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RECENT POPULATION TRENDS OF AFRICAN PENGUINS *SPHENISCUS DEMERSUS* IN NAMIBIA

*J. KEMPER**†, *J-P. ROUX**, *P. A. BARTLETT**, *Y. J. CHESSELET**, *J. A. C. JAMES**, *R. JONES**, *S. WEPENER** *and F. J. MOLLOY*†

The African penguin *Spheniscus demersus* is endemic to southern Africa and is listed overall as "vulnerable". Over the past century, however, the Namibian population has been severely reduced and is currently listed as "critically endangered". Recent trends at Possession, Halifax, Ichaboe and Mercury islands, which account for 97% of the Namibian population, were examined using counts of moulting adults and active nests at peak breeding. Since 1996, the adult population has decreased at a rate of 2.6% per year. Since 1990, the breeding population has decreased by 3.7% per year. Mercury Island is the only Namibian breeding site where penguin numbers are increasing. Improving the conservation status of the species is critical. Better management strategies need to be identified and implemented.

Key words: African penguin, census methods, conservation management, Namibia, population estimates, population trends, *Spheniscus demersus*

The African penguin *Spheniscus demersus* is endemic to the coasts of South Africa and Namibia. Over the past century, numbers have been severely reduced. Various factors have been implicated in this decline. These include historical exploitation and disturbance by humans, such as egg collecting and guano harvesting (Frost *et al*. 1976), insufficient prey (Crawford and Shelton 1981), competition with other animals and humans for space and food (Crawford *et al.* 1989, David 1989), oiling (Williams 1993, Underhill *et al.* 1999) and predation (Marks *et al.* 1997, Du Toit in prep.). Breeding by African penguins is restricted to suitable, predator-free sites such as offshore islands. Penguins historically bred at 14 islands in southern and central Namibia (Whittington *et al*. 2000), but now breed at just eight islands and one mainland site in this region (Fig. 1). By the early 1990s, Mercury and Ichaboe islands were the only breeding sites in Namibia to support more than 1 000 breeding pairs (Crawford *et al*. 1995).

As a result of its severe decline, the African penguin is listed as globally "vulnerable" according to IUCN Red Data criteria (Ellis *et al*. 1998), with the Namibian population classified as "critically endangered" (Robertson *et al.* 1998). Population estimates for the African penguin were last revised in 1994 (Crawford *et al*. 1995). This paper presents population information for the most important breeding colonies in Namibia over the past decade, considers recent (1990–1999) and long-term (1956–1999) trends and highlights the need for better management strategies to improve the conservation status of the species.

MATERIAL AND METHODS

Counts of African penguins at breeding sites in Namibia were first made in 1956 by means of aerial photographs (Rand 1963). Counts of moulting birds and active nests at peak breeding are currently used to obtain population estimates for the species (Crawford *et al*. 1990, 1995). African penguins moult once a year, usually at their breeding island (Randall 1989), although this statement requires further verification (Crawford *et al*. 2000). During the feather-shedding stage, which lasts on average 12.7 days (Randall *et al.* 1986), they are land-bound. Bimonthly counts of moulting adults were used to estimate the number of adult penguins at breeding localities in Namibia, where the moulting period can last throughout the year, with no distinct moulting peak. Using Underhill and Crawford's (1999) method, counts were interpolated linearly between actual counts to calculate daily numbers of moulting birds. Daily tallies were summed for each year from July to June and divided by 12.7 to estimate the number of birds moulting per year.

Counts of active nests, i.e. nests containing eggs or chicks, conducted monthly were used to estimate the proportion of breeding adults in a population and to trace the proportion of adults breeding in a given year (July–June). At each island, trends in the peak count of active nests during the period July–June were used as an indication of trends in the breeding population. Trends calculated from peak nest counts assume that breeding synchrony at a particular breeding site does

* Ministry of Fisheries and Marine Resources, P.O. Box 394, Lüderitz, Namibia. E-mail: jkemper@mfmr.gov.na
† Department of Biology, University of Namibia, Private Bag 13301, Windhoek, Namibia

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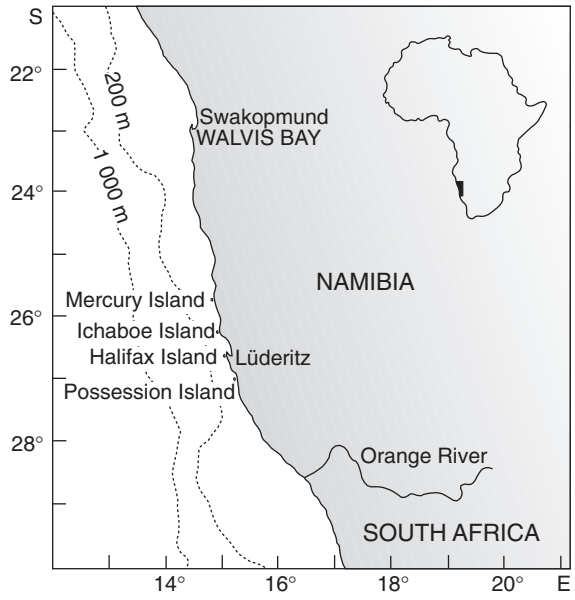

Fig. 1: Locations of African penguin breeding sites in Namibia

not change over time, yielding comparable annual estimates. Clutch replacements and second clutches, which can result in several breeding peaks, are not accounted for.

