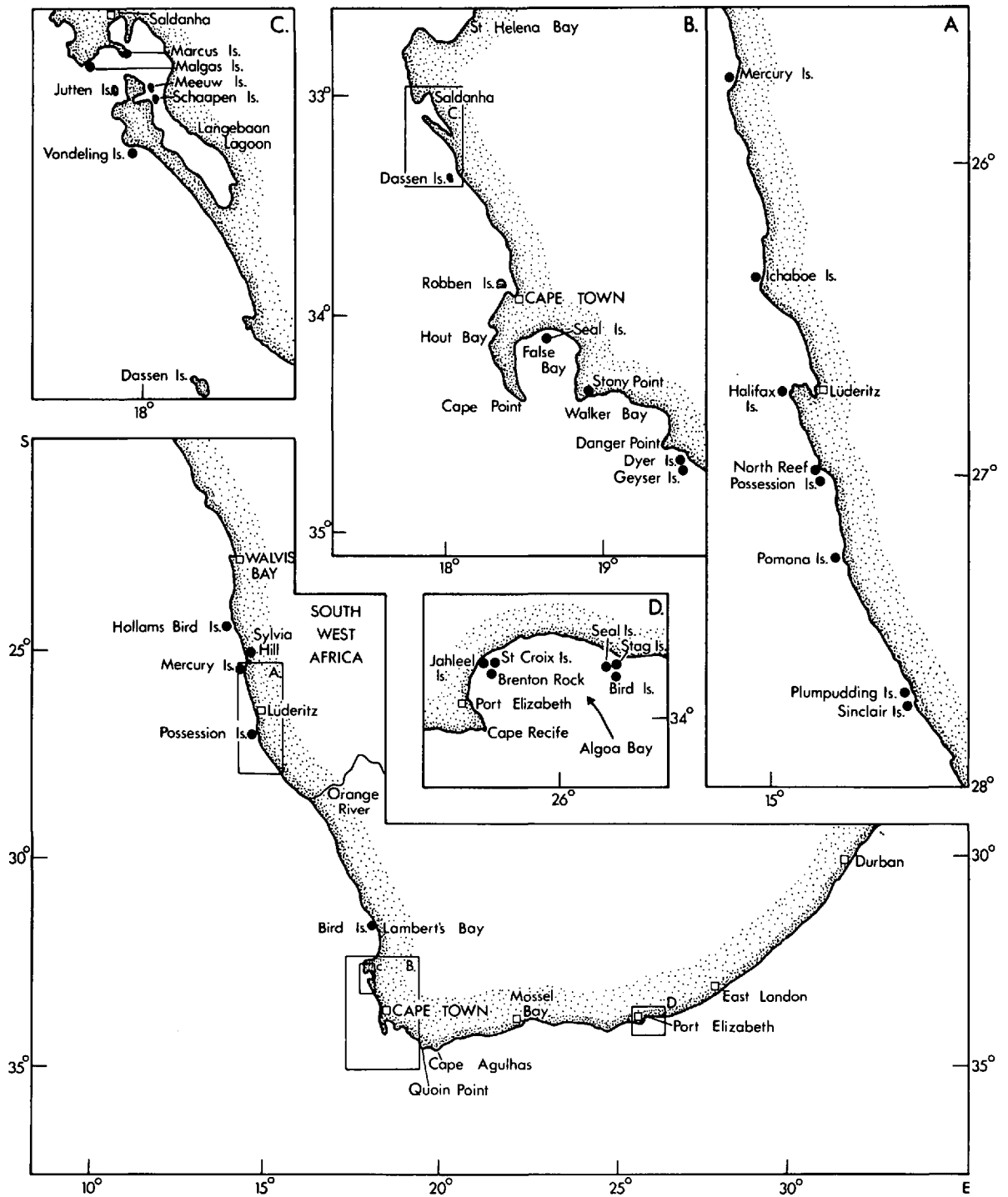


Fig. 1: Jackass penguin breeding localities, both extinct and extant

Pequena and West Coast Claims Joint Commission 1885). Rand (1952) assumed from Eden's account that numbers did not at that time "... exceed a few hundred ...".

Rand (1952) recorded two penguin nests in April or May 1951 and Frost *et al.* (1976) assumed, without further evidence, that about 10 individuals occupied the island. The population has apparently decreased since the 1840s as a result of competition for space with Cape fur seals (Rand *op. cit.*). One of the 1951 penguins bred underneath a hut and the other under a pile of sacks, and both nest sites were therefore afforded protection from Cape fur seals (Rand *op. cit.*). Remnants of a hut are evident on photographs taken by P. D. Shaughnessy (*in litt.*) and penguins could still breed within it. Elsewhere on the island the presence of seals presumably precludes breeding. No penguins were noticed on aerial photographs taken at 14h15 on 28 November 1978. Previously, on 25 March 1977, P. D. Shaughnessy (*in litt.*) made an unsuccessful attempt to land. He saw no penguins ashore while circumnavigating the island in a small boat, and none can be seen on a series of overlapping photographs he took at the time.

### Sylvia Hill

Two mainland caves c. 1.5 km south of Sylvia Hill contained 254 penguins including incubating and moulting birds and seven chicks on 28 February 1984 (R. Loutit, Nature Conservation Division, South West Africa, *in litt.*). Entrance to the main cave was not possible by land, even at low tide. An adjacent cave north of the breeding colony was accessible and contained three newly dead penguins. The inaccessibility of the one cave has presumably allowed mainland breeding by jackass penguins on a coast where a significant number of mammalian predators occur (Stuart 1975, Siegfried 1984, R. Loutit *in litt.*). R. Loutit (*in litt.*) reported earlier counts by H. Finkeldey of 30 penguins in June 1981, and 60 in June 1983 when 15 nests had chicks. Therefore the colony at Sylvia Hill appears to be increasing.

### Mercury Island

Morell [*sic*] (1844) and Morrell (in Petrie 1844) in an entry dated 22 October 1828 states "... its summit is thickly inhabited by penguins. ...". Capt. John Spence in his statement under oath (Angra Pequena and West Coast Claims Joint Commission 1885) reported that this island "... has malagas [gannets], penguins and duiker [cormorants]". No

other information on population status exists before 1956 when the first census was conducted (Appendix 1). Aerial photographs suggest that the population decreased marginally between 1956 and 1967, but that it subsequently increased rapidly. A total of 10 820 birds was counted on photographs taken on 28 November 1978, compared with c. 3 000 in 1956 and 1967 (Appendix 1).

If trends observed on aerial photographs accurately reflect the actual increase, the instantaneous coefficient of population growth ( $r$ ) was probably between 0,10 and 0,16 (Table I). The necessary first-year survivals computed from the life table were 84 and 66 per cent for the periods 1967 — 1969 and 1969 — 1978 respectively (Table I), considerably in excess of the value of 32 per cent observed at St Croix Island during the period 1976 — 1982 (Randall 1983). Because St Croix Island is one of only a few breeding localities at which there has been an overall population increase since 1956 (Appendix 1), it is considered unlikely that first-year survival has attained much higher levels elsewhere. Fledging success could conceivably have improved, but adult mortality rates used in the life table were about 30 per cent lower than those adopted by Furness and Cooper (1982). It has additionally been assumed that each breeding pair produced two clutches per annum. As tentatively postulated by Crawford and Shelton (1981), a possible reason for the population increase at Mercury Island could have been movement to the island of penguins from breeding localities situated south of Lüderitz.

Records, from aerial photographs or visits to the islands, of the number of adult seals hauling out during summer suggest that there has been an increase from less than 10 prior to 1981 to about 7 000 in both 1982 and 1983 (J. H. M. David, Sea Fisheries Research Institute, pers. comm.). It is unlikely that these seals constitute a regular breeding colony because the number of pups recorded has been low and, unlike at regular breeding colonies, few seals are present during winter (J. H. M. David pers. comm.). In December 1983 the seals were occupying at least part of the area where breeding penguins had previously been recorded (A. Berruti, Sea Fisheries Research Institute, pers. comm.).

### Hottentot Bay

An island in Hottentot Bay was "... frequented by duikers [cormorants] and penguins." according to Capt. John Spence in his statement under oath (Angra Pequena and West Coast Claims Joint Commission 1885). However, Mr John Gove, head-

Table I: Estimated instantaneous coefficients of population growth for breeding localities of jackass penguins that showed moderate growth at any stage during the period 1956–1978 as deduced from counts of aerial photographs, and first-year survival necessary to achieve this observed growth assuming population parameters to be constant — demographic data used are discussed in the text

Island	Mercury			Ichaboe			Dyer			St Croix
	1967–'69	1969–'78	1967–'78	1967–'69	1969–'78	1967–'78	1956–'67	1967–'78	1956–'78	1956–'69
Instantaneous coefficient of population growth ( $r$ )	0,1595	0,1084	0,1177	0,0564	0,1304	0,1170	0,1699	0,0359	0,1029	0,0663
Breeding adults in year $x$ ( $N_x$ )	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000
Eggs laid	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000
Chicks hatched	1 260	1 260	1 260	1 260	1 260	1 260	1 260	1 260	1 260	1 260
Chicks fledged	377	377	377	377	377	377	377	377	377	377
Adults dying	89	89	89	89	89	89	89	89	89	89
Breeding adults in year $x + 1$ ( $N_{x+1}$ )	1 173	1 115	1 125	1 058	1 139	1 124	1 185	1 037	1 108	1 069
Recruits required (= adults dying + increase in adults)	262	204	214	147	228	213	274	126	197	158
3-year-olds	262	204	214	147	228	213	274	126	197	158
2-year-olds	288	224	235	161	250	234	301	138	216	173
1-year-olds	318	248	260	178	276	259	333	152	239	191
Necessary first-year survival (%)	84	66	69	47	73	69	88	40	63	51

man of Ichaboe Island, in his evidence to the same Commission stated that no birds occurred "... within the memory of man" at Hottentot Bay and that the guano collected at the locality under "Six or seven feet of sand" was old "... perished, it has lost its smell." After questioning, he agreed that the "spot" was originally an island. It would seem that either there was once an island which north-moving sand had long since joined to the mainland or that Hottentot Point, the southern end of the Bay where Cape cormorants now breed (Cooper and Smith 1982), is meant. Hottentot Bay has not, apparently, been visited by an ornithologist but it seems likely that jackass penguins have not occurred there in the last 100 years, not least because the 1: 50 000 Government Printer map (2614BB & 2615AA Hottentotsbaai), shows no island in Hottentot Bay.

### Ichaboe Island

Morell [*sic*] (1844) and Morrell (in Petrie 1844) stated in an entry dated 6 October 1828 that "In the months of October and November this island is literally covered with jackass-penguins ...". During the guano rush of 1843/44 (Ex-member of the Committee 1845) jackass penguins apparently aban-

doned Ichaboe Island. Eden (1846) visited Ichaboe Island on 28 May 1845 and recorded "... immense numbers of penguins were assembled at the west side of the island, and at our approach resembled an army in motion, as far as I could judge there might be 100 000: they were more numerous here than at any other part of the coast which I have seen." However, John Gove, the headman from 1853 onwards, told the Commission that it was not until 1860 that the island had returned to its normal status as a major seabird breeding and guano-producing site (Angra Pequena and West Coast Claims Joint Commission 1885). Lowe (1912) gives a map showing where birds were breeding during his visit in December 1910. From this, it appears that jackass penguins occupied two small areas, one at the pinnacle rocks at the extreme south end and one just west of the beacon south of the centre of the island. Gill and Zeederberg (1928) only describe one breeding area, that near the beacon. Between 1928 and 1956 there must have been an increase in the number of breeding birds to account for the distribution of penguins on the island in 1956 shown by Rand (1963b).

Since 1956, trends in the numbers of jackass penguins at Ichaboe and Mercury Islands have been similar (Appendix I, Table II, Crawford and Shelton 1981). The population at Ichaboe Island has been

Table II: Some estimates of the number of jackass penguins at southern African breeding localities, 1956-1979 — some further details of the origin of information are given in Appendix 1

Breeding locality	Estimated adult population, 1956 $\xi$	Estimated adult population, 1956 $\theta$	Count on aerial photographs, 1956 $\xi$	Count on aerial photographs, 1967	Estimated population, c. 1972 $\pi$	Count on aerial photographs, 1978	Count of occupied nest sites, $\lambda$ spring-summer of 1978-1979	Estimated spring-summer population 1978-1979 $\rho$	Estimated total breeding population 1978-1979 $\alpha$
Hollams Bird Island	9 500	4 896 $\beta$	3 264	2 964	10	10 820	3 218	12 655	6 436
Mercury Island	8 400	8 400 $\gamma$	4 179 $\epsilon$	2 882	3 000	10 437	3 598	12 207	7 196
Ichaboe Island	10 000	10 000 $\gamma$	8 639	5 412 $\theta$	5 400	2 755	1 750	3 222	3 500
Halifax Island	3 500	2 040	1 360	389		256	151	299	302
North Reef	46 000	55 788	37 192	14 528		3 757	2 568	4 394	5 136
North Reef and Possession Island	49 500	57 828	38 552	14 917	25 000	4 013	2 719	4 693	5 438
Pomona Island	12 000	14 511	9 676	6 357	7 000	149	123	174	246
Plumpudding Island	6 000	7 201	4 801	5 515	3 000	803	438	939	876
Sinclair Island	3 000	3 555	2 370	646	200	343	246	401	492
South West Africa	98 400	106 391	71 481	38 693	45 610	29 320	12 092	34 291	24 184
Bird Island, Lambert's Bay	500	500 $\gamma$	450 $\zeta$		150	143 $\iota$	c. 10	167	72
Malgas Island	5 000	5 000 $\gamma$	1 063		1 000	4 448	576	5 202	2 044
Marcus Island	9 500	8 751	5 834	2 915	9 000	2 941	374	3 440	2 486
Jutton Island	15 000	14 166	9 444		7 000	3 861	712	4 516	5 756
Vondeling Island	600	562	375		400	304	276	356	990
Dassen Island	145 000	145 000 $\gamma$	80 562		70 000	16 049	11 220	18 771	25 292
Seal Island, False Bay	500	500 $\gamma$	2 765	17 926	50	100 $\delta$	50	100	164
Dyer Island	8 000	4 147			15 000	26 599	18 712	31 110	45 310
Geyser Island						302 $\delta$	151	302	636
Jaheel Island						300 $\kappa$	150 $\mu$	351	1 170 $\gamma$
Brenton Rock						21 $\kappa$	11 $\mu$	25	92 $\gamma$
St Croix Island	12 000	11 205	7 470	17 696 $\theta$	23 000	11 053	5 796 $\mu$	12 927	21 000 $\gamma$
Seal Island	300 $\alpha$	300 $\alpha$	300 $\alpha$			639	1 107 $\mu$	747	2 200 $\gamma$
Stag Island	42	63	42			126 $\kappa$	60 $\mu$	147	118 $\gamma$
Bird Island, Algoa Bay	158	120 $\delta$	120 $\delta$		500	1 177 $\kappa$	314	1 377	2 100 $\gamma$
South Africa	196 600	190 314	108 927		126 100	68 063	39 519	79 538	109 430
All localities	295 000	296 705	180 408		171 710	97 383	51 611	113 829	133 614

 $\alpha$  Rough estimate in 1958 $\beta$  Estimated from a recount of the 1956 photographs $\gamma$  Rand's (1963a, b) estimate, based on ground observations accepted $\delta$  Double the count of number of pairs or nests $\epsilon$  Considered by Rand (1963b) to be a minimum value $\zeta$  Midpoint of range resulting from ground observations (Rand 1963a) $\eta$  From ground observations made c. 1950 (Rand 1951) $\theta$  Count on aerial photographs taken in 1969 $\iota$  Head count in January 1979 $\kappa$  Head count in December 1979 $\lambda$  See "methods" section of text for fuller details $\mu$  Half of 1978 or 1979, head count of adults $\nu$  Randall *et al.* (1981) $\xi$  Rand (1963a, b) $\theta$  Absenteeism from nests standardized as described in text $\pi$  Frost *et al.* (1976) $\rho$  Based on aerial photographs with correlation for absenteeism as described in text $\sigma$  Based on ground counts of penguins and nest sites as described in text



increasing rapidly since 1969, and the high first-year survival computed as necessary for the observed growth to have taken place again suggests that penguins may have immigrated to Ichaboe Island from breeding localities south of Lüderitz (see Table I).

### Seal Island (Lüderitz)

Morell [*sic*] (1844) and Morrell (in Petrie 1844), in an entry dated 24 September 1828, refers to two small islands "Two miles east-by-north from Angra Point," and said "... shags [cormorants] and penguins had now taken entire possession . . . in such numbers that ships might procure any quantity of their eggs . . .". We consider these islands to be Seal Island, Lüderitz, and Penguin Island.

This island was reported as "... frequented by penguins and duikers [cormorants];" by Capt. John Spence in his statement under oath (Angra Pequena and West Coast Claims Joint Commission 1885). Human disturbance on this and Penguin Island probably led to the cessation of breeding by jackass penguins before 1900. Such disturbance was considered in detail by the Commission.

### Penguin Island

Breeding jackass penguins were present in numbers in September 1828 (see account for Seal Island, Lüderitz). Capt. John Spence in his statement under oath to the Commission reported that this island "... has penguins and duikers [cormorants]". No later evidence, despite the island's name, of jackass penguins breeding on the island is available, and they definitely do not now breed there. As for Seal Island, the human disturbance, of which the Commission took note, probably put an end to breeding before 1900.

### Halifax Island

Capt. John Spence in his statement under oath (Angra Pequena and West Coast Claims Joint Commission 1885) reported that this island "... used to be exclusively occupied by penguins, but now it has penguins, malagas and duikers;". A photograph of most of the main penguin breeding area at Halifax Island (Gill and Zeederberg 1928) probably taken in 1926 (see account for Seal Island, Mossel Bay) shows a very large number of penguins, suggesting that a decrease in population had commenced prior to the

first census made in 1956. This conclusion is supported by Meinertzhagen (1950) who reported 1 200 penguins in May 1949 at the height of the hatching season. The number of 1 200 is acceptable, unlike the grossly exaggerated figures he gave for cormorants *Phalacrocorax* spp.

Berry *et al.* (1974) reported a decrease in the population of jackass penguins at Halifax Island between 1956 and 1971/1972. Counts on aerial photographs confirm this trend, the value for 1978 being about 32 per cent of that recorded in 1956 (Appendix 1). However, the decrease has not been as severe as at islands located further south, possibly because of greater prey availability. Disturbance of birds by guano collectors may have influenced the population decrease (Berry *et al.* op. cit.).

### North Long Island

Morell [*sic*] (1844) does not mention the presence of penguins at this locality, which he apparently visited on 2 October 1828. Capt. John Spence in his statement under oath (Angra Pequena and West Coast Claims Joint Commission 1885) recorded that the island "... has seals and penguins;". Shaughnessy (1984) reviews the evidence for the occurrence of penguins on North Long Island and concludes that there have been no penguins since 1926. Jackass penguins were not present when the island was visited on 1 December 1978.

### North Reef and Possession Island

Morell [*sic*] (1844) and Morrell (in Petrie 1844) stated "... in the months of August, September and October, any quantity of penguins' eggs may be collected;" an observation dated 20 September 1828 for Possession Island. Eden (1846) saw "Numerous penguins . . ." on his visit to Possession Island on 14 May 1845.

Capt. John Spence in his statement under oath to the Commission said "Possession Island used to be exclusively occupied by penguins, but now the malagas have come there, and there are also duikers;". According to evidence reviewed by Shaughnessy (1984) jackass penguins were decreasing in number early in the twentieth century. On aerial photographs of North Reef and Possession Island taken in 1967, the numbers of jackass penguins were respectively 71 and 61 per cent less than counts made from photographs taken in 1956 (Appendix 1). A large decrease therefore occurred before the collapse of the South West African pilchard resource. Disturbance by

sealers, who used Possession Island as a base, may have contributed to this trend (Crawford and Shelton 1981). Numbers of penguins at both localities had decreased further by 1978 (Appendix 1).

Between 1972 and 1978, counts were made of the maximum annual number of occupied nest sites within eight colonies in the central part of Possession Island. Most of these counts were made by the headman, Mr G. E. Nel. By 1978, four of the eight colonies were extinct and the total number of occupied nests had decreased substantially (Table III).

### Albatross Rock

Capt. John Spence in his statement under oath (Angra Pequena and West Coast Claims Joint Commission 1885) claimed that this island "... has penguins and ducks;". No other evidence for breeding of jackass penguins is available (Shaughnessy 1984), and we believe that none now takes place there. The island was circled in a small boat during the period 6–8 December 1978, but we were unable to land or to see any sign of penguins breeding. The island has a large colony of Cape fur seals.

### Pomona Island

Capt. John Spence in his statement under oath to the Commission called Pomona Island "... exclusively a penguin island;". No information exists on the population before 1956, when the first census was conducted (Appendix 1). Numbers of jackass penguins at the island have decreased markedly since 1956, especially following the collapse of the South West African pilchard population (Appendix 1, Crawford and Shelton 1981). The count of penguins in 1978 was only 1.5 per cent of that in 1956. This is the largest relative decrease for any breeding locality.

### Plumpudding Island

Capt. John Spence in his statement (Angra Pequena and West Coast Claims Joint Commission 1885) called this island "... exclusively a penguin island". Rand (1949a) reports the presence of breeding penguins in 1948, but no information on population trends at Plumpudding Island is available before 1956, when the first census was conducted (Appendix 1). The population increased between 1956 and 1967 by about 15 per cent (Appendix 1), possibly as a result of displacement of birds by seals from nearby

Table III: Counts of the maximum number of occupied nests, 1972–1976 and 1978, within eight colonies on Possession Island, mostly from records of the headman, G. E. Nel

Year	Month	Estimate
1972	November	517
1973	November	241
1974	September*	42
1975	November	312
1976	December	48
1978	December	59

\* No November count made

Sinclair Island. Thereafter, there was a sharp decrease which coincided with the collapse of the South West African pilchard stocks (Crawford and Shelton 1981). The 1978 population was only about 9 per cent of that of 1956 (Appendix 1).

### Sinclair Island

Capt. John Spence in his statement to the Commission called it "... a penguin and seal island". Jackass penguins on Sinclair Island, the southernmost breeding locality off South West Africa, decreased from about 6 000 adults in 1948 to 2 370 adults and chicks in 1956 (Appendix 1). Aerial photographs suggest a further 63 per cent decrease by 1967, and numbers continued to fall thereafter (Appendix 1). In 1940 a concrete wall, 1 m high, was built around the colony to prevent seal disturbance, but after 1956 three gaps were opened in the wall, and these probably were largely responsible for the subsequent decrease in numbers of penguins (Shaughnessy 1980). The wall was repaired in 1980 or 1981 (C. S. Bosman, Marine Development Branch, pers. comm.), but seals were observed in the penguin enclosure in January 1983 (J. H. M. David, pers. comm.). In view of the poor recent performance of penguins at islands between Lüderitz and the Orange River, there is no guarantee that numbers of penguins at Sinclair Island will increase immediately even if seals are successfully excluded from the penguin breeding area.

### Bird Island (Lambert's Bay)

The first known record of jackass penguins breeding at Bird Island, Lambert's Bay, the northernmost breeding locality off the Republic of South Africa, is for 1871 when 15 200 eggs were collected (Appendix 3). Green (1950) observed that early 20th

century photographs showed "... breeding flats covered with penguins, and with not a gannet in sight." Jarvis (1971) stated that "verbal testimony" maintained that Bird Island was almost exclusively inhabited by jackass penguins in the latter part of the nineteenth century and that "... some penguins were even breeding on the mainland, only 150 yards from the island." A further record of mainland breeding was made between April and June 1982, when a single nest with eggs was found in a discarded section of rubber pipe on the landward side of the harbour (B. Dyer, Sea Fisheries Research Institute, pers. comm.). The nest was subsequently abandoned by the birds before hatching took place. Based on the number of eggs collected commercially (Appendix 3), Frost *et al.* (1976) estimated the population in the decade 1900–1909 to be at least 2 700 birds (greatest number of eggs per year multiplied by 0,662 and rounded to the nearest hundred). Earlier, in 1871–1879, nearly twice as many eggs were collected (Appendix 3, Frost *et al.* op. cit.), suggesting that the population decreased between these two dates. There were about 500 adults at the island in 1956, but the population had decreased substantially by 1978/79, when the mean of 12 ground counts of adults conducted in all seasons was 68 (maximum 132, Appendix 1).

By contrast, the earliest record of Cape gannets breeding at Bird Island is of one or two pairs in 1912, but the numbers of this species increased rapidly thereafter (Jarvis 1971, Crawford *et al.* 1983). A decrease in the number of penguins may have occurred before 1956, possibly as a result of competition with gannets for breeding space. Also, paving the central area with flat stones to facilitate guano scraping (Jarvis and Cram 1971) adversely influenced the quality of the penguin nesting habitat (Frost *et al.* 1976). Rand (1963a) cites M. E. Gillham as stating that penguins abandoned their breeding site at the island in mid 1958 because of disturbance created by harbour construction, and that they had not returned by the time of her visit on 29 May 1960. The recent decrease in numbers of penguins can probably be attributed to the concomitant collapse of the South African pilchard resource after 1960. Pilchards formed a large portion (30–64 per cent) of the diet of penguins sampled off the Western Cape in the 1950s (Davies 1955, 1956, Rand 1960).

#### Jacob's Reef

Rand (1960) noted: "Occasional penguins nest on seal rookeries such as Jacob's Reef, Quoin Rock, Geyser Island and Seal Island (False Bay) but only

the latter island affords sufficient protection among the loose boulders to maintain a sizeable colony." No visit to Jacob's Reef has been possible.

#### Malgas Island

In October 1648 penguins were the most abundant breeding seabird on the Saldanha Bay islands, according to Etienne de Flacourt in Raven-Hart (1967), but although this author carefully distinguished the five islands (Crawford *et al.* 1983) he did not indicate on which the penguins were most abundant. It seems certain that Malgas Island was one of the islands used for breeding. The "guano rush" of 1845 caused great disturbance to the island's bird life, including penguins (Burman and Levin 1974), as it did at Ichaboe Island. However, on 1 October 1846 the "... penguins has [*sic*] resumed their sway" (Burman and Levin op. cit.). Penguin eggs were commercially harvested on Malgas Island only in 1903, when 19 800 were collected, and 1905, when 13 000 were collected (Appendix 3). Calculations made as for other islands by Frost *et al.* (1976) showed there was a population of at least 13 100 birds in 1903. Rand (1963a) counted 1 062 or 1 063 jackass penguins on aerial photographs of Malgas Island taken in November 1956, but he believed that many were concealed by boulders and therefore estimated the population as about 5 000 adults. Frost *et al.* (op. cit.) roughly estimated the population as 1 000 during the early 1970s. The highest of the six counts of nests undertaken between December 1978 and December 1979 was 1 022 on 18 July 1979 (Appendix 1). Therefore, the population appears to have decreased between 1956 and the early 1970s, though it has subsequently partially recovered. However, reliability of the estimate for the early 1970s is questionable. Counts of birds on aerial photographs indicated a population increase between 1956 and 1978 (Appendix 1).

#### Marcus Island

As for Malgas Island, it seems certain that jackass penguins bred on Marcus Island in October 1648 (Etienne de Flacourt in Raven-Hart 1967). Based on egg collections (Appendix 3), Frost *et al.* (1976) estimated the 1900–1909 population of penguins at Marcus Island to have been at least 19 500 birds. A decrease in population size commenced prior to the 1956 census, when 5 834 were counted on aerial photographs (Rand 1963a, Appendix 1). Counts on aerial photographs suggest that the population halved

between 1956 and 1967, but that it then remained relatively stable until 1978 (Appendix 1). This is the only island off the Western Cape located west of Cape Point for which counts of penguins on aerial photographs from the late 1960s are available. The observed decrease between 1956 and 1967 has led to the suggestion that it and similar overall decreases at Malgas, Jutten and Dassen Islands between 1956 and 1978 may all be attributed to the collapse of the South African pilchard resource (Crawford and Shelton 1981). The breeding population in a study colony at Marcus Island has continued to decrease over the period 1977–1983 (records of the Percy FitzPatrick Institute). Since February 1976 Marcus Island has been joined to the mainland by a breakwater, and mortality of penguin adults and chicks by mammalian predators has been recorded (Cooper *et al.* in press). Underwater blasting for harbour development at Saldanha Bay has also killed Marcus Island penguins (Cooper 1982).

#### Jutten Island

This was certainly a penguin breeding island in October 1648, because breeding birds were killed here for food (Etienne de Flacourt in Raven-Hart 1967). Based on egg collections (Appendix 3), Frost *et al.* (1976) estimated the 1900–1909 population of jackass penguins at Jutten Island to have been at least 78 000 birds. A decrease in population size occurred prior to the 1956 census (Rand 1963a, Appendix 1). Counts on aerial photographs decreased by 59 per cent, from 9 444 in 1956 to 3 861 in 1978 (Appendix 1). This last decrease is similar to that recorded over the same time period at Marcus Island, and the collapse of the South African pilchard resource is again believed to have been the main cause (Crawford and Shelton 1981).

#### Vondeling Island

The first known record of jackass penguins breeding at Vondeling Island is for 1871, when 34 100 eggs were collected (Appendix 3). Based on egg collections (Appendix 3), Frost *et al.* (1976) estimated the population in 1900–1909 to have been at least 4 400 birds. Again, a large decrease in population size occurred prior to the 1956 census, when 375 birds were counted on aerial photographs (Rand 1963a, Appendix 1). Aerial surveys suggest that the penguin numbers subsequently decreased by about 20 per cent between 1956 and 1978, considerably less than the decrease at Marcus, Jutten and

Dassen Islands (Appendix 1). In marked contrast to observations made at other localities, kelp gulls breeding at Vondeling Island showed no interest in the nest contents of disturbed birds, and it is believed that human disturbance at the island is negligible (Crawford *et al.* 1982). The guano-collecting staff were withdrawn in about 1963, and Vondeling Island is one of the most difficult islands on which to land.

#### Dassen Island

Jackass penguins were first reported here on 29 November 1601 by Joris van Spillerbergen, and this date also spelled the first of many exploitations of penguins and their eggs on Dassen Island (Rand 1949b, Cott 1953, Raven-Hart 1967, Frost *et al.* 1976). Nicoll (1906, 1908) was told by a lighthouse keeper in February 1906 that nine million penguins frequented Dassen Island, and Kearton (1930) reported "... no less than five million birds ...". Neither of these figures can be taken at face value (Frost *et al.* op. cit.), but they do indicate the large numbers of jackass penguins then on the island. Frost *et al.* (op. cit.), from records of eggs collected (Appendix 3), estimated the breeding population between 1900 and 1930 to have been at least 300 000 birds. The island remained the most populous breeding locality of jackass penguins in 1956 (Rand 1963a, b), was believed by Frost *et al.* (op. cit.) to be so in the early 1970s, but by 1978 had been surpassed by Dyer Island (Table II). In both 1956 and 1978, the number of penguins at Dassen Island was roughly equivalent to the combined number at all breeding localities off South West Africa, and the substantial decrease in the number of penguins at Dassen Island since 1956 has had a considerable influence on the overall population trend (Table II).

From 1870 to 1967 Dassen Island was the principal source of eggs of jackass penguins collected for human consumption (Appendix 3, Frost *et al.* 1976; see also the figures given by Sclater 1904, repeated in 1907). Excessive exploitation of eggs is believed to have initiated a decrease in the number of penguins at the island well prior to the commercial exploitation of pelagic fish resources off the Western Cape (Frost *et al.* op. cit., Siegfried and Crawford 1978). Official egg collecting was suspended after 1968 as a result of increased collecting costs (Rand 1971), although Frost *et al.* (op. cit.) noted that illegal egg harvests, probably small, still occurred.

Competition with the pelagic fishing industry for prey species has probably been the major cause of further decreases in the number of penguins at Dassen Island (Appendix 1, Crawford and Shelton

1981). In addition, resident feral cats *Felis catus* have been recorded as killing penguins, although their impact was not considered sufficiently serious to warrant control measures (Apps 1983). Nevertheless, based on the overall effect of cats on all birds and wildlife, Cooper *et al.* (in press) correctly recommend their total removal from Dassen Island.

### Robben Island

Jackass penguins bred in large numbers on Robben Island in the 1660s but, because of human exploitation and disturbance, stopped breeding there before 1800, perhaps before 1700 (Brooke 1983 and references therein). Recently, during October 1983, islanders noticed about 18 penguins breeding to the north of the harbour where rehabilitated oiled birds are often released (E. O. J. Westphal, Hon. Secretary, South African National Foundation for the Conservation of Coastal Birds, *in litt.*). The presence of breeding jackass penguins on the island was confirmed by Prof. Westphal in April 1984 when 12 nests, one containing a chick, were observed in dense cover from a distance, and by one of us (R.J.M.C.) on 30 May 1984, when 45 adults, 4 downy chicks, 7 eggs and 24 recognizable sites were counted. None of the observed penguins appeared to be ringed, although ringing is standard Foundation procedure for rehabilitated penguins.

### Seal Island (False Bay)

Shaughnessy (1984) has reviewed the early historical records of jackass penguins on Seal Island. The first known record is that of Sparrman (1785), who visited Seal Island in the winter of 1772 and reported "The little island of Malagas in False Bay, is particularly resorted to by penguins and seals". Layard (1867) reported hundreds of nests among the rocks when he visited there with Commodore Trotter, probably in 1856 (Brooke 1981b). The commercial egg collection amounted to 7 500 in 1874 (Appendix 3), which more than corroborates Layard's (*op. cit.*) "hundreds of nests". The implied minimum population, following the method of Frost *et al.* (1976), would have been 5 000 birds. This was at a time when the seal population was low (Shaughnessy *op. cit.*). Wyndham (1932) mentions a few small colonies as present on 16 November 1930. The population of penguins at this island appears to have decreased by 76–80 per cent between 1950 and the late 1970s (Appendix 1), but nest counts suggest an increase in population size between 1978 and 1979 (Appendix 1,

Shaughnessy *et al.* 1979). The penguin population may be disturbed by both seals and commercial sealing.

### Stony Point

A penguin nest containing large chicks was observed at Stony Point on 17 November 1982, the first recorded successful mainland breeding in South Africa (Broni 1982) if the anecdotal account for Lambert's Bay in Jarvis (1971) is discounted. The birds, one of which was ringed soon after discovery, again bred successfully during the period September 1983 – January 1984. On 1 June 1984, four occupied nests and a total of 11 adults were present, suggesting that this mainland colony is expanding. The presence of birds at this locality may be a result of a shortage of nest sites at Dyer Island, c. 60 km south-east (Broni *op. cit.*).

### Dyer Island

Penguin eggs are first known to have been commercially exploited on Dyer Island in 1875 (Appendix 3). Sclater (1906) published a photograph of breeding birds taken on 3 December 1901. The maximum annual commercial collection of eggs was 62 500, in 1905 (Appendix 3). Following the method of Frost *et al.* (1976), a minimum population of 41 400 birds is implied, comparable to the estimate from nests counted of c. 45 000 adults in June 1979 (Appendix 1).

In 1978, Dyer Island was the most populous breeding locality of jackass penguins (Table II). Counts on aerial photographs numbered 2 765–4 982 in 1956, 17 926 in 1967 and 26 599 in 1978, indicating a steady increase after the mid 1950s (Appendix 1). No reliable evidence of trends prior to 1956 exists. Necessary first-year survival to attain the observed increase between 1956 and 1967 was estimated as 88 per cent (Table I) but, as for Mercury and Ichaboe Islands, this estimate is believed to be unrealistically high. It seems possible that the population at Dyer Island has been augmented by birds immigrating from breeding localities west of Cape Point. The greatest concentrations of adult pilchard and anchovy off South Africa currently occur east of Cape Point (Crawford 1980).

### Geysers Island

Jackass penguins, including young ready to go to

sea, were numerous on Geysler Island in the second half of 1830 (Jardine 1830). No record of a subsequent visit by a naturalist has been found until Rand (1960) landed, and he noted that penguins occasionally nested there among the large numbers of Cape fur seals. Subsequently, Rand (1963a) noted that gulls *Larus* spp. and various cormorants *Phalacrocorax* spp. roosted and possibly nested at Geysler Island in 1956, but for jackass penguins he observed "No penguins were located on the photographs and few are known to use the rock." It seems possible that increases in the population of Cape fur seals resulted in a decrease in the number of penguins sometime between 1830 and 1956 (Appendix 1). Alternatively, sealers may have had an adverse influence on the penguin population. More than 300 nests were counted in June 1979. Therefore, as with adjacent Dyer Island, the penguin population appears to have increased considerably since 1956. Far more likely than for Stony Point, it is probable that this increase resulted from a shortage of breeding space at Dyer Island.

#### Quoin Rock

Rand (1960) suggested that penguins occasionally nested at Quoin Rock. No signs of nesting were recorded during a visit made on 17 June 1979, and there are no other positive records.

#### Seal Island (Mossel Bay)

Jackass penguins were recorded on Seal Island, Mossel Bay, as early as 1497, were breeding there in 1576 and, on a photograph of the island published by Gilchrist (1914), c. 130 birds were counted (Shaughnessy and Shaughnessy 1978 and references therein). The photograph showed adult birds on the shoreline, but no unequivocal signs of breeding. Shaughnessy and Shaughnessy (op. cit.) gave the last record of birds observed at Seal Island, Mossel Bay, as 1923. However, a suite of photographic negatives in the Transvaal Museum taken by Herbert Lang in April 1926 has been examined. One negative shows at least 25 adults standing near the centre of the island, and another shows smaller numbers which may or may not have belonged to the 25 individuals counted. In either event a decrease appears to have taken place between 1914 and 1926. Jackass penguins no longer occur on the island, which is now exclusively utilized by Cape fur seals (Shaughnessy and Shaughnessy op. cit.). These authors consider that jackass penguins stopped breeding on the island in the first half of the

20th century. No sign of breeding could be discerned on the 1926 negatives.

#### Cape Recife

A breeding attempt took place on the mainland at Cape Recife in May or June 1981. Three adults and one egg were present, but the outcome of the attempt is unknown (Every 1983). No other breeding records for this locality are known.

#### Jahleel Island and Brenton Rock

These islands are outliers of St Croix Island, and jackass penguins currently breed on both of them, estimated populations being c. 1 170 for Jahleel Island and c. 92 for Brenton Rock (Randall *et al.* 1981). Penguins were breeding on Jahleel Island in 1969 (G. J. B. Ross, Port Elizabeth Museum, pers. comm.), but the earlier breeding status of these islands is uncertain. Rand (1963a) provides no details.

#### St Croix Island

Although de Perestrelo (in Theal 1898) gave some notes on the zoology of Seal Island, Mossel Bay, for 1576, he gave no information on the zoology of the islands in Algoa Bay, which he described purely from the point of view of a navigator. In mid January 1900, Harris (1901) found very few penguins breeding, but he published a photograph (his Plate 55) of a breeding bird. Hewitt (1920) found penguins breeding in great numbers all over the island on 20 April 1919.

Aerial photography at St Croix Island has been conducted near the November peak in incidence of moulting birds (Randall and Randall 1981) and, because the numbers of birds on the island are at their lowest just before or after the moult (Randall *et al.* 1981), the counts may not accurately reflect population trends. Numbers counted on aerial photographs more than doubled between 1956 and 1969, but had decreased to an intermediate value by 1978 (Appendix 1). Rand (1963a) estimated that there were about 12 000 in 1956, and Ross (1971) estimated about 21 000 in 1971. Therefore, the trend suggested by aerial photography appears to have been real, at least for the period 1956–1969. Necessary first-year survival for the increase in this period to have occurred would have been about 51 per cent (Table I), compared with the value of 32 per cent observed

by Randall (1983).

Ross (1971) suggested that the increase in numbers by the 1970s may have resulted from decreased human interference following suspension of guano-collecting at the island in 1957. Conversely, Randall *et al.* (1981) believe that human disturbance is probably the main factor inhibiting population growth of penguins in Algoa Bay, the illegal collection of penguin eggs apparently continuing. Together with Jahleel Island and Brenton Rock, St Croix Island has recently been proclaimed a marine nature reserve falling under the jurisdiction of the Provincial Department of Nature and Environmental Conservation of the Cape of Good Hope (Randall *et al.* op. cit.), and jurisdiction under the Department of Environment Affairs terminated in December 1979.

#### Seal and Stag Islands (Algoa Bay)

These two small islands lie in close proximity to Bird Island, Algoa Bay (Rand 1963a), and a land bridge is formed between them at low spring tide (Randall *et al.* 1981). In keeping with the general trend for localities east of Cape Hangklip, the penguin population at Seal Island, Algoa Bay, appears to have increased markedly since the 1940s and 1950s, and that at Stag Island moderately (Appendix 1). Estimates of numbers of penguins during the period 1973–1979 were respectively c. 2 200 and c. 118 (Randall *et al.* op. cit.).

#### Bird Island, Algoa Bay

Jackass penguins were first recorded breeding on Bird Island, Algoa Bay, in 1755 (Ross 1978). Pinchin (1871) said that jackass penguins occurred in thousands on Bird Island. However, he was interested in geology, not zoology, and his comment should be interpreted as a vague "many". Ross (1978) considered that there was no significant difference between the numbers present in 1755 and the 1970s. This view is supported by Harris (1901), who visited the island in mid January 1900 and found that there were only a few penguins. Gill and Zeederberg (1928) stated that the island supported a few penguins.

The estimated number of breeding pairs of jackass penguins on Bird Island, Algoa Bay, was c. 80 in the first half of November 1945 (Courtenay-Latimer and Gibson-Hill 1946), c. 50 in March 1954 (Taylor 1954), 60 in 1958 (Rand 1963a) and 314 in December 1979 (Appendix 1). The total population for the period 1973–1981 was believed to be about 2 100

birds (Randall *et al.* 1981). There is, therefore, good evidence that the population has increased. Numbers of Cape gannets at this island have also increased in recent years (Randall and Ross 1979, Crawford *et al.* 1983), possibly as a result of birds moving to the island from breeding localities off the west coast of southern Africa following the collapses of the pilchard resources in that area.

### OVERALL POPULATION STATUS

Many estimates of the number of jackass penguins at individual breeding localities exist (Appendix 1), but there are few estimates of overall population size. This fact can probably be attributed to the unsuitability of aerial photography as a census technique at islands where jackass penguins nest in burrows or under boulders (Shelton *et al.* 1982), to alternative types of synoptic surveys being hard to organize because of the widespread nature of, and often difficulty of access to, breeding localities and to the continued uncertainty regarding the annual breeding cycle of jackass penguins at many localities.

The first attempt to estimate the population size of jackass penguins was that of Rand (1963a, b). His attempt was based mainly on aerial photography, and he assumed generally 40 per cent (islands off South West Africa) or 75 per cent (islands off South Africa) absenteeism of mates from nests at the time of photography, but modified to a limited extent on the basis of ground observations (e.g. at Ichaboe, Halifax, Possession, Bird at Lambert's Bay and Malgas Islands). Rand's (1963a, b) estimate of the total population of adult jackass penguins in 1956 was 295 000 (Table II). However, some of the computations (e.g. for North Reef and Possession Island) appear to have been in error, and the large differences in assumptions concerning absenteeism of mates from nests were not adequately explained. Further, Rand (1963b) noted that jackass penguins, Cape cormorants and bank cormorants *Phalacrocorax neglectus* could not be separated on aerial photographs of Mercury Island.

On the basis of observations made during the more recent visits to this island, it has been possible to re-analyse the 1956 photographs (Appendix 1). Use has also been made of Rand's (1963b, p.7) assumption of absenteeism of mates from nests at Halifax Island (67 per cent) — an assumption based on ground observations and falling between his assumptions of absenteeism at islands off South and South West Africa — to standardize his estimates of adult population size at all breeding localities (Rand 1963a,

Table IV: Comparison between aerial photography and ground counts as census methods for jackass penguins at islands off South West and South Africa, October 1978—January 1979

Locality	Aerial photography			Ground count		Ratio aerial photography: nest count
	Date	Time of day	Number of birds	Date	Number of nests	
Mercury Island	28 Nov. 1978	13h45	10 820	20—23 Nov. 1978	3 218	3,36
Ichaboe Island	28 Nov. 1978	13h30	10 437	24—28 Nov. 1978	3 598	2,90
Halifax Island	28 Nov. 1978	12h55	2 755	30 Nov. 1978	1 750	1,57
North Reef	28 Nov. 1978	12h15	256	1 Dec. 1978	151	1,70
Possession Island	28 Nov. 1978	12h15	4 013	1—4 Dec. 1978	2 719	1,48
Pomona Island	28 Nov. 1978	12h00	149	7 Dec. 1978	123	1,21
Plum pudding Island	28 Nov. 1978	11h45	803	8 Dec. 1978	438	1,83
Sinclair Island	28 Nov. 1978	11h45	343	8 Dec. 1978	246	1,39
Malgas Island	27 Nov. 1978	10h00	4 448	29 Dec. 1978	576	7,72
Marcus Island	27 Nov. 1978	10h05	2 941	26 Dec. 1978—7 Jan. 1979	374	7,86
Jutten Island	27 Nov. 1978	09h50	3 861	29 Dec. 1978	712	5,42
Vondeling Island	27 Nov. 1978	09h00	304	27 Oct. 1978	276	1,10
Dassen Island	11 Dec. 1978	16h10	16 049	23—30 Oct. 1978	11 220	1,43
Dyer Island	22 Nov. 1978	09h15	26 599	18 Oct. 1978	18 712	1,42
Mean						2,89
Standard deviation						2,38

b). Interestingly, the total population estimate remains almost identical (Table II). The underlying assumption that all birds counted on aerial photographs were adults was probably incorrect, but the mistake may have been partially offset by a likely absence of some adults not breeding at the time (Liversidge and Le Gras 1981). Rand's (1963a, b) survey omitted some of the minor localities (Hollams Bird Island, Sylvia Hill, Stony Point, Geyser Island, Jahleel Island, Brenton Rock), but it is probable that jackass penguins were not breeding at some of these in 1956, and their presence at others would have had little impact on the overall estimate of *c.* 300 000 adults.

Aerial photography during 1967 and 1969 covered all the major breeding localities off South West Africa, but most islands off South Africa were inadequately surveyed (Table II). A comparison of counts suggests that, between 1956 and the late 1960s, the South West African population of jackass penguins decreased by 46 per cent, mainly as a result of the large decrease at Possession Island.

The second attempt to estimate overall population size of jackass penguins was that of Frost *et al.* (1976), an attempt based to a large extent on census information (often approximate) from the period 1970–1972 for Halifax, Possession, Marcus, Dassen, Dyer and St Croix Islands. Estimates for other localities, including the important colonies at Mercury, Ichaboe, Malgas and Jutten Islands, were based on an unpublished document produced by the

Division of Government Guano Islands which was, at best, a rough estimate (D. M. Price, Division of Government Guano Islands, pers. comm.). The estimated population for South West African islands was 45 610 (Table II), suggesting a decrease of 54–57 per cent from the 1956 figure and corroborating the trend indicated by the aerial photographs of the late 1960s (results of which were not available to Frost *et al.* op. cit.). A population of 126 100 was estimated for islands off South Africa during the early 1970s (Table II, Frost *et al.* op. cit.), 34–36 per cent less than the values for 1956. The combined population of about 170 000 birds was some 42 per cent lower than that estimated for 1956.

A comprehensive survey was conducted during the spring/summer breeding season of 1978/79, when aerial photography was combined with ground counts at all the (then) known breeding localities with the exception of Hollams Bird Island and Jacob's Reef, allowing a comparison of the two census methods (Table IV). The mean ratio between the number of birds counted on the aerial photographs to the number of nests counted on the ground is close to 3 showing that, on average and as would be expected, a number of non-breeders are counted on the aerial photographs.

Preliminary results from the survey have been reported by Crawford and Shelton (1981), but they are presented in more detail here (Appendix 1, Table II). Counts on aerial photographs suggest decreases of 59, 38 and 46 per cent respectively after 1956 for



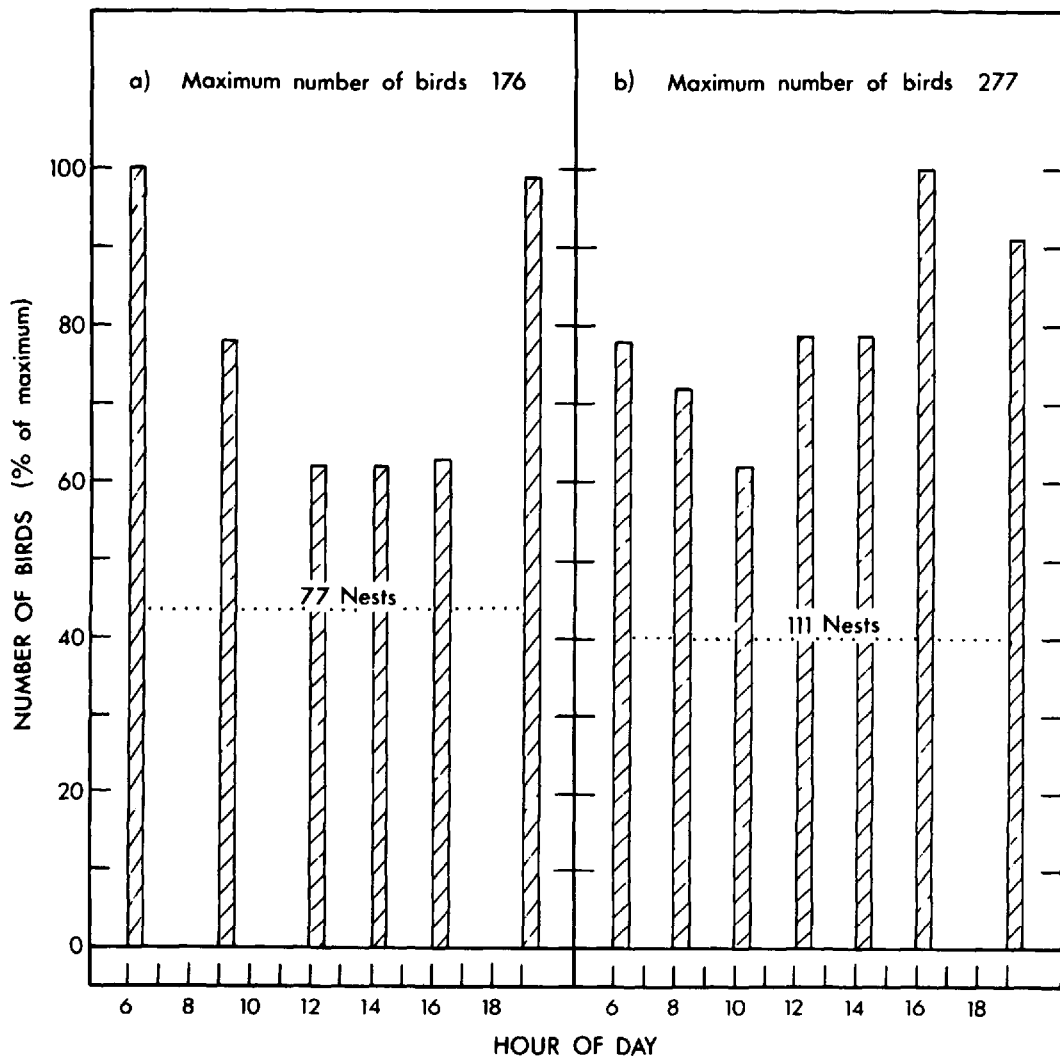


Fig. 2: Fluctuations in observed numbers of jackass penguins at breeding localities as a function of time of day at a) Mercury Island, 23 November 1978, b) Possession Island, 5 December 1978

islands off South West Africa, off South Africa and for the population as a whole. The frequent similarity in trends derived from aerial photographs for islands located close to each other (e.g. for Mercury and Ichaboe Islands and for Pomona and Plumpudding Islands) suggests that aerial photography is useful for assessment of population trends, in spite of its shortcomings as an estimator of absolute population size.

Trends in the proportion of birds present at surface breeding colonies throughout the day at

Mercury and Possession Islands during November and December 1978 were similar (Fig. 2). The mean value for absenteeism of mates from nests (29 per cent) recorded between 08h00 and 16h00, the time during which photography was conducted, has been used to correct counts on aerial photographs (Table II). The estimate of the total spring/summer breeding population from counts on aerial photographs, about 114 000 adults, differs from the value of approximately 134 000 adults, which may be assumed from ground counts of nesting sites (Table II).

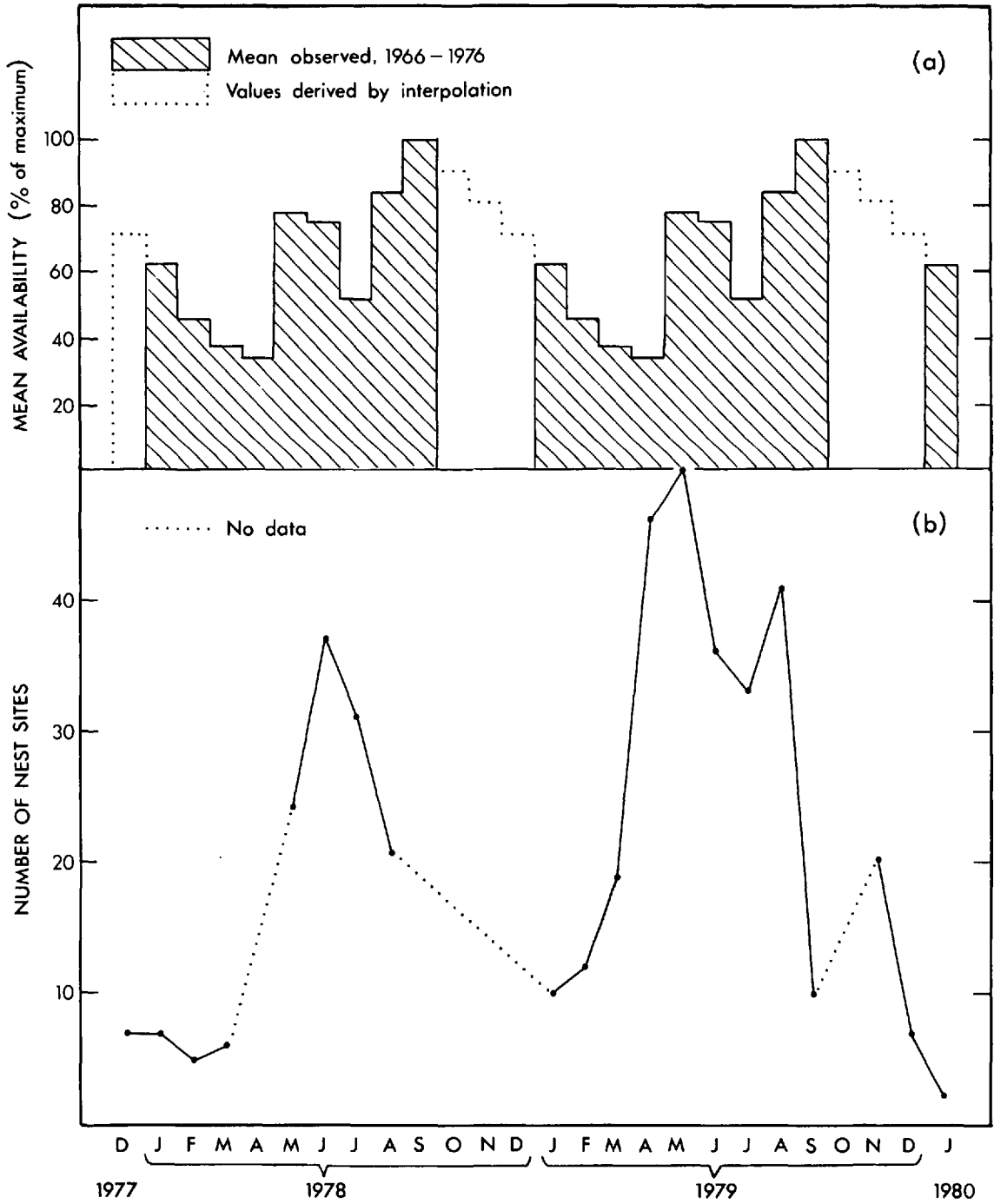


Fig. 3: (a) Seasonal variations in availability of nought-year-old pilchard (modified from Crawford 1979), (b) number of nest sites occupied by jackass penguins at Bird Island (Lambert's Bay), 1977-1980

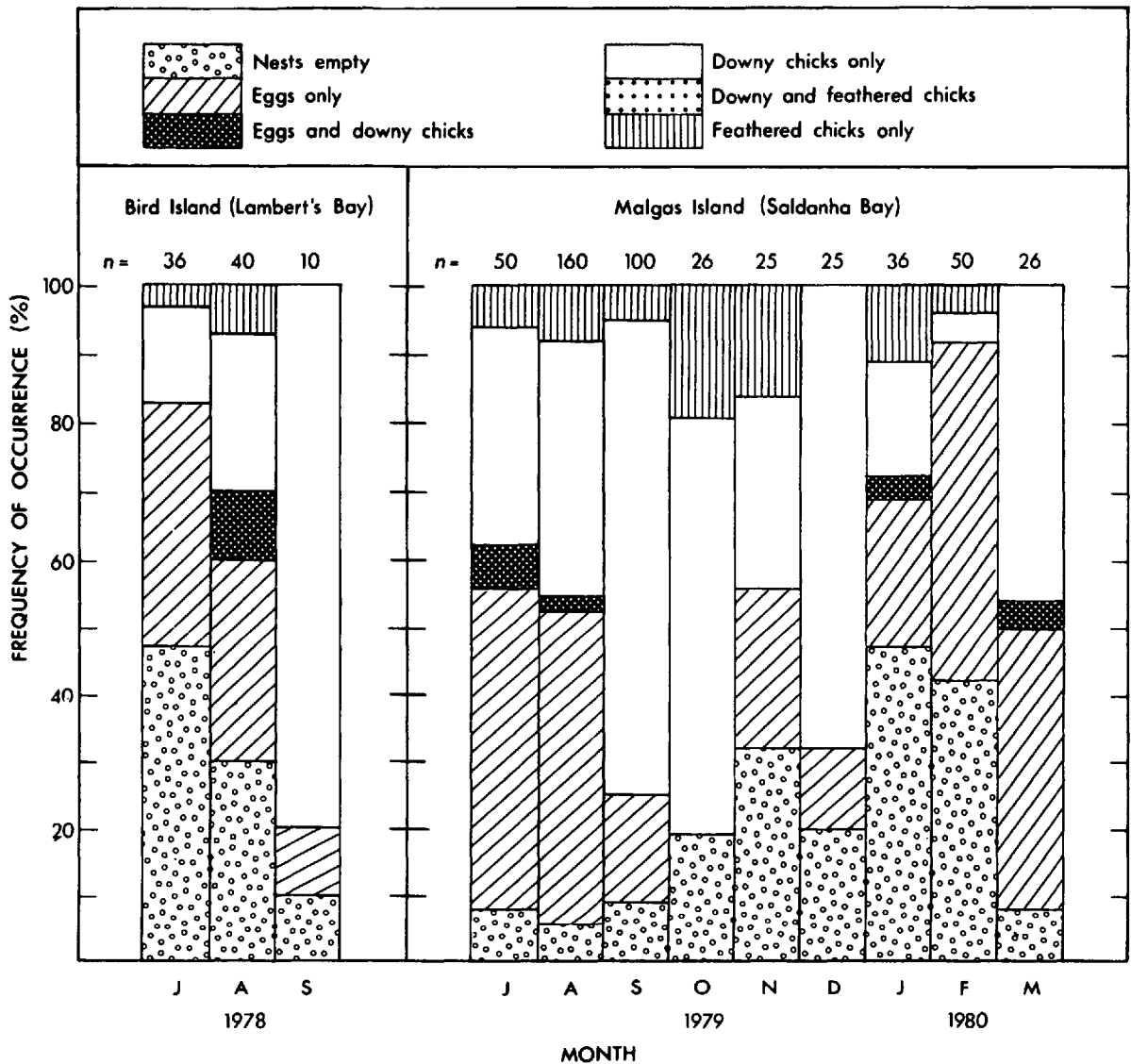


Fig. 4: Contents of nests of jackass penguins at Bird Island (Lambert's Bay), July—September 1978, and Malgas Island, July 1979—March 1980

In considering the overall population trend it is worth returning to earlier population estimates for Dassen Island alone, which ranged as high as nine million (Nicoll 1906, 1908) and five million birds (Kearton 1930). These were most likely gross over-estimates, but in 1930 there may have been as many as 1.5 million penguins on the island (Westphal and Rowan 1971, Frost *et al.* 1976), and there must have been at least 393 400 breeding adults to produce the

594 000 eggs collected commercially in 1919 (Appendix 3). The decrease over the subsequent half century has been enormous. Initially, it is likely to have been caused by over-exploitation of penguin eggs (Cott 1953, Frost *et al.* op. cit., Siegfried and Crawford 1978). Egg collection on a large scale may have begun as early as 1652, resulting in the extinction of the Robben Island colony by 1700 (Brooke 1983). Attention was then directed to Dassen Island. Incubated

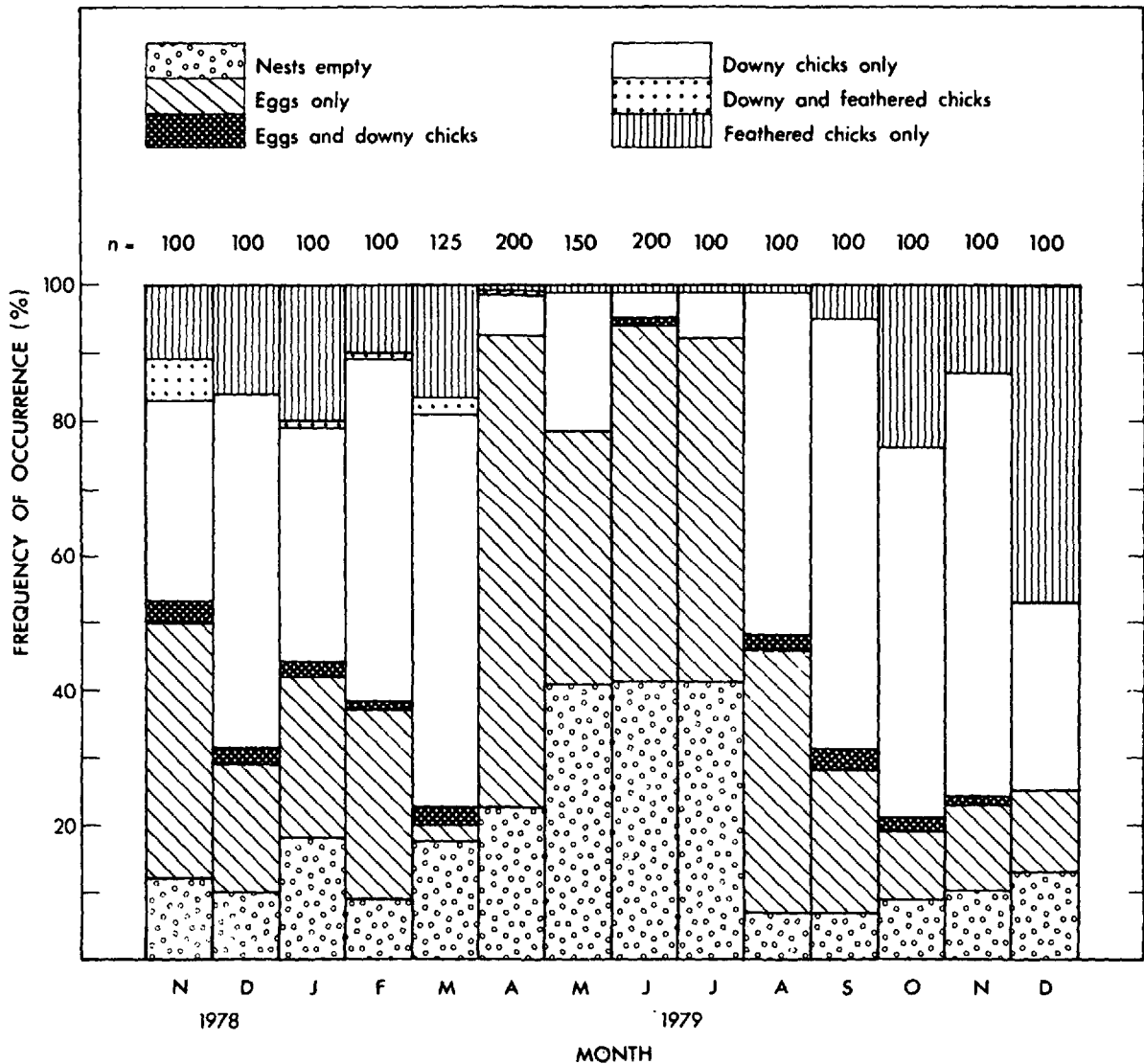


Fig. 5: Contents of nests of jackass penguins at Ichaboe Island, November 1978—December 1979

eggs were sometimes smashed to ensure that only freshly laid eggs would be collected (Siegfried and Crawford op. cit.). From data on egg collection given in Appendix 3 it is evident that egg collection would have had the severest effect on population trends in the late 1800s and early 1900s. More recently the greatly diminished abundance of preferred prey species (Crawford and Shelton 1981) has been the cause of a substantial further decrease. Also, there have recently been reports of seals taking penguins in

significant numbers close to some of the breeding islands (Cooper 1974, Shaughnessy 1978, A. Berruti, pers. comm.).

The estimates discussed above refer to the spring/summer breeding population, although all nest sites occupied by adults (including those occupied by moulting birds) were included in the nest counts, as well as sites with recently collected nest material or a large quantity of moulted feathers. Because of the prolonged breeding season (Figs. 3, 4 and 5, Cooper

Table V: Comparison between late-spring and winter counts of numbers of jackass penguins at some islands off South West Africa derived from aerial photographs

Island	Late-spring count (28 Nov. 1978)		Winter count (9 Jul. 1979)		Ratio late-spring: winter count
	Time	Number of birds	Time	Number of birds	
Ichaboe	13h30	10 437	14h00	2 120	4,92
Halifax	12h55	2 755	13h40	1 802	1,53
Possession	12h15	3 757	13h20	1 833	2,05
Plumpudding	11h45	803	13h00	96	8,36
Sinclair	11h45	343	13h00	158	2,17

1980, Randall and Randall 1981), derivation of absolute population size is considerably more complicated. However, in view of the importance of estimates of absolute abundance for ecological studies incorporating trophic interactions (e.g. Furness and Cooper 1982, Field 1983), census data have been used to provide the current best estimate of the minimum adult populations that existed in 1978 and 1979.

For all islands off South West Africa, the spring/summer nest counts have been accepted as a minimum estimate of the number of breeding pairs because, in each of five instances permitting comparison, numbers of birds present in late spring were considerably higher than in winter (Table V). At Sinclair Island during 1947–1949, Rand (1960) recorded peaks in egg laying in early spring (September) and late summer (February). Conversely, in winter the proportion of empty nests at Ichaboe Island increased (Fig. 5) and at Possession Island the number of nests containing eggs reached a minimum (Cooper 1980). At Halifax Island in 1971 and 1972, higher proportions of young (immatures and chicks) were recorded in May than in August or November (Berry *et al.* 1974).

For all islands off the Western Cape, nest counts made during winter 1979 have been taken as a minimum estimate of the number of breeding pairs. Late autumn or winter peaks in breeding have been recorded at Bird Island (Lambert's Bay) and Dassen Island (Fig. 4, Cooper 1980), although Cooper (*op. cit.*) also noted a late spring peak at Dassen Island. Availability of juvenile pilchards (Fig. 3a) and other small pelagic fish (Crawford 1980) increases along the Western Cape coast from autumn, providing a greater abundance of food for parents when they would be required to feed chicks. During the period 1978–1979, counts of nests in winter at all nine islands off the South-Western Cape were higher than those made in spring or summer (Table VI). In

agreement with Cooper's (*op. cit.*) observation of peaks of breeding in spring and winter at Dassen Island, the difference between spring and winter counts at this island was least. Relative parity was also recorded at Dyer Island (Table VI). Whether or not the twice-yearly peak at Dassen Island (and possibly at Dyer Island) results from breeding by the same set of adults remains uncertain. Jackass penguins at Dassen Island were historically numerous (e.g. Kearton 1930) and the current population at Dyer Island is high (Appendix 1). A staggering of the breeding season would be one possible strategy to counter a limitation of breeding space. Conversely, the possibility of a pair of jackass penguins raising two broods in one year has been demonstrated by Randall and Randall (1981), and it is considered that this is a more likely explanation for there being two apparent peaks of egg production at these islands.

At St Croix Island the main breeding season extends from early January to September (Randall and Randall 1981). Three peaks in egg laying have been observed, the first (January) representing initial laying for a breeding season, and the latter two (March/April and May/June) the laying of replacement clutches by failed breeders or of second clutches by successful breeders (Randall and Randall *op. cit.*). The nest census conducted in Algoa Bay during December 1979 therefore fell outside the main breeding season (Appendix 1). The head counts of adults (shore-based or from aerial photographs) for 1978 and 1979 were made close to a November peak in the incidence of moulting birds recorded at St Croix Island by Randall and Randall (*op. cit.*). However, although duration of moult is 18–21 days (Rand 1960, Cooper 1978, Randall and Randall *op. cit.*), the numbers of penguins on islands in Algoa Bay are lowest just before and after the moult (Randall *et al.* 1981). There is therefore a likelihood that the head counts of adults underestimated actual populations. The values presented by Randall *et al.* (*op. cit.*) have been accepted as being a more realistic measure of the breeding population in Algoa Bay. These values apparently refer to the overall, rather than the breeding, population, but they were considered by Randall *et al.* (*op. cit.*) to be underestimates.

The best estimate of the minimum total breeding population of the jackass penguin in 1978/79 is therefore approximately 134 000 birds, of which 82 per cent were at islands off South Africa (Table II).

Counts of moulting jackass penguins at islands in the vicinity of Saldanha Bay (Malgas, Marcus, Jutten, Vondeling) during 1977–1978 (Furness and Cooper 1982) suggest a population of 52 400 adults. The estimate based on nest counts (11 276) is substantially less. The discrepancy could have arisen if a

Table VI: Comparison between spring/summer and winter counts of nests of jackass penguins at some islands off South Africa's south-western coast

Island	Spring/summer count		Winter count		Ratio spring/ summer: winter counts
	Date	Number of nests	Date	Number of nests	
Bird (Lambert's Bay)	4 January 1979	10	27—28 June 1979	36	0,28
Malgas	29 December 1978	576	18 July 1979	1 022	0,56
Marcus	26 December 1978—7 January 1979	374	17—18 July 1979	1 243	0,30
Jutten	29 December 1978	712	26 July 1979	2 878	0,25
Vondeling	27 October 1978	276	8 June 1979	495	0,56
Dassen	23—30 October 1978	11 220	1—12 June 1979	12 646	0,89
Seal	20 October 1978	50	18 June 1979	82	0,61
Dyer	18 October 1978	18 712	14—16 June 1979	22 655	0,83
Geyser	19 October 1978	151	17 June 1979	318	0,47

large proportion of adults were not breeding off the Western Cape during the late 1970s. Alternatively, if most adults of breeding age moult at their "home" locality (as information collected by J. C. suggests), it would invalidate the (conservative) assumption contained herein that birds nesting at different times of the year were the same individuals.

Ratios of counts of penguins on aerial photographs to nest counts were noticeably high for Mercury and Ichaboe Islands and for the three islands within Saldanha Bay (Table IV), an unexpected finding in view of the relative unsuitability of aerial photography for these islands where many penguins nest on steep slopes or amongst boulders.

## CONSERVATION

Frost *et al.* (1976) and Brooke (in press) have previously reviewed the conservation status of the jackass penguin. Because the jackass penguin breeds successfully in captivity (e.g. Leloup 1982) the species is unlikely to become extinct. However, its conservation status continues to deteriorate and it is categorized as vulnerable in the revised South African Red Data Book - Aves (Brooke *op. cit.*). Since the late 1960s this deterioration can be attributed largely to heavy commercial overfishing of the South West and South African pelagic fish resources, in particular the pilchard. Although anchovy has, to some extent, replaced pilchard in the commercial catches and perhaps also in the Benguela system as a whole (Crawford *et al.* 1983), it appears to be a less suitable prey item, especially off South Africa west of Cape Point where it is only seasonally available (Crawford 1981). The only recent increases in colony sizes of jackass penguins have been at the periphery of the breeding distribution, apparently associated with an

abundant resource of pelagic goby in the north, an increasing number of adult anchovies in the south and contractions of the remnants of the South West and South African pilchard populations to the north and south-east respectively. In a single acoustic/mid-water-trawl survey over a large portion of the South African coastal region in 1983, pilchard were most abundant in Algoa Bay (I. Hampton, Sea Fisheries Research Institute, pers. comm.).

Because of the large-scale decrease in numbers of penguins at colonies which were historically most populous (notably Possession and Dassen Islands), attention should be given to increasing the available nesting space at or near localities that have shown marked increases since the mid 1950s. That nesting space at such localities is currently limiting is suggested by the recent breeding or attempted breeding at four mainland sites (Sylvia Hill, Lambert's Bay, Stony Point and Cape Recife), three of which are near expanding colonies, the return of penguins to Robben Island and also a large increase since 1956 in the number of penguins breeding at Geysers Island adjacent to Dyer Island. There is evidence that jackass penguins and Cape fur seals compete for space at a number of localities (see sections on Hollams Bird, North Long, Sinclair, Seal [False Bay], Geysers and Seal [Mossel Bay] Islands, on Albatross and Quoin Rocks, and on Jacob's Reef and recently at Mercury Island). Shaughnessy (1984) has shown that guano removal allows Cape fur seals to occupy penguin breeding sites and that the process may be irreversible. Therefore, the possibility of excluding seals from parts of some of these islands (as at Sinclair Island, Shaughnessy 1980) should be examined. Geysers Island appears particularly suitable in view of the 300 pairs of penguins already resident on the island (Appendix 1), whereas Seal Island (Mossel Bay) lies midway between the healthy colonies of Algoa Bay and those at Dyer and Geysers

Islands. The exclusion of mammalian predators from certain headlands by adequate walls or fences (see Cooper *et al.* in press), for example Stony, Danger and Quoin Points and Cape Recife, could also be considered. Erection of predator-proof walls on mainland headlands in Peru has led to increases in seabird populations (e.g. Duffy 1983) including the Peruvian or Humboldt penguin *S. humboldti* (Hays 1984). Following successful rehabilitation of oiled birds (Morant *et al.* 1981), the potential now exists for the use of rehabilitated birds to create new colonies. Detailed studies of feasibility and ecological impact (beyond the scope of this report) would be required before any attempt is made to either increase breeding space or create new colonies. Particular attention should be given to the expected durability of any structures built to exclude seals or terrestrial predators, to the risk of oil spills reaching selected sites (e.g. Shannon and Chapman 1983), and to the desirability of buffering the overall population against oiling disasters by spacing "healthy" colonies as widely as possible. It should also be borne in mind that mainland colonies could prove to be popular tourist attractions, and that finances derived from tourism may to some extent offset costs of construction and maintenance.

Further considerations in the conservation of the jackass penguin should include minimizing disturbance at the breeding colonies. Also, halting the decrease of the population of jackass penguins is intimately associated with the state of the pelagic fish resources, particularly pilchard. The biomass of pilchard off South Africa is continuing to decrease (Armstrong *et al.* 1983), but the 1983 catch was the largest since 1973. It is possible that the heavy exploitation of pelagic fish may be having deleterious effects of a permanent nature throughout the system.

#### ACKNOWLEDGEMENTS

We are grateful to Messrs A. Berruti and B. Dyer (Sea Fisheries Research Institute), Mr R. Loutit (Nature Conservation Division, South West Africa), Dr R. M. Randall (Zoology Department, University of Port Elizabeth), Dr P. D. Shaughnessy (formerly of the Sea Fisheries Research Institute), Dr P. T. van der Walt (Deputy Director of Nature Conservation, South West Africa) and Prof. E. O. J. Westphal (Hon. Secretary of the South African National Foundation for the Conservation of Coastal Birds) for making available information on jackass penguins, and to Mr A. L. Batchelor (formerly of the Port Elizabeth Museum) and Dr R. M. Randall for

arranging our visits to the islands in Algoa Bay. We thank all our present and past colleagues, especially Mr F. Kriel, Mrs P. J. Meyer and Mr G. E. Nel, who assisted with field collection of data and counting the aerial photographs, and the Captain and crew of P. V. *Malagas II* for transport to and from many breeding localities. We are grateful for valuable comments received from Mr C. S. Bosman (Marine Development Branch), Dr R. M. Randall, Dr G. J. B. Ross (Port Elizabeth Museum) and our colleagues Drs J. H. M. David and L. V. Shannon. J. C. thanks the South African Nature Foundation for financial support towards research on jackass penguins in 1971/72 and 1981/82. The Percy FitzPatrick Institute of African Ornithology gratefully acknowledges financial support for conservation research on jackass penguins received from the Endangered Wildlife Trust and the National Geographic Society during the writing of this paper.

#### LITERATURE CITED

- ANGRA PEQUENA AND WEST COAST CLAIMS JOINT COMMISSION 1885 — *Proceedings of the Angra Pequena and West Coast Claims Joint Commission, March–September 1885*. Cape Town; Saul Solomon: 118 pp. + 48 pp. of Minutes and 45 pp. of Appendices.
- ANON. 1973 — Marcus Island — A new wildlife sanctuary? *Afr. Wildl.* 27(4): 162–164.
- APPS, P. J. 1983 — Aspects of the ecology of feral cats on Dassen Island, South Africa. *S. Afr. J. Zool.* 18(4): 393–399.
- ARMSTRONG, M. J., SHELTON, P. A., PROSCH, R. M. and W. S. GRANT 1983 — Stock assessment and population dynamics of anchovy and pilchard in ICSEAF Division 1.6 in 1982. *Colln scient. Pap. int. Commn SE. Atl. Fish.* 10(1): 7–25.
- EVERY, G. (in press) — Late Holocene avian remains from Wortel, Walvis Bay, SWA/Namibia, and some observations on seasonality and Topnaar Hottentot prehistory. *Madoqua*.
- BERRY, H. H., SEELY, M. K. and R. E. FRYER 1974 — The status of the jackass penguin *Spheniscus demersus* on Halifax Island off South West Africa. *Madoqua ser. 2* 3: 27–29.
- BERRY, H. H. and C. U. BERRY 1975 — A check list and notes on the birds of Sandvis, South West Africa. *Madoqua* 9(2): 5–18.
- BEST, P. B. and P. D. SHAUGHNESSY 1979 — An independent account of Captain Benjamin Morrell's sealing voyage to the south-west coast of Africa in the *Antarctic*, 1828/29. *Fish. Bull. S. Afr.* 12: 1–19.
- BRONI, S. C. 1982 — First recorded mainland breeding by the jackass penguin *Spheniscus demersus*. *Cormorant* 10(2): p. 120.
- BROOKE, R. K. 1981a — The seabirds of the Moçâmedes Province, Angola. *Gerfaut* 71(2): 209–225.
- BROOKE, R. K. 1981b — Layard's bird hunting visit to Tromelin or Sandy Island in December 1856. *Atoll Res. Bull.* 255: 73–82.
- BROOKE, R. K. 1983 — On the 17th century avifauna of Robben

- Island, South Africa. *Cormorant* 11: 15-20.
- BROOKE, R. K. (in press) — The rare and vulnerable birds of South Africa. *Rep. S. Afr. natn. scient. Progm.*
- BURMAN, J. and S. LEVIN 1974 — *The Saldanha Bay Story*. Cape Town; Human and Rousseau: 165 pp.
- CLANCEY, P. A. (Ed.) 1980 — *S.A.O.S. Checklist of Southern African Birds*. Johannesburg; Southern African Ornithological Society: 325 pp.
- COOPER, J. 1977 — Census of the jackass penguin on Dyer Island. *Cormorant* 2: 15-17.
- COOPER, J. 1978 — Moults of the black-footed penguin *Spheniscus demersus*. *Int. Zoo Yb.* 18: 22-27.
- COOPER, J. 1980 — Breeding biology of the jackass penguin with special reference to its conservation. In *Proceedings of the Fourth Pan-African Ornithological Congress, Seychelles, 1976*. Johnson, D. N. (Ed.). Johannesburg; Southern African Ornithological Society: 227-231.
- COOPER, J. 1982 — Methods of reducing mortality of seabirds caused by underwater blasting. *Cormorant* 10(2): 109-113.
- COOPER, J., BROOKE, R. K., SHELTON, P. A. and R. J. M. CRAWFORD 1982 — Distribution, population size and conservation of the Cape cormorant *Phalacrocorax capensis*. *Fish. Bull. S. Afr.* 16: 121-143.
- COOPER, J., HOCKEY, P. A. R. and R. K. BROOKE (in press) — Introduced mammals on South and South West African islands: history, effects on birds and control. In *Proceedings of the Birds and Man Symposium*. Bunning, L. J. (Ed.). Johannesburg; Witwatersrand Bird Club.
- COOPER, J. and P. D. SHAUGHNESSY 1977 — Census of the jackass penguin on Seal Island, False Bay. *Cormorant* 2: p. 20.
- COOPER, J. and P. D. SHAUGHNESSY 1978 — Second census of the jackass penguin on Seal Island, False Bay: January 1978. *Cormorant* 4: p. 33.
- COOPER, J. and B. H. SMITH 1982 — New breeding locality data for southern African seabirds: Cape cormorant *Phalacrocorax capensis*. *Cormorant* 10(2): p. 125.
- COOPER, J., WILLIAMS, A. J. and P. L. BRITTON (in press) — Distribution, population sizes and conservation of breeding seabirds in the Afrotropical Region. In: *The Status and Conservation of Seabirds*. Croxall, J. P., Evans P. G. H. and R. W. Schreiber (Eds.). Cambridge; International Council for Bird Preservation.
- COTT, H. B. 1953 — The exploitation of the wild birds for their eggs. *Ibis* 95(3): 409-449.
- COURTENAY-LATIMER, M. and C. A. GIBSON-HILL 1946 — A preliminary note on the Bird Island group in Algoa Bay. *Ostrich* 17(2): 75-86.
- CRAWFORD, R. J. M. 1979 — Implications of recruitment, distribution and availability of stocks for management of South Africa's Western Cape purse-seine fishery. Ph.D. thesis, University of Cape Town: xii + 467 pp.
- CRAWFORD, R. J. M. 1980 — Seasonal patterns in South Africa's Western Cape purse-seine fishery. *J. Fish Biol.* 16(6): 649-664.
- CRAWFORD, R. J. M. 1981 — Catch per standard-boat-day and deployment of effort in the South African purse-seine fishery, 1964-1976. *Investl Rep. Sea Fish. Inst. S. Afr.* 122: 24 pp.
- CRAWFORD, R. J. M. and P. A. SHELTON 1978 — Pelagic fish and seabird interrelationships off the coasts of South West and South Africa. *Biol. Conserv.* 14(2): 85-109.
- CRAWFORD, R. J. M. and P. A. SHELTON 1981 — Population trends for some southern African seabirds related to fish availability. In *Proceedings of the Symposium on Birds of the Sea and Shore, 1979*. Cooper, J. (Ed.). Cape Town; African Seabird Group: 15-41.
- CRAWFORD, R. J. M., COOPER, J. and P. A. SHELTON 1982 — Distribution, population size, breeding and conservation of the kelp gull in southern Africa. *Ostrich* 53(3): 164-177.
- CRAWFORD, R. J. M., SHELTON, P. A., COOPER, J. and R. K. BROOKE 1983 — Distribution, population size and conservation of the Cape gannet *Morus capensis*. *S. Afr. J. mar. Sci.* 1: 153-174.
- CRUICKSHANK, R. A., COOPER, J. and I. HAMPTON 1980 — Extension to the geographical distribution of pelagic goby *Sufflogobius bibarbatus* off South West Africa and some mensural and energetic information. *Fish. Bull. S. Afr.* 13: 77-82.
- CURREY, C. 1892 — *Memorandum on Working of the Guano Islands, G55-1892*: 3 pp.
- CYRUS, D. and N. ROBSON 1980 — *Bird Atlas of Natal*. Pietermaritzburg; University of Natal: 320 pp.
- CYRUS, D. and N. ROBSON 1984 — *Rare Birds Report 1980 to 1982*. Pietermaritzburg; Natal Bird Club: 28 pp.
- DA FRANCA, P. 1967 — Sur la présence d'*Arctocephalus pusillus* (Schreber) (Otariidae) et de *Mirounga leonina* (Linné) (Phocidae) au sud de l'Angola. *Mammalia* 31(1): 50-54.
- DAVIES, D. H. 1955 — The South African pilchard (*Sardinops ocellata*). Bird predators, 1953-4. *Investl Rep. Div. Fish. S. Afr.* 18: 32 pp.
- DAVIES, D. H. 1956 — The South African pilchard (*Sardinops ocellata*) and maasbanker (*Trachurus irachurus*). Bird predators 1954-55. *Investl Rep. Div. Fish. S. Afr.* 23: 40 pp.
- DAVIES, D. H. 1962 — Ori the penguin. *Bull. S. Afr. Ass. mar. biol. Res.* 3: 24-27.
- DE SEABRA, A. F. 1906 — Aves de Porto Alexandre. *J. Sci. Math. Phys. Nat. ser.* 2 7: 143-148.
- DUFFY, D. C. 1983 — Competition for nesting space among Peruvian guano birds. *Auk* 100(3): 680-688.
- EDEN, T. E. 1846 — *The search for Nitre, and the True Nature of Guano. Being an Account of a Voyage to the South-West Coast of Africa; etc.* London; R. Groombridge: 133 pp.
- ELLIOTT, C. C. H. 1974 — Sixteenth ringing report for southern Africa. *Ostrich* 45(3): 161-166.
- ELLIOTT, C. C. H. and M. J. F. JARVIS 1973 — Fifteenth ringing report. *Ostrich* 44(1): 34-78.
- ELLIOTT, H. F. I. 1953 — The fauna of Tristan da Cunha. *Oryx* 2(1): 41-53.
- ELLIOTT, H. F. I. 1957 — A contribution to the ornithology of the Tristan da Cunha group. *Ibis* 99(4): 545-586.
- EVERY, B. 1983 — Second record of mainland breeding by the jackass penguin *Spheniscus demersus*. *Cormorant* 11: p. 62.
- EX-MEMBER OF THE COMMITTEE 1845 — The African guano trade. *Naut. Mag., enlarged ser.* 11: 617-666.
- FALLA, R. A. and R. L. MOUGIN 1979 — Sphenisciformes. In *Check-list of the Birds of the World 1, 2nd Ed.* Mayr, E. and G. W. Cottrell (Eds.). Cambridge, Mass.; Museum of Comparative Zoology: 121-134.
- FIELD, J. G. 1983 — Flow patterns of energy and matter. *Mar. Ecol.* 5(2): 785-794.
- FROST, P. G. H., SIEGFRIED, W. R. and J. COOPER 1976 — Conservation of the jackass penguin (*Spheniscus demersus* (L.)). *Biol. Conserv.* 9(2): 79-99.
- FURNESS, R. W. and J. COOPER 1982 — Interactions between breeding seabird and pelagic fish populations in the southern Benguela region. *Mar. Ecol. Prog. Ser.* 8(3): 243-250.
- GILCHRIST, J. D. F. 1914 — An enquiry into fluctuations in fish supply on the South African coast. *Mar. biol. Rep. Cape Tn* 2: 8-35.
- GILL, E. L. and W. ZEEDERBERG 1928 — Guano islands of South Africa. In *Official Yearbook of the Union and of Basutoland, Bechuanaland Protectorate and Swaziland* (9). Pretoria; Union Office of Census and Statistics: 41-43.
- GOODBAN, G. E. 1879 — Returns showing the amount of



- revenue derived from guano islands of the colony. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope A24—1879*: 25 pp.
- GREEN, L. G. 1950 — *At Daybreak to the Isles*. Cape Town; Howard Timmins: 220 pp.
- HARRIS, H. E. 1901 — *Essays and Photographs. Some Birds of the Canary Island and South Africa*. London; R. H. Porter: 212 pp.
- HAYS, C. 1984 — The Humboldt penguin in Peru. *Oryx* 18(2): 92–95.
- HEWITT, J. 1920 — Notes on the fauna of St. Croix Island. *S. Afr. J. nat. Hist.* 2(1): 98–112.
- HEWITT, J. H. C. 1937 — The Government Guano Islands. *Fmg S. Afr.* 12: 591–592.
- HEWITT, J. H. C. 1938 — The Government Guano Islands. *Fmg S. Afr.* 13: 589–590.
- HEWITT, J. H. C. 1939 — Government Guano Islands. *Fmg S. Afr.* 14: 592–593.
- HEWITT, J. H. C. 1940 — Government Guano Islands. *Fmg S. Afr.* 15: 541–542.
- HOCKEY, P. A. R. and J. HALLINAN 1981 — Effect of human disturbance on the breeding behaviour of jackass penguins *Spheniscus demersus*. *S. Afr. J. Wildl. Res.* 11(2): 59–62.
- JACKSON, F., SIEGFRIED, W. R. and J. COOPER 1976 — A simulation model for the population dynamics of the jackass penguin. *Trans. R. Soc. S. Afr.* 42(1): 11–21.
- JACKSON, C. H. 1894 — Memorandum on Working of the Guano Islands: Annual report for the season 1893–1984. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G66—1894*: 6 pp.
- JACKSON, C. H. 1898 — Report on the Government Guano Islands for the Year 1897, by the Government Agent in charge. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G75—1898*: 8 pp.
- JACKSON, C. H. 1899 — Report of the Superintendent of the Government Guano Islands for the Year 1898. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G58—1899*: 7 pp.
- JACKSON, C. H. 1900 — Report of the Superintendent of the Government Guano Islands for the Year 1899. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G17—1900*: 7 pp.
- JACKSON, C. H. 1901 — Report of the Superintendent of the Government Guano Islands for the Year 1900. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G29—1901*: 5 pp.
- JACKSON, C. H. 1902 — Report of the Superintendent of the Government Guano Islands for the Year 1901. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G33—1902*: 6 pp.
- JACKSON, C. H. 1903 — Report of the Superintendent of the Government Guano Islands for the Year 1902. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G17—1903*: 4 pp.
- JACKSON, C. H. 1904 — Report of the Superintendent of the Government Guano Islands for the Year 1903. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G50—1904*: 4 pp.
- JACKSON, H. 1929 — A valuable asset to the farmer: guano and other island products. *Fmg S. Afr.* 4: p. 444.
- JACKSON, H. 1930 — A valuable asset to the farmer: guano and other island products. *Fmg S. Afr.* 5: p. 428.
- JACKSON, H. 1931 — The Government Guano Islands. *Fmg S. Afr.* 6: p. 359.
- JACKSON, H. 1932 — The Government Guano Islands. *Fmg S. Afr.* 7: p. 380.
- JACKSON, H. 1933 — Report on the Government Guano Islands. *Fmg S. Afr.* 8: p. 519.
- JACKSON, H. 1934 — Report on the Government Guano Islands. *Fmg S. Afr.* 9: p. 581.
- JACKSON, H. 1935 — The Government Guano Islands. *Fmg S. Afr.* 10: p. 596.
- JACKSON, H. 1936 — The Government Guano Islands. *Fmg S. Afr.* 11: p. 614.
- JARDINE, A. K. 1830 — Observations on the seal-fishery of the Colony, and some of the physiological peculiarities of seals, with remarks on Dyer's Islands, etc. *S. Afr. Quart. J.* 1(3): 286–292.
- JARVIS, M. J. F. 1971 — Ethology and ecology of the South African gannet *Sula capensis*. Ph.D. thesis, University of Cape Town: 224 + 29 pp.
- JARVIS, M. J. F. and D. L. CRAM 1971 — Bird Island, Lambert's Bay, South Africa: an attempt at conservation. *Biol. Conserv.* 4: 269–272.
- JEX, D. A. 1965 — A preliminary list of the birds of the Umvoti River mouth and its environs. *Natal Bird Club News Sheet* 122: 1–3.
- KEARTON, C. 1930 — *The Island of Penguins*. London; Longmans, Green & Co.: 223 pp.
- KING, W. B. 1981 — *Endangered Birds of the World*. Washington; International Council for Bird Preservation: unpaginated.
- KRUGER, T. L. 1947a — The Government Guano Islands. *Fmg S. Afr.* 22: 339–342.
- KRUGER, T. L. 1947b — The Government Guano Islands. *Fmg S. Afr.* 22: 1156–1158.
- KRUGER, T. L. 1949 — The Government Guano Islands. *Fmg S. Afr.* 24: 154–156.
- KRUGER, T. L. 1950 — The Government Guano Islands. *Fmg S. Afr.* 25: 503–504.
- KRUGER, T. L. 1951 — The Government Guano Islands. *Fmg S. Afr.* 26: 526–528.
- LAMBERT, K. 1971 — Seevogelbeobachtungen auf zwei Reisen in oestlichen Atlantik mit besonderer Beruecksichtigung des Seegebietes vor Suedwest Afrika. *Beitr. Vogelkd.* 17(1): 1–32.
- LAYARD, E. L. 1867 — *The Birds of South Africa*. Cape Town; Juta: 382 + 21 pp.
- LELOUP, M.-J. A. E. 1982 — The black-footed penguins *Spheniscus demersus* in Artiszoo Amsterdam, 1961–1982. *Bijdr. Dierk.* 52(2): 61–81.
- LIVERSIDGE, R. and G. M. LE GRAS 1981 — Observations of seabirds off the Eastern Cape, South Africa, 1958–1963. In *Proceedings of the Symposium on Birds of the Sea and Shore, 1979*. Cooper, J. (Ed.). Cape Town; African Seabird Group: 149–167.
- LOWE, W. P. 1912 — Description of Ichabo Island. *Ibis ser.* 9 6(2): 263–268.
- MALBRANT, R. and A. MACLATCHY 1958 — A propos de l'occurrence de deux oiseaux d'Afrique australe au Gabon: le manchot du Cap, *Spheniscus demersus* Linné et la grue couronnée, *Balearica regulorum* Bennett. *Oiseau Rev. Franc. Orn.* 28(1): 84–86.
- MALBRANT, R. and A. MACLATCHY 1959 — Occurrence inattendue de deux oiseaux d'Afrique australe au Gabon: le manchot du Cap *Spheniscus demersus* Linné et la grue couronnée *Balearica regulorum* Bennett. *Ostrich Suppl.* 3: 96–97.
- MATHEWS, J. P. 1961 — The pilchard of South West Africa *Sardinops ocellata* and the maasbanker *Trachurus trachurus*. Bird predators, 1957–1958. *Investl Rep. mar. Res. Lab. S.W. Afr.* 3: 35 pp.
- McNAUGHTON, H. H. 1891 — Memorandum on working of the Guano Islands. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G55—1891*: 3 pp.
- MEINERTZHAGEN, R. 1950 — The Namib of South West Africa. *Ibis* 92(4): 567–573.
- MORANT, P. D., COOPER, J. and R. M. RANDALL 1981

- The rehabilitation of oiled jackass penguins *Spheniscus demersus*, 1970—1980. In *Proceedings of the Symposium on Birds of the Sea and Shore, 1979*. Cooper, J. (Ed.) Cape Town; African Seabird Group: 267–301.
- MORELL [MORRELL, B.] 1844 — The coast of Africa from the Cape Colony to Ichaboe Island. *Nautical Mag.* 1844: 366–374, 418–423.
- NICOLL, M. J. 1906 — On the birds collected and observed during the voyage of the 'Valhalla', R.Y.S., from November 1905 to May 1906. *Ibis ser.* 8 6(4): 666–712.
- NICOLL, M. J. 1908 — *Three Voyages of a Naturalist*, etc. London; H. F. & G. Witherby: 246 pp.
- PETRIE, P. 1844 — *Morrell's Narrative of a Voyage to the South and West Coast of Africa: Containing the Information from Whence Originated the Present Trade in Guano. Found on Certain Islands on the Coast*. London; Whittaker & Co.: 144 pp.
- PIKE, E. O. 1965 — The birds of Kobonqaba, Transkei. *S. Afr. Avifauna Ser.* 24: 1–22.
- PINCHIN, R. 1871 — The bird islands. *Cape Monthly Mag. new ser.* 2: 354–357.
- PINTO, A. A. DA R. 1958 — A contribution towards the study of the avifauna of the Island of Inhaca. *Bol. Soc. Estud. Prov. Moçambique* 112: 29–62.
- RAND, R. W. 1949a — Notes on birds observed on Sinclairs Island (South West Africa). *Ostrich* 20(3): 130–136.
- RAND, R. W. 1949b — Some early references to the Cape penguin. *Ostrich* 20(1): 2–5.
- RAND, R. W. 1951 — Birds breeding on Seal Island (False Bay, Cape Province). *Ostrich* 22(2): 94–103.
- RAND, R. W. 1952 — The birds of Hollamsbird Island, South West Africa. *Ibis* 94(3): 452–457.
- RAND, R. W. 1960 — The biology of guano-producing seabirds. The distribution, abundance and feeding habits of the Cape penguin, *Spheniscus demersus*, off the south-western coast of the Cape Province. *Investl Rep. Div. Fish. S. Afr.* 41: 28 pp.
- RAND, R. W. 1963a — The biology of guano-producing seabirds. 4. Composition of colonies on the Cape islands. *Investl Rep. Div. Sea Fish. S. Afr.* 43: 32 pp.
- RAND, R. W. 1963b — The biology of guano-producing seabirds. 5. Composition of colonies on the South West African islands. *Investl Rep. Div. Sea Fish. S. Afr.* 46: 26 pp.
- RAND, R. W. 1971 — Some hazards to seabirds. *Ostrich Suppl.* 8: 515–520.
- RANDALL, R. M. 1983 — Biology of the jackass penguin *Spheniscus demersus* (L.) at St Croix Island, South Africa. Ph.D. thesis, University of Port Elizabeth: 262 pp.
- RANDALL, R. M. and B. M. RANDALL 1981 — The annual cycle of the jackass penguin *Spheniscus demersus* at St Croix Island, South Africa. In *Proceedings of the Symposium on Birds of the Sea and Shore, 1979*. Cooper, J. (Ed.) Cape Town; African Seabird Group: 427–450.
- RANDALL, R. M., RANDALL, B. M., BATCHELOR, A. L. and G. J. B. ROSS 1981 — The status of seabirds associated with islands in Algoa Bay, South Africa, 1973–1981. *Cormorant* 9(2): 85–104.
- RANDALL, R. [M.] and G. J. B. ROSS 1979 — Increasing population of Cape gannets on Bird Island, Algoa Bay, and observations on breeding success. *Ostrich* 50(3): 168–175.
- RAVEN-HART, R. 1967 — *Before van Riebeeck*. Cape Town; C. Struik: 216 pp.
- ROSS, G. J. B. 1971 — The jackass penguin on St. Croix: a census. *E. Cape Naturalist* 44: 22–24.
- ROSS, G. J. B. 1976 — Marine biologist's report. *A. Rep. Port Elizabeth Mus.* 1975: 21–22.
- ROSS, G. J. B. 1978 — Historical status of gannets and other seabirds on Bird Island, Algoa Bay. *Cormorant* 4: 18–21.
- RYAN, P. G., COOPER, J. and C. J. STUTTERHEIM (in press) — Waders (Charadrii) and other coastal birds of the Skeleton Coast, South West Africa. *Madoqua* 14(1).
- SCLATER, W. L. 1904 — Saldanha Bay and its bird-islands. *Ibis Ser.* 8 4(1): 79–88.
- SCLATER, W. L. 1906 — *The Birds of South Africa*. 4. London; R. H. Porter: 545 pp.
- SCLATER, W. L. 1907 — The bird islands of South Africa. *Condor* 9(1): 71–76.
- SHANNON, L. V. and P. CHAPMAN 1983 — Suggested mechanism for the chronic pollution by oil of beaches east of Cape Agulhas, South Africa. *S. Afr. J. mar. Sci.* 1: 231–244.
- SHAUGHNESSY, P. D. 1977 — Jackass penguins on the northern guano islands. *Cormorant* 2: 18–19.
- SHAUGHNESSY, P. D. 1980 — Influence of Cape fur seals on jackass penguin numbers at Sinclair Island. *S. Afr. J. Wildl. Res.* 10(1): 18–21.
- SHAUGHNESSY, P. D. 1984 — Historical population levels of seals and seabirds on islands off southern Africa, with special reference to Seal Island, False Bay. *Investl Rep. Sea Fish. Res. Inst. S. Afr.* 127: 61 pp.
- SHAUGHNESSY, P. D. COOPER J. and P. D. MORANT 1979 — Third census of the jackass penguin on Seal Island, False Bay: January 1979. *Cormorant* 6: 33–34.
- SHAUGHNESSY, P. D. and M. A. MEYER 1979 — An estimate of the jackass penguin population on Possession Island in 1977 and 1978. *Cormorant* 6: 21–24.
- SHAUGHNESSY, P. D. and G. L. SHAUGHNESSY 1978 — The jackass penguin colony at Seal Island in Mossel Bay. *Cormorant* 5: 27–28.
- SHELTON, P. A., CRAWFORD, R. J. M., KRIEL, F. and J. COOPER 1982 — Methods used to census three species of southern African seabirds, 1978–1981. *Fish. Bull. S. Afr.* 16: 115–120.
- SIEGFRIED, W. R. 1984 — An analysis of faecal pellets of the brown hyaena on the Namib Coast. *S. Afr. J. Zool.* 19(1): p. 61.
- SIEGFRIED, W. R., FROST, P. G. H., KINAHAN, J. B. and J. COOPER 1975 — Social behaviour of jackass penguins at sea. *Zool. Afr.* 10(1): 87–100.
- SIEGFRIED, W. R. and R. J. M. CRAWFORD 1978 — Jackass penguins, eggs and guano: diminishing resources at Dassen Island. *S. Afr. J. Sci.* 74(10): 389–390.
- SPARRMAN, A. 1785 — *A Voyage to the Cape of Good Hope towards the Antarctic Polar Circle, round the World and to the Country of the Hottentots and the Caffres from the Year 1772–1776*. I. Forbes, V.S. (Ed.). Cape Town: Van Riebeeck Society: 331 pp.
- SPENCE, J. 1906 — Report of the Superintendent of the Government Guano Islands for the half year ended 31st December, 1904 and for the year 1905. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G36–1906*: 7 pp.
- SPENCE, J. 1907 — Report of the Superintendent of the Government Guano Islands for the year 1906. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G33–1907*: 4 pp.
- STUART, C. T. 1975 — Preliminary notes on the mammals of the Namib Desert Park. *Madoqua ser.* 2 4: 5–68.
- SUMMERHAYES, C. P., HOFMEYER, P. K. and R. H. RIOUX 1974 — Seabirds off the southwestern coast of Africa. *Ostrich* 45(2): 83–109.
- TAYLOR, J. S. 1954 — Bird Island expedition, 1954. *Bee-eater* 5(1): 2–3.
- THEAL, G. M. 1898 — *Records of South-eastern Africa*. 1. London; W. Clowes & Sons: 506 pp.
- WESTPHAL, A. and M. K. ROWAN 1971 — Some observations on the effects of oil pollution on the jackass penguin.

- Ostrich* Suppl. 8: 521-526.
- WOODWARD, R. B. and J. D. S. WOODWARD 1899 — *Natal Birds*. Pietermaritzburg; P. Davis & Sons: 215 + 6 pp.
- WYNDHAM, C. 1932 — Pelicans breeding on Seal Island. *Ostrich* 3(1): 1-5.
- ZEEDERBERG, W. R. 1908 — Report of the Superintendent of the Government Guano Island for the year 1907. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G23—1908*: 113-115.
- ZEEDERBERG, W. R. 1909 — Report of the Superintendent of the Government Guano Islands for the year 1908. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G31—1909*: 125-127.
- ZEEDERBERG, W. R. 1910 — Report of the Superintendent of the Government Guano Islands for the year 1909. In *Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope G10—1910*: 189-192.
- ZEEDERBERG, W. R. 1912a — Report of the Superintendent of the Government Guano Islands for the year 1910. In *Annexures to the Votes and Proceedings of the House of Assembly, Union of South Africa UG16—1912*: 167-172.
- ZEEDERBERG, W. R. 1912b — Report of the Superintendent of the Government Guano Islands. In *Annexures to the Votes and Proceedings of the House of Assembly, Union of South Africa UG54—1912*: 467-474.
- ZEEDERBERG, W. R. 1913 — Report of the Superintendent of the Government Guano Islands. In *Annexures to the Votes and Proceedings of the House of Assembly, Union of South Africa UG47—1913*: 351-357.
- ZEEDERBERG, W. R. 1915 — Government Guano Islands, Annual Report 1913-14. In *Annexures to the Votes and Proceedings of the House of Assembly, Union of South Africa UG2—1915*: 275-280.
- ZEEDERBERG, W. R. 1917 — Government Guano Islands, Annual Report 1915-16. In *Annexures to the Votes and Proceedings of the House of Assembly, Union of South Africa UG25—1917*: 131-135.
- ZEEDERBERG, W. R. 1918a — Government Guano Islands, Annual Report 1916-17. In *Annexures to the Votes and Proceedings of the House of Assembly, Union of South Africa UG5—1918*: 143-147.
- ZEEDERBERG, W. R. 1918b — Government Guano Islands. In *Annexures to the Votes and Proceedings of the House of Assembly, Union of South Africa UG39—1918*: 149-153.
- ZEEDERBERG, W. R. 1919 — Government Guano Islands. In *Annexures to the Votes and Proceedings of the House of Assembly, Union of South Africa UG40—1919*: 145-150.
- ZEEDERBERG, W. R. 1921 — Government Guano Islands. In *Annexures to the Votes and Proceedings of the House of Assembly, Union of South Africa UG13—1921*: 71-74.
- ZEEDERBERG, W. R. 1922a — Government Guano Islands. *J. Dep. Agric. Un. S. Afr.* 4: 84-86.
- ZEEDERBERG, W. R. 1922b — Government Guano Islands. *J. Dep. Agric. Un. S. Afr.* 5: 577-579.
- ZEEDERBERG, W. R. 1923 — Government Guano Islands. *J. Dep. Agric. Un. S. Afr.* 7: 586-588.
- ZEEDERBERG, W. R. 1924 — Government Guano Islands. *J. Dep. Agric. Un. S. Afr.* 9: 592-595.
- ZEEDERBERG, W. R. 1925 — Government Guano Islands. *J. Dep. Agric. Un. S. Afr.* 11: 568-570.
- ZEEDERBERG, W. R. 1926 — A valuable asset to the farmer: guano and other island products. *Fmg S. Afr.* 1: p. 330.
- ZEEDERBERG, W. R. 1928 — A valuable asset to the farmer: guano and other island products. *Fmg S. Afr.* 3: p. 1133.

## APPENDIX 1

Schedule of counts or estimates of numbers of jackass penguins at possible extant breeding localities, 1900—1984

Date	Time <sup>α</sup>	Census technique	Parameter counted <sup>β</sup>	Number	Source
<i>Hollams Bird Island</i>					
Apr./May 1951		Visit	Nests	2	Rand (1952)
c. 1972		Rough estimate	Total population	10	Frost et al. (1976)
<i>Sylvia Hill</i>					
Jun. 1981		Visit	Individuals	30	R. Loutit ( <i>in litt.</i> )
Jun. 1983		Visit	Individuals	60	R. Loutit ( <i>in litt.</i> )
			Nest with chicks	15	
Feb. 1984		Visit	Adults and immatures	230	R. Loutit ( <i>in litt.</i> )
			Chicks	7	
<i>Mercury Island</i>					
20 Nov. 1956		Aerial photography	Individuals	3 264 <sup>γ</sup>	
15 Nov. 1967		Aerial photography	Individuals	2 964	
25 or 26 Nov. 1969		Aerial photography	Individuals	4 078	
1970		Rough estimate <sup>δ</sup>	Total population	3 000	Frost et al. (1976)
17 Mar. 1977		Island visit	Adults	Several thousand	Shaughnessy (1977)
20—23 Nov. 1978		Transects	Nests	3 218	
28 Nov. 1978	13h45	Aerial photography	Individuals	10 820	
30—31 Jan. 1980		Head count	Adults	2 906	
<i>Ichaboe Island</i>					
20 Nov. 1956		Aerial photography	Individuals	4 179	Rand (1963b)
15 Nov. 1967		Aerial photography	Individuals	2 882	
25 or 26 Nov. 1969		Aerial photography	Individuals	3 226	
1970		Rough estimate <sup>δ</sup>	Total population	2 000	Frost et al. (1976)
12—13 Mar. 1977		Island visit	Adults	Several thousand	Shaughnessy (1977)
24—28 Nov. 1978		Transects	Nests	3 598	
28 Nov. 1978	13h30	Aerial photography	Individuals	10 437	
9 Jul. 1979	14h00	Aerial photography	Individuals	2 120	
3—7 Feb. 1980		Head count	Adults	4 200	
<i>Halifax Island</i>					
May 1949		Visit	Individuals	1 200	Meinertzhagen (1950)
21 Nov. 1956		Aerial photography	Individuals	8 639	Rand (1963b)
25 or 26 Nov. 1969		Aerial photography	Individuals	5 412	
1970		Rough estimate <sup>δ</sup>	Total population	5 000	Frost et al. (1976)
May 1971		Head count	Adults	3 628	Berry et al. (1974)
			Immatures & pulli	435	
Aug. 1971		Head count	Adults	3 488	Berry et al. (1974)
			Immatures & pulli	126	
May 1972		Head count	Adults	2 215	Berry et al. (1974)
			Immatures & pulli	235	
Aug. 1972		Head count	Adults	5 269	Berry et al. (1974)
			Immatures & pulli	120	
Nov. 1972		Head count	Adults	4 836	Berry et al. (1974)
			Immatures	25	
			Pulli	>39	
19 May 1977		Head count	Adults	2 129	
			Chicks	197	
28 Nov. 1978	12h55	Aerial photography	Individuals	2 755	
30 Nov. 1978		Transects	Nests	1 750	
9 Jul. 1979	13h40	Aerial photography	Individuals	1 802	
20 Jan. 1980		Head count	Adults	1 850	
14 Dec. 1981	09h30—15h15	Head count	Adults	2 162	P. T. v.d. Walt ( <i>in litt.</i> )
			Immatures	347	
		Transects	Nests	1 007	

## Appendix 1 (continued)

Date	Time <sup>α</sup>	Census technique	Parameter counted <sup>β</sup>	Number	Source
<i>North Reef, Possession Island</i>					
21 Nov. 1956		Aerial photography	Individuals	1 360	Rand (1963b)
14 Nov. 1967		Aerial photography	Individuals	389	
13 Jan. 1978		Head count	Adults	200	Shaughnessy & Meyer (1979)
28 Nov. 1978	12h15	Aerial photography	Individuals	256	
1 Dec. 1978		Transects	Nests	151	
26 Jan. 1980		Transects	Nests	58	
26 Jan. 1980		Head count	Adults	181	
			Immatures	30	
<i>Possession Island</i>					
21 Nov. 1956		Aerial photography & head count amongst bushes <sup>ε</sup>	Individuals	37 192	Rand (1963b)
14 Nov. 1967		Aerial Photography <sup>ζ</sup>	Individuals	14 528	
8—29 Aug. 1977		Head count <sup>ζ</sup>	Adults	3 505	Shaughnessy & Meyer (1979)
28 Nov. 1978	12h15	Aerial photography <sup>ζ</sup>	Individuals	3 757	
2—4 Dec. 1978		Transects	Nests	2 568	
9 Jul. 1979	13h20	Aerial photography <sup>ζ</sup>	Individuals	1 833	
22—27 Jan. 1980		Head count	Adults	2 250	
<i>Possession Island, including North Reef</i>					
21 Nov. 1956		Aerial photography & head count amongst bushes <sup>η</sup>	Individuals	38 552	Rand (1963b)
14 Nov. 1967		Aerial photography <sup>ζ</sup>	Individuals	14 917	
1970		Rough estimate <sup>δ</sup>	Total population	25 000	Frost <i>et al.</i> (1976)
28 Nov. 1978		Aerial photography <sup>ζ</sup>	Individuals	4 013	
1—4 Dec. 1978		Transects	Nests	2 719	
22—27 Jan. 1980		Head count	Adults	2 431	
<i>Pomona Island</i>					
21 Nov. 1956		Aerial photography	Individuals	9 676	Rand (1963b)
14 Nov. 1967		Aerial photography	Individuals	6 357	
25 or 26 Nov. 1969		Aerial photography	Individuals	8 974	
1970		Rough estimate <sup>δ</sup>	Total population	7 000	Frost <i>et al.</i> (1976)
13 Jan. 1977	13h00	Head count and extrapolation	Adults	740	Shaughnessy (1977)
28 Nov. 1978	12h00	Aerial photography	Individuals	149	
7 Dec. 1978	16h15	Transects	Nests	123	
7 Dec. 1978	16h15	Head count	Adults	339	
20 Sep. 1979		Aerial photography	Individuals	310	
23 Jan. 1980		Transects	Nests	20	
23 Jan. 1980		Head count	Adults	116	
			Immatures	34	
<i>Plumpudding Island</i>					
21 Nov. 1956		Aerial photography	Individuals	4 801	Rand (1963b)
14 Nov. 1967		Aerial photography	Individuals	5 515	
25 or 26 Nov. 1969		Aerial photography	Individuals	4 547	
1970		Rough estimate <sup>δ</sup>	Total population	3 000	Frost <i>et al.</i> (1976)
21 Jan. 1978	14h00	Head count	Adults	881	Shaughnessy (1980)
28 Nov. 1978	11h45	Aerial photography	Individuals	803	
8 Dec. 1978	14h23	Transects	Nests	438	
8 Dec. 1978	14h23	Head count	Adults	1 068	
9 Jul. 1979	13h00	Aerial photography	Individuals	96	
23 Jan. 1980		Transects	Nests	100	
23 Jan. 1980		Head count	Adults	592	
			Immatures	144	

## Appendix 1 (continued)

Date	Time <sup>a</sup>	Census technique	Parameter counted <sup>β</sup>	Number	Source
<i>Sinclair Island</i>					
1948		Rough estimate	Pairs	3 000	Rand (1949a)
21 Nov. 1956		Aerial photography	Individuals	2 370	Rand (1963b)
14 Nov. 1967		Aerial photography	Individuals	632	
5 Dec. 1971	13h30	Aerial photography	Individuals	373	Shaughnessy (1980)
1970		Rough estimate <sup>δ</sup>	Total population	200	Frost <i>et al.</i> (1976)
17 Dec. 1976	13h45	Aerial photography	Individuals	314	Shaughnessy (1980)
20 Dec. 1977	16h30	Aerial photography	Individuals	283	Shaughnessy (1980)
28 Nov. 1978	11h45	Aerial photography	Individuals	343	
8 Dec. 1978	11h30	Transects	Nests	246	
8 Dec. 1978	11h30	Head count	Adults	358	
9 Jul. 1979	13h00	Aerial photography	Individuals	158	
12—14 Oct. 1979	06h30	Head count	Individuals	398	P. D. Shaughnessy ( <i>in litt.</i> ) <sup>θ</sup>
19 Dec. 1979	12h15	Aerial photography	Individuals	321	Shaughnessy (1980)
23 Jan. 1980		Transects	Nests	124	
23 Jan. 1980		Head count	Adults	308	
			Immatures	93	
<i>Bird Island, Lambert's Bay</i>					
1900—1909		Estimate from egg collection	Total population	2 700	Frost <i>et al.</i> (1976)
Nov. 1956		Rough estimate	Adults	500 <sup>ι</sup>	Rand (1963a)
1970		Rough estimate <sup>δ</sup>	Total population	200	Frost <i>et al.</i> (1976)
c. 1971		Rough estimate	Breeding pairs	c. 10 <sup>κ</sup>	Jarvis and Cram (1971)
1972		Rough estimate	Total population	150	Frost <i>et al.</i> (1976)
20 Dec. 1977		Transects	Nests	7	
20 Dec. 1977		Head count	Adults	309	
			Immatures & pulli	18	
8 Jan. 1978		Transects	Nests	7	
8 Jan. 1978		Head count	Adults	132	
			Immatures & pulli	11	
24 Feb. 1978		Transects	Nests	5	
24 Feb. 1978		Head count	Adults	60	
			Immatures & pulli	19	
11 Mar. 1978		Transects	Nests	6	
11 Mar. 1978		Head count	Adults	80	
			Immatures & pulli	5	
13 May 1978		Transects	Nests	24	
13 May 1978		Head count	Adults	71	
			Immatures & pulli	9	
5 Jun. 1978	14h00	Transects	Nests	37	
5 Jun. 1978	14h00	Head count	Adults	93	
			Immatures & pulli	42	
14 Jul. 1978		Transects	Nests	31	
14 Jul. 1978		Head count	Adults	77	
			Immatures & pulli	25	
29 Aug. 1978		Transects	Nests	22	
29 Aug. 1978		Head count	Adults	67	
			Immatures & pulli	18	
4 Jan. 1979		Transects	Nests	10	
16 Feb. 1979		Transects	Nests	12	
16 Mar. 1979		Transects	Nests	19	
16 Mar. 1979		Head count	Adults	22	
			Immatures & pulli	8	
19 Apr. 1979		Transects	Nests	46	
19 Apr. 1979		Head count	Adults	64	
			Immatures & pulli	8	
21 May 1979		Transects	Nests	50	

## Appendix 1 (continued)

Date	Time <sup>a</sup>	Census technique	Parameter counted <sup>b</sup>	Number	Source
<i>Bird Island (Lambert's Bay) - continued</i>					
21 May 1979		Head count	Adults	54	
			Immatures & pulli	27	
27—28 Jun. 1979		Transects	Nests	36	
27—28 Jun. 1979		Head count	Adults	59	
24—25 Jul. 1979		Transects	Nests	33	
23 Aug. 1979	09h00	Transects	Nests	41	
27 Sep. 1979	15h00	Transects	Nests	10	
27 Sep. 1979	15h00	Head count	Adults	33	
			Immatures & pulli	12	
27 Nov. 1979		Transects	Nests	c. 20	
21 Dec. 1979	10h30	Transects	Nests	7	
8 Jan. 1980	11h00	Transects	Nests	2	
<i>Lambert's Bay, mainland</i>					
Apr. 1982		Ground count	Nests	1	
<i>Malgas Island</i>					
1903		Estimate from egg collections <sup>λ</sup>	Total population	13 100	
23 Nov. 1956		Aerial photography	Individuals	1 063 <sup>ν</sup>	Rand (1963a)
Nov. 1956		Rough estimate	Adults	5 000	Rand (1963a)
1970		Rough estimate <sup>δ</sup>	Total population	1 000	Frost <i>et al.</i> (1976)
27 Nov. 1978	10h00	Aerial photography	Individuals	4 448	
29 Dec. 1978		Transects	Nests	576	
18 Jul. 1979		Transects	Nests	1 022	
22 Aug. 1979		Transects	Nests	303	
23 Oct. 1979		Transects	Nests	739	
26 Nov. 1979		Transects	Nests	>375	
20 Dec. 1979		Transects	Nests	113	
<i>Marcus Island</i>					
1900—1909		Estimate from egg collection	Total population	19 500	Frost <i>et al.</i> (1976)
23 Nov. 1956		Aerial photography	Individuals	5 834	Rand (1963a)
10 Nov. 1967		Aerial photography	Individuals	2 915	
1970		Rough estimate <sup>δ</sup>	Total population	3 000	Frost <i>et al.</i> (1976)
1972		Rough estimate	Total population	9 000	Anon. (1973)
10—11 Nov. 1973		Head count	Nests	c. 1 222	J. Cooper & C. C. H. Elliott (unpubl. ms.)
29 Apr. 1976		Transects	Occupied nests	717	
27 Nov. 1978	10h05	Aerial photography	Individuals	2 941	
26 Dec. 1978— 7 Jan. 1979		Transects	Nests	374	A. J. Williams (pers. comm.)
17—18 Jul. 1979		Transects	Nests	1 243	
<i>Jutten Island</i>					
1900—1909		Estimate from egg collections	Total population	78 000	Frost <i>et al.</i> (1976)
23 Nov. 1956		Aerial photography	Individuals	9 444	Rand (1963a)
1970		Rough estimate <sup>δ</sup>	Total population	7 000	Frost <i>et al.</i> (1976)
27 Nov. 1978	09h50	Aerial photography	Individuals	3 861	
29 Dec. 1978		Transects & extrapolation	Nests	712	
10—15 Feb. 1979		Transects	Nests	2 397	
25—26 Jul. 1979		Transects	Nests	2 878	
<i>Vondeling Island</i>					
1900—1909		Estimate from egg collections	Total population	4 400	Frost <i>et al.</i> (1978)
23 Nov. 1956		Aerial photography	Individuals	375	Rand (1963a)
1970		Rough estimate <sup>δ</sup>	Total population	400	Frost <i>et al.</i> (1976)

## Appendix 1 (continued)

Date	Time <sup>α</sup>	Census technique	Parameter counted <sup>β</sup>	Number	Source
<i>Vondeling Island - continued</i>					
26 Apr. 1976		Transects	Occupied nests	1 028	
27 Apr. 1976		Transects	Adults on shoreline	650	
			Juveniles on shoreline	7	
27 Oct. 1978		Transects	Nests	276	
27 Nov. 1978	09h00	Aerial photography	Individuals	304	
8 Jun. 1979		Transects	Nests	495	
<i>Dassen Island</i>					
1900—1930		Estimate from egg collections	Total population	300 000	Frost <i>et al.</i> (1976)
23 Nov. 1956		Aerial photography	Individuals	80 562	Rand (1963a)
1970		Rough estimate <sup>δ</sup>	Total population	50 000	Frost <i>et al.</i> (1976)
1972		Ground count of occupied burrows	Total population	70 000	Frost <i>et al.</i> (1976)
Jan.—Dec. 1973		Not specified	Adults	70 000	Jackson <i>et al.</i> (1976)
			Immatures	12 000	
23—30 Oct. 1978		Transects	Nests	11 220	
11 Dec. 1978	16h00	Aerial photography	Individuals	16 049	
1—12 Jun. 1978		Transects	Nests	12 646	
<i>Robben Island</i>					
Apr. 1984		Ground count	Nests	12	E.O.J. Westphal ( <i>in litt.</i> )
30 May 1984		Ground count	Nests	24	
			Adults	45	
			Chicks	7	
<i>Seal Island, False Bay</i>					
1874		Estimate from egg collection <sup>λ</sup>	Total population	5 000	
Oct. c. 1950		Ground count	Nests	c. 200	Rand (1951)
end Nov. c. 1950		Head count	Adults <sup>£</sup>	502	Rand (1951)
1970		Rough estimate <sup>δ</sup>	Total population	50	Frost <i>et al.</i> (1976)
17 Jan. 1977		Transects	Nests	24	Cooper & Shaughnessy (1977)
17 Jan. 1977		Head count	Total population	111	Cooper & Shaughnessy (1977)
17 Jan. 1978		Transects	Nests	23	Cooper & Shaughnessy (1978)
17 Jan. 1978		Head count	Total population	102	Cooper & Shaughnessy (1978)
20 Oct. 1978		Transects	Nests	50	
23 Jan. 1979		Transects	Nests	43	Shaughnessy <i>et al.</i> (1979)
23 Jan. 1979		Head count	Total population	118	Shaughnessy <i>et al.</i> (1979)
18 Jun. 1979		Transects	Nests	82	
<i>Stony Point</i>					
17 Nov. 1982		Visit	Nests	1	Broni (1982)
30 Sep. 1983		Ground count	Occupied nests	1	
14 Nov. 1983		Ground count	Occupied nests	1	
9 Jan. 1984		Ground count	Occupied nests	1	
1 Jun. 1984		Ground count	Occupied nests	4	
<i>Dyer Island</i>					
1905		Estimate from egg collections <sup>λ</sup>	Total population	41 400	
8 Oct. 1956		Aerial photography	Individuals	4 982	Rand (1963a)
23 Nov. 1956		Aerial photography	Individuals	2 765	Rand (1963a)
8 Nov. 1967		Aerial photography	Individuals	17 926	
1970		Rough estimate <sup>δ</sup>	Total population	15 000	Frost <i>et al.</i> (1976)
12 Aug. 1971		Extrapolation from partial nest count	Adults	16 000	Cooper (1977)



## Appendix 1 (continued)

Date	Time <sup>α</sup>	Census technique	Parameter counted <sup>β</sup>	Number	Source
<i>Dyer Island - continued</i>					
c. 1972		Sampling and extrapolation <sup>α</sup>	Total population	38 000	Frost <i>et al.</i> (1976)
17 Jan. 1976		Head count	Adults	11 243	Cooper (1977)
18 Oct. 1978		Transects	Nests	18 712	
22 Nov. 1978	09h15	Aerial photography	Individuals	26 599	
14—16 Jun. 1979		Transects	Nests	22 655	
23 Dec. 1979		Search	Eggs	<10	
14 Jan. 1980	07h00	Transects	Nests	27	
<i>Geyser Island</i>					
19 Oct. 1978		Transects	Nests	151	
11 Jan. 1979		Transects	Nests	117	
17 Jun. 1979		Transects	Nests	318	
<i>Quoin Rock</i>					
10 Sep. 1978		Telescope from mainland	Adults	1	
17 Jun. 1979		Head count	Population	0	
<i>Cape Recife</i>					
May—Jun. 1981		Not specified	Adults	3	Every (1983)
			Eggs	1	
<i>Jahleel Island</i>					
1973—1981		Maximum count on visits	Population	c. 1 170	Randall <i>et al.</i> (1981)
1 Dec. 1979		Head count from boat	Adults	300	
<i>Brenton Rock</i>					
1973—1981		Maximum count on visits	Population	c. 92	Randall <i>et al.</i> (1981)
1 Dec. 1979		Head count from boat	Adults	21	
<i>St Croix Island</i>					
26 Nov. 1970		Aerial photography	Individuals	7 470	Rand (1963a)
25 or 26 Nov. 1969		Aerial photography	Individuals	17 696	Frost <i>et al.</i> (1976)
1970		Rough estimate <sup>δ</sup>	Total population	15 000	
1971		Estimated from nesting area and density of breeding birds, both determined by photography	Total population	21 043	Ross (1971)
1975		Not specified	Total population	23 000	Ross (1976)
23 Nov. 1978	08h55	Aerial photography	Adults & chicks	11 053	R. M. Randall (pers. comm.)
26 Nov. 1978		Head count	Adults	11 591	
<i>Seal Island, Algoa Bay</i>					
1945		Not specified	Pairs	c. 100	Courtenay-Latimer and Gibson-Hill (1946)
1958		Not specified	Breeding pairs	100	
1973—1981		Maximum count on visits	Population	c. 2 200	Randall <i>et al.</i> (1981)
23 Nov. 1978	09h15	Aerial photography	Adults & chicks	639	
5 Dec. 1979		Transects	Nests	26	
5 Dec. 1979		Head count	Adults	2 213	
<i>Stag Island</i>					
1945		Not specified	Pairs	c. 60	Courtenay-Latimer and Gibson-Hill (1946)
26 Nov. 1956		Aerial photography	Individuals	42	
Apr. 1958		Ground count	Adults	80	Rand (1963a)
1973—1981		Maximum count on visits	Population	c. 118	Randall <i>et al.</i> (1981)
5 Dec. 1979		Transects	Nests	4	
5 Dec. 1979		Head count	Adults	120	
5 Dec. 1979			Immatures	6	

## Appendix 1 (continued)

Date	Time <sup>a</sup>	Census technique	Parameter counted <sup>b</sup>	Number	Source
<i>Bird Island, Algoa Bay</i>					
Nov. 1945		Not specified	Pairs	c. 80	Courtenay-Latimer and Gibson-Hill (1946)
Jan. 1954		Not specified	Pairs	c. 50	Taylor 1954
358		Not specified	Nests	60	Rand (1963a)
370		Rough estimate <sup>δ</sup>	Total population	500	Frost <i>et al.</i> (1976)
1973—1981		Maximum count on visits	Population	c. 2 100	Randall <i>et al.</i> (1981)
Dec. 1979		Transects	Nests	314	
Dec. 1979		Head count	Adults	1 098	
			Immatures	79	

When transects were undertaken the midpoint of the census is indicated

The terms immatures and juveniles may be regarded as equivalent, as also may be pulli and chicks. It is known that some counts of immatures included chicks (e.g. Berry *et al.* 1974)

Rand's (1963b) estimate was "6 000?". The indicated value is from a recount of the photographs

Government Guano Islands manuscript cited in Frost *et al.* (1976)

Count on aerial photographs = 35 905; count amongst bushes = 1 287

Birds amongst bushes not counted

Count on aerial photographs = 37 265; count amongst bushes = 1 287

Estimate from J. Hanekom — average of one count on each of the three days made at 06h30. From photographs at that time, adults appear to have dominated but chicks were presumably also included

Value from Rand (1963a), Table 5, p. 19 — "a growing population of about 200 pairs"

"A small group of Jackass Penguins, usually about 10 pairs, nest on the road . . . and a few others nest elsewhere under rock ledges or in burrows"

Similar to the method used by Frost *et al.* (1976)

From Rand (1963a) Table 5, p. 19 — the text on p. 13 indicates 1 062

Including birds approaching maturity

Cited from Cooper (1973)

## APPENDIX 2

Records of jackass penguins *Spheniscus demersus* north of their breeding range on the west and east coasts of Africa

Locality	Co-ordinates	Date	Number	Age class	Source
<i>West Africa</i>					
GABON					
Sette Cama	2°32'S 9°46'E	25 December 1956	1	moulting juvenile	Malbrant and Maclatchy (1958, 1959)
CONGO					
Point Noire	4°48'S 11°51'E	March 1954	1	—	Malbrant and Maclatchy (1959)
ANGOLA					
Punta de Sao Jose	12°35'S 13°13'E	October 1964	1	—	da Franca (1967)
near Moçâmedes	15°10'S 12°10'E	—	2	—	da Franca (1967)
Porto Alexandre	15°49'S 11°53'E	—	1	juvenile	de Seabra (1906)
Baia dos Tigres	16°36'S 11°43'E	10 October 1898	"several"	—	Brooke (1981a) and references therein
South of Baia dos Tigres		"winter"	1	—	Brooke (1981a)
SOUTH WEST AFRICA					
At sea off Cape Frio	18°33'S 11°52'E	17 February 1967	1	—	Lambert (1971)
Rocky Point	19°00'S 12°29'E	28 December 1983	1	juvenile	R. Loutit ( <i>in litt.</i> , 1984)
At sea	19°30'S 12°13'E	27 September 1974	1	juvenile	K. Lambert ( <i>in litt.</i> , 1975)
1 km south of koppies north of Toscanini	20°36'S 13°20'E	3 April 1984	1	adult	South African Museum Specimen SAMZC6
6 km south of koppies north of Toscanini	20°38'S 13°20'E	3 April 1984	1	juvenile	South African Museum Specimen SAMZC7
Huab River mouth	20°55'S 13°27'E	1 December 1982	1	adult	G. Avery ( <i>in litt.</i> , 1984)
Huab River mouth	20°55'S 13°27'E	5 December 1982	1	adult	G. Avery ( <i>in litt.</i> , 1984)
Huab River mouth	20°55'S 13°27'E	7 December 1982	1	juvenile	G. Avery ( <i>in litt.</i> , 1984)
north of Ugab River	21°06'S 13°33'E	24 September 1982	1	adult	G. Avery ( <i>in litt.</i> , 1984)
north of Ugab River	21°09'S 13°35'E	24 September 1982	1	adult	G. Avery ( <i>in litt.</i> , 1984)
near Ugab River mouth	21°11'S 13°37'E	—	3	2 juveniles 1 adult	Ryan <i>et al.</i> ( <i>in press</i> ); R. Loutit ( <i>in litt.</i> , 1984)
Ugab River mouth	21°12'S 13°37'E	23 December 1980	1	juvenile	R. Loutit ( <i>in litt.</i> , 1984)
Cape Cross Cape fur seal colony	21°47'S 13°57'E	12 January 1978	1	moulting juvenile	J. Cooper (pers. obs.)
at sea	21°51'S 13°41'E	4 October 1974	16	15 juveniles 1 adult	K. Lambert ( <i>in litt.</i> , 1975)
at sea	22°21'S 14°17'E	21 October 1977	1	juvenile	P. D. Shaughnessy ( <i>in litt.</i> , 1977)

## Appendix 2 (continued)

Locality	Co-ordinates	Date	Number	Age class	Source
between Cape Cross and Swakopmund	—	c. 1969–1974	c. 15	juveniles	H. von Schwind ( <i>in litt.</i> , 1975)
'Mile 72'		19 May 1980	1	adult	R. Loutit ( <i>in litt.</i> , 1984)
Swakopmund	22°40'S 14°31'E	19 February 1969	1	juvenile	H. H. Berry ( <i>in litt.</i> 1972), Safring records
Swakopmund	22°40'S 14°31'E	15 March 1969	1	juvenile	H. H. Berry ( <i>in litt.</i> 1972), Safring records
Swakopmund	22°40'S 14°31'E	13 November 1972	1	juvenile	Elliott (1974), Berry and Berry (1975), Safring records (P5485)
Swakopmund	22°40'S 14°31'E	10 November 1976	1	juvenile	Safring records
Swakopmund	22°40'S 14°31'E	July 1979	1	juvenile	R. Loutit ( <i>in litt.</i> , 1984)
Swakopmund	22°40'S 14°31'E	11 December 1979	1	juvenile	Safring records (T7639)
Swakopmund	22°40'S 14°31'E	20 February 1980	1	juvenile	Safring records (T5146)
at sea, off Swakopmund	c. 22°40'S 14°31'E	1 December 1974	1	juvenile	P. G. H. Frost (pers. comm.)
at sea, off Swakopmund	c. 22°40'S 14°31'E	3 December 1974	1	9 juveniles	P. G. H. Frost (pers. comm.)
at sea, off Swakopmund	c. 22°40'S 14°31'E	27 August 1975	2	adults	P. D. Shaughnessy ( <i>in litt.</i> , 1975)
at sea	22°41'S 14°14'E	2 December 1972	1	juvenile	K. Lambert ( <i>in litt.</i> , 1975)
at sea, inside Pelican Point	22°52'S 14°27'E	23 November 1983	3	—	A. J. Williams (pers. comm.)
at sea, off Pelican Point	22°52'S 14°27'E	19 October 1977	1	juvenile	P. D. Shaughnessy ( <i>in litt.</i> , 1977)
at sea	22°52'S 13°20'E	28 January 1973	5	juveniles	K. Lambert ( <i>in litt.</i> , 1975)
Between Pelican Point and Sandwich Harbour	—	—	3	adults	R. Loutit ( <i>in litt.</i> , 1984)
at sea	22°54'S 14°14'E	27 October 1972	46	5 adults, 41 juveniles	K. Lambert ( <i>in litt.</i> , 1975)
at sea	22°56'S 14°22'E	25 November 1971	5	juveniles	Summerhayes <i>et al.</i> (1974), P. K. Hofmeyr ( <i>in litt.</i> , undated)
at sea, in Walvis Bay	—	—	2	adults	R. Loutit ( <i>in litt.</i> , 1984)
Walvis Bay	22°57'S 14°30'E	8–15 June 1970	1	adult	H. H. Berry ( <i>in litt.</i> 1972), Safring records (G0035), Elliott and Jarvis (1973)
Walvis Bay	22°57'S 14°30'E	24–28 June 1970	2	juveniles	H. H. Berry ( <i>in litt.</i> 1972), Safring records (G0037), Elliott and Jarvis (1973)
Walvis Bay	22°57'S 14°30'E	14 January 1971	1	juvenile	Transvaal Museum specimen
Walvis Bay	22°57'S 14°30'E	6 August 1972	1	juvenile	Safring records (P1364)
Walvis Bay	22°57'S 14°30'E	13 December 1972	1	juvenile	Berry and Berry (1975), Safring records

## Appendix 2 (continued)

Locality	Co-ordinates	Date	Number	Age class	Source
Walvis Bay	22°57'S 14°30'E	21 December 1972	1	juvenile	Safring records (P2275)
Walvis salt works	22°59'S 14°27'E	22 November 1983	1	juvenile	A. J. Williams (pers. comm.)
Wortel, south of Walvis Bay	23°03'S 14°27'E	Archaeological specimens	13	12 adults, 1 juvenile	G. Avery (in press)
on coast between Swakopmund and Sandwich Harbour	—	Nov. 1969 – Oct. 1972	5	4 juveniles, 1 adult	H. H. Berry ( <i>in litt.</i> , 1972)
Sandwich Harbour	23°22'S 14°29'E	30 December 1969	1	juvenile	H. H. Berry ( <i>in litt.</i> , 1972); Safring records
Sandwich Harbour	23°22'S 14°29'E	5 January 1970	1	juvenile	H. H. Berry ( <i>in litt.</i> , 1972) Safring records
Sandwich Harbour	23°22'S 14°29'E	9 January 1970	1	juvenile	H. H. Berry ( <i>in litt.</i> , 1972), Safring records
Sandwich Harbour	23°22'S 14°29'E	22 March 1970	1	adult	H. H. Berry ( <i>in litt.</i> , 1972), Safring records
Sandwich Harbour	23°22'S 14°29'E	2 May 1970	1	adult	H. H. Berry ( <i>in litt.</i> , 1972) Safring records
Sandwich Harbour	23°22'S 14°29'E	July 1970	1	juvenile	Berry and Berry (1975)
Sandwich Harbour	23°22'S 14°29'E	January 1971	1	juvenile	Berry and Berry (1975)
at sea	24°02'S 14°01'E	6 February 1967	8	1 adult, 3 juveniles	Lambert (1971), K. Lambert ( <i>in litt.</i> , 1975)
at sea	24°10'S 13°48'E	May 1972	3	3 adults	Summerhayes <i>et al.</i> (1975), P. K. Hofmeyr ( <i>in litt.</i> , undated)
at sea	24°12'S 14°17'E	22 March 1977	1	—	P. D. Shaughnessy ( <i>in litt.</i> , 1975)
at sea	24°16'S 13°57'E	2 May 1968	3	2 juveniles 1 adult	K. Lambert ( <i>in litt.</i> , 1975)
at sea	24°23'S 13°51'E	5 May 1968	3	adults	K. Lambert ( <i>in litt.</i> , 1975)
Meob Bay	24°31'S 14°37'E	25 August 1977	1	juvenile	Safring records (T0406)
at sea	24°34'S 14°32'E	21 March 1977	1	juvenile	P. D. Shaughnessy ( <i>in litt.</i> , 1977)
at sea	c. 24°36'S 14°32'E	21 March 1977	2	juveniles	P. D. Shaughnessy ( <i>in litt.</i> , 1977)
at sea off Hollams Bird Island	24°39'S 14°32'E	21 March 1977	1	adult	P. D. Shaughnessy ( <i>in litt.</i> , 1977)
<i>East Africa</i>					
MOÇAMBIQUE					
Inhaca Island	26°58'S 32°59'E	1918?	2	—	Pinto (1958)
NATAL					
Redsands	27°28'S 32°42'E	13 August 1980	1	juvenile	G. Avery ( <i>in litt.</i> , 1984)
near Sodwana Bay	27°32'S 32°41'E	13 August 1980	1	juvenile	Cyrus and Robson (1984)

## Appendix 2 (continued)

Locality	Co-ordinates	Date	Number	Age class	Source
St Lucia estuary	28°23'S 32°25'E	15 August 1980	1	juvenile	Cyrus and Robson (1984)
Port Durnford	28°55'S 31°55'E	15 August 1971	1	juvenile	Durban Museum specimen
Mtunzini	28°57'S 31°48'E	August 197?	1	—	Cyrus and Robson (1980)
Mtunzini	28°57'S 31°48'E	October 197?	1	—	Cyrus and Robson (1980)
Ballito Pool	29°32'S 31°13'E	27 August 1981	1	juvenile	G. Avery ( <i>in litt.</i> , 1984)
Umvoti River mouth	29°23'S 31°20'E	196?	1	—	Jex (1965)
Umhlanga Rocks	29°43'S 31°05'E	August 1952	1	juvenile	Durban Museum specimen
Umhlanga Rocks	29°43'S 31°05'E	26 January 1953	1	adult	Durban Museum specimen
Umhlanga Rocks	29°43'S 31°05'E	February 1953	1	adult	Durban Museum specimen
Umhlanga Rocks	29°43'S 31°05'E	28 December 1953	1	adult	Durban Museum specimen
Umhlanga Rocks	29°43'S 31°05'E	March 1960	1	adult	Durban Museum specimen
Umhlanga Rocks	29°43'S 31°05'E	28 August 1961	1	adult	Durban Museum specimen
Umhlanga Rocks	29°43'S 31°05'E	26 October 1972	1	—	Durban Museum specimen
Umhlanga Rocks	29°43'S 31°05'E	10 September 1973	1	juvenile	Durban Museum specimen
Umhlanga Rocks	29°43'S 31°05'E	23 July 1975	1	—	Durban Museum specimen
Umhlanga Rocks	29°43'S 31°05'E	August 197?	1	—	Cyrus and Robson (1980)
Durban	29°51'S 31°02'E	1899	1	adult	Durban Museum specimen
Durban	29°51'S 31°02'E	1952?	1	adult	Durban Museum specimen
Durban	29°51'S 31°02'E	August 1952	1	juvenile	Durban Museum specimen
Durban	29°51'S 31°02'E	1953	1	adult	Durban Museum specimen
Durban	29°51'S 31°02'E	1965	1	juvenile	Durban Museum specimen
Durban	29°51'S 31°02'E	November 1965	1	juvenile	Durban Museum specimen
Durban	29°51'S 31°02'E	10 February 1967	1	adult	Durban Museum specimen
Durban	29°51'S 31°02'E	February 1968	1	—	Durban Museum specimen
Durban	29°51'S 31°02'E	June 197?	1	—	Cyrus and Robson (1980)

## Appendix 2 (continued)

Locality	Co-ordinates	Date	Number	Age class	Source
Durban	29°51'S 31°02'E	August 1977	1	—	Cyrus and Robson (1980)
Isipingo Beach	30°00'S 30°57'E	15 August 1981	2	—	G. Avery ( <i>in litt.</i> , 1984)
Umbogintwini	30°01'S 30°55'E	September 1977	1	—	Cyrus and Robson (1980)
Umbogintwini	30°01'S 30°55'E	24 August 1974	1	juvenile	R. van der Elst ( <i>in litt.</i> , 1974)
Amanzimtoti	30°03'S 30°53'E	1897	1	—	Woodward and Woodward (1899)
Amanzimtoti	30°03'S 30°53'E	1 September 1973	1	juvenile	R. van der Elst ( <i>in litt.</i> , 1974)
Umkomaas	30°12'S 30°48'E	1894	1	—	Natal Museum annual report
Umkomaas	30°12'S 30°48'E	July 1932	1	—	Natal Museum catalogue
Umkomaas	30°12'S 30°48'E	28 August 1980	1	—	Cyrus and Robson (1984)
Scottburgh	30°17'S 30°45'E	August 1905	1	—	Natal Museum catalogue
Scottburgh	30°17'S 30°45'E	1932	1	—	Natal Museum catalogue
Scottburgh	30°18'S 30°44'E	11 December 1976	1	adult	Safring records (P8797)
Park Rynie	30°19'S 30°45'E	10 August 1974	1	juvenile	Durban Museum specimen
Park Rynie	30°19'S 30°45'E	13 August 1974	1	juvenile	R. van der Elst ( <i>in litt.</i> , 1974)
Park Rynie	30°19'S 30°45'E	June 1977	1	—	Cyrus and Robson (1980)
Sezela	30°24'S 30°41'E	26 October 1983	1	juvenile	Safring records (V0617)
Ifafa Beach	30°28'S 30°39'E	1910	1	adult	Transvaal Museum specimen
Ifafa Beach	30°28'S 30°39'E	July 1961	1	juvenile	Davies (1962)
St Michaels-on-sea	30°49'S 30°24'E	17 January 1980	1	juvenile	Cyrus and Robson (1984)
St Michaels-on-sea	30°39'S 30°24'E	6 September 1980	1	adult	Cyrus and Robson (1984)
TRANSKEI					
Port St Johns	31°37'S 29°32'E	24 September 1902	1	—	South African Museum catalogue
Port St Johns	31°37'S 29°32'E	19 November 1977	1	adult	Safring records (P9424)
Coffee Bay	31°59'S 29°09'E	25 December 1923	1	—	East London Museum specimen
Mpame village	32°06'S 29°04'E	—	1	adult	Archaeological specimen (G. Avery, pers. comm.)

## Appendix 2 (continued)

Locality	Co-ordinates	Date	Number	Age class	Source
Ntlonyane	32°11'S 28°56'E	1 June 1977	1	adult	Safring records (P9620)
Dwesa Point	32°18'S 28°51'E	13 September 1977	2	1 juvenile 1 adult	G. Avery ( <i>in litt.</i> , 1984)
Nqabara	32°20'S 28°48'E	13–18 Sept. 1977	2	—	G. Avery ( <i>in litt.</i> , 1984)
Mazeppa Bay	32°29'S 28°39'E	15 December 1972	1	adult	Safring records (G3566)
Kobonqaba	32°36'S 28°29'E	1945– 1965	2	—	Pike (1965)
Kei River mouth	32°41'S 28°23'E	25 September 1977	1	adult	Safring records (P4190)



## APPENDIX 3

Number of eggs collected each year at Jackass penguin breeding islands between 1871 and 1968

Year	Island								Source *
	Dassen	Vondeling	Bird (Lambert's Bay)	Jutten	Marcus	Seal (False Bay)	Dyer	All islands	
1871	9 000	34 100	15 200	—	1 600	—	—	59 900	Goodban (1879)
1872	74 300	27 800	2 000	17 000	—	—	—	121 100	Goodban (1879)
1873	50 700	2 000	2 000	51 600	—	3 500	—	109 800	Goodban (1879)
1874	215 000	4 400	1 500	89 000	—	7 500	—	317 400	Goodban (1879)
1875	130 500	1 800	1 000	93 800	—	—	2 000	229 100	Goodban (1879)
1876	118 400	20 500	1 500	61 000	9 000	—	1 500	211 900	Goodban (1879)
1877	130 300	24 000	10 300	90 000	—	—	—	254 600	Goodban (1879)
1878	109 800	5 000	27 900	92 600	—	—	—	235 300	Goodban (1879)
1879-1890	—	—	—	—	—	—	—	No data	
1891	—	—	—	—	—	—	—	500 000	McNaughton (1891)
1892	—	—	—	—	—	—	—	600 000	Currey (1892)
1893	—	—	—	—	—	—	—	285 750	Jackson (1894)
1894-1896	—	—	—	—	—	—	—	No data	
1897	—	—	—	—	—	—	—	762 400	Jackson (1898)
1898	—	—	—	—	—	—	—	693 500	Jackson (1899)
1899	—	—	—	—	—	—	—	801 500	Jackson (1900)
1900	412 000	—	3 500	169 000	49 900	—	4 000	638 400	Jackson (1901)
1901	431 000	—	—	154 000	—	—	26 000	611 000	Jackson (1902)
1902	325 000	—	—	98 000	20 000	Malgas	26 400	469 400	Jackson (1903)
1903	526 500	—	2 600	88 000	—	19 800	13 500	650 400	Jackson (1904)
1904	—	—	—	—	—	—	—	No data	
1905	409 000	76 250	6 100	135 000	43 400	13 000	62 500	745 250	Spence (1906)
1906	484 430	36 500	—	122 400	28 200	—	9 200	680 730	Spence (1907)
1907	457 740	57 690	—	95 580	9 540	—	27 000	647 550	Zeederberg (1908)
1908	480 060	75 060	—	107 900	26 690	—	1 680	691 390	Zeederberg (1909)
1909	399 330	87 480	—	85 912	28 620	—	—	601 342	Zeederberg (1910)
1910	489 240	20 700	—	70 020	33 120	—	—	613 080	Zeederberg (1912a)
1911	436 500	—	—	—	—	—	—	436 500	Zeederberg (1912b)
1912	400 500	—	—	—	—	—	—	400 500	Zeederberg (1913)
1913	—	—	—	—	—	—	—	c. 425 000	Zeederberg (1915)
1914	—	—	—	—	—	—	—	No data	
1915	418 140	66 780	—	63 360	23 760	—	—	572 040	Zeederberg (1917)
1916	424 260	46 800	—	54 360	18 900	—	—	544 320	Zeederberg (1918a)
1917	410 400	—	—	—	—	—	—	410 400	Zeederberg (1918b)
1918	546 300	—	—	—	—	—	—	546 300	Zeederberg (1919)
1919	594 000	—	—	—	—	—	—	594 000	Zeederberg (1921)
1920	485 100	—	—	—	—	—	—	485 100	SFRI (unpubl.)
1921	574 740	—	—	—	—	—	—	574 740	Zeederberg (1922a)
1922	535 680	—	—	—	—	—	—	535 680	Zeederberg (1922b)
1923	184 320	—	—	—	—	—	—	184 320	Zeederberg (1923)
1924	475 920	—	—	—	—	—	—	475 920	Zeederberg (1924)
1925	527 400	—	—	—	—	—	—	527 400	Zeederberg (1925)
1926	489 600	—	—	—	—	—	—	489 600	Zeederberg (1926)
1927	485 460	—	—	—	—	—	—	485 460	Zeederberg (1928)
1928	438 300	—	—	—	—	—	—	438 300	Jackson (1929)
1929	420 120	—	—	—	—	—	—	420 120	Jackson (1930)
1930	413 640	—	—	—	—	—	—	413 640	Jackson (1931)
1931	373 320	—	—	—	—	—	—	373 320	Jackson (1932)
1932	Nil	—	—	—	—	—	—	Nil	Jackson (1933)
1933	Nil	—	—	—	—	—	—	Nil	Jackson (1934)
1934	Nil	—	—	—	—	—	—	Nil	Jackson (1935)
1935	177 977	—	—	—	—	—	—	177 977	Jackson (1936)
1936	Nil	—	—	—	—	—	—	Nil	Hewitt (1937)
1937	Nil	—	—	—	—	—	—	Nil	SFRI (unpubl.)
1938	105 700	—	—	—	—	—	—	105 700	Hewitt (1938)
1939	109 550	—	—	—	—	—	—	109 550	Hewitt (1939)
1940	213 800	—	—	2 700	—	—	900	217 400	Hewitt (1940), SFRI (unpubl.)
1941	247 364	—	—	15 200	500	—	42 500	305 564	SFRI (unpubl.)

## Appendix 3 (continued)

Year	Island								Source *	
	Dassen	Vondeling	Bird (Lambert's Bay)	Jutten	Marcus	Possession (& Pomona)	Dyer	All islands		
1942	Nil	—	—	—	—	—	—	Nil	SFRI (unpubl.)	
1943	174 912	—	—	1 152	—	—	—	176 064	SFRI (unpubl.)	
1944	160 434	—	—	—	—	—	—	160 434	SFRI (unpubl.)	
1945	Nil	—	—	—	—	—	—	Nil	SFRI (unpubl.)	
1946	135 000	—	—	—	—	—	—	135 000	Kruger (1947a)	
1947	129 888	—	—	—	—	—	—	129 888	Kruger (1947b)	
1948	97 128	—	—	—	—	—	—	97 128	Kruger (1949)	
1949	Nil	—	—	—	—	—	—	Nil	Kruger (1950)	
1950	Nil	—	—	—	—	—	—	Nil	Kruger (1950)	
1951	148 608	—	—	—	—	—	—	148 608	Kruger (1951)	
1952	158 856	—	—	—	—	—	—	158 856	SFRI (unpubl.)	
1953	Nil	—	—	—	—	—	—	Nil	SFRI (unpubl.)	
1954	148 220	—	—	—	—	—	—	148 220	SFRI (unpubl.)	
1955	Nil	—	—	—	—	—	—	Nil	SFRI (unpubl.)	
1956	126 816	—	—	—	—	4 512	—	131 328	SFRI (unpubl.)	
1957	98 640	—	—	—	—	—	—	98 640	SFRI (unpubl.)	
1958	Nil	—	—	—	—	—	—	Nil	SFRI (unpubl.)	
1959	79 440	—	—	1 368	—	—	—	80 808	SFRI (unpubl.)	
1960	Nil	—	—	—	—	—	—	Nil	SFRI (unpubl.)	
1961	Nil	—	—	—	—	—	—	Nil	SFRI (unpubl.)	
1962	Nil	—	—	—	—	—	—	Nil	SFRI (unpubl.)	
1963	Nil	—	—	—	—	—	—	Nil	SFRI (unpubl.)	
1964	47 160	—	—	Nil	—	—	—	47 160	SFRI (unpubl.)	
1965	43 728	—	—	11 856	—	—	—	55 584	SFRI (unpubl.)	
1966	12 313	—	—	—	—	—	—	12 313	SFRI (unpubl.)	
1967	10 056	—	—	3 600	—	—	—	13 656	SFRI (unpubl.)	
1968	Cessation of commercial egg collecting									

\* SFRI denotes Sea Fisheries Research Institute, Cape Town  
 Nil signifies an explicit statement that no eggs were collected