Counts of moulting birds and active nests were conducted regularly at Possession, Ichaboe and Mercury islands from 1996, 1992 and 1991 respectively. These islands are permanently staffed. Data for Mercury Island were few in 1991 and not available for 1993. Less regular counts were done at Halifax Island from 1996. Only sporadic counts of active nests and no moult counts are available for the other breeding localities of African penguins in Namibia. In the early 1990s, these other localities together contributed <3% of the overall Namibian population (Crawford *et al*. 1995), and they are not considered here.

Some counts of active nests for all islands are listed by Crawford *et al*. (1995), and information on numbers of adults is provided by Rand (1963). Although some of these data are not strictly comparable, because they include extrapolations from head counts and active nests were defined as nests containing eggs or chicks or defended by an adult penguin (Crawford *et al*. 1990), they are nevertheless useful for examining long-term trends for the colonies.

Exponential curves were fitted by least-squares regression to estimate population trends at each of the four islands as well as for the four islands combined.

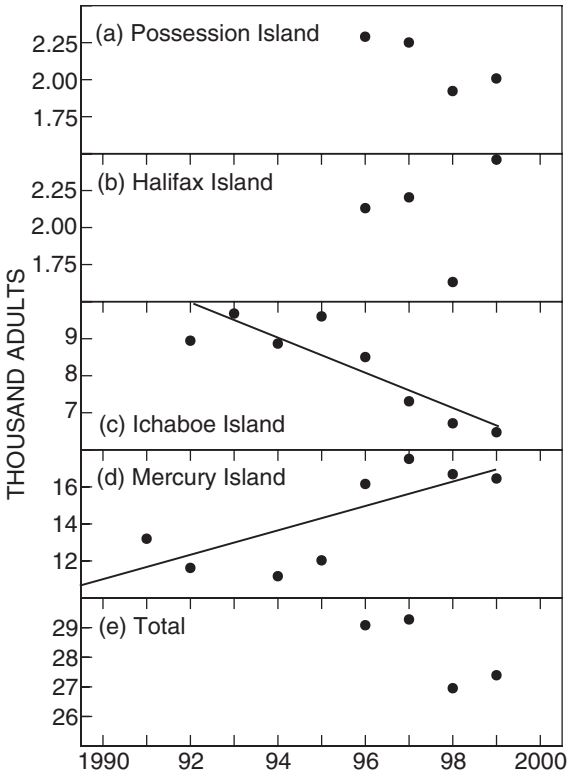

Fig. 2: Numbers of African penguin adults estimated from moult counts between 1991 and 1999 at (a) Possession Island, (b) Halifax Island, (c) Ichaboe Island, (d) Mercury Island and (e) these four breeding sites combined

RESULTS

Recent population trends (1990–1999)

Regression details for population trend lines are listed in Table I. Only significant trends are reported. Between 1996 and 1999, numbers of adult penguins at Possession Island (Fig. 2a) decreased from 2 300 to 2 000 individuals, an annual rate of decrease of 5.5%. Since 1996, the adult population at Halifax Island fluctuated between 1 600 and nearly 2 500 individuals (Fig. 2b) and, apart from 1998, appears stable. Ichaboe Island has the second largest population of African penguins in Namibia. Since 1992, this colony has decreased by more than 3 000 adult penguins, at a rate of loss of 5.7% per year (Fig. 2c). The annual rate of decrease after 1995 was 10.3%. Mercury

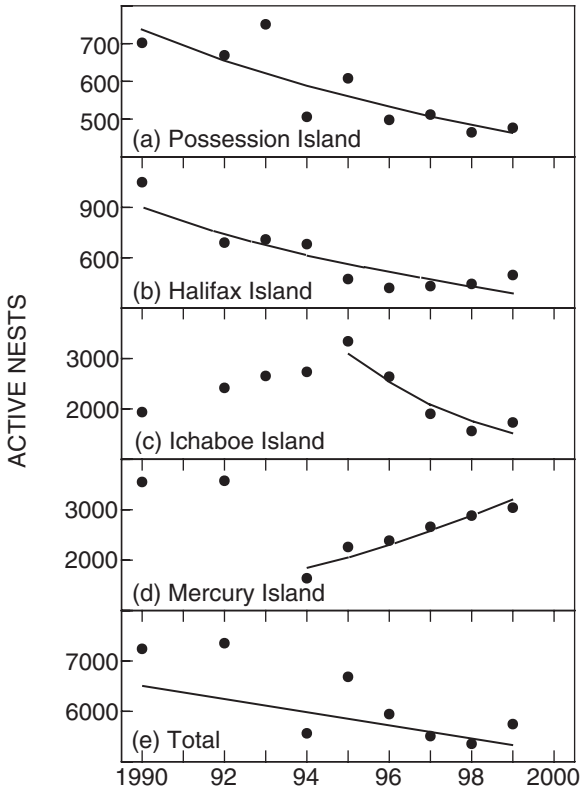

Fig.3: Numbers of active nests of African penguins at peak breeding as an indication of breeding population trends between 1990 and 1999 at (a) Possession Island, (b) Halifax Island, (c) Ichaboe Island, (d) Mercury Island and (e) these four breeding sites combined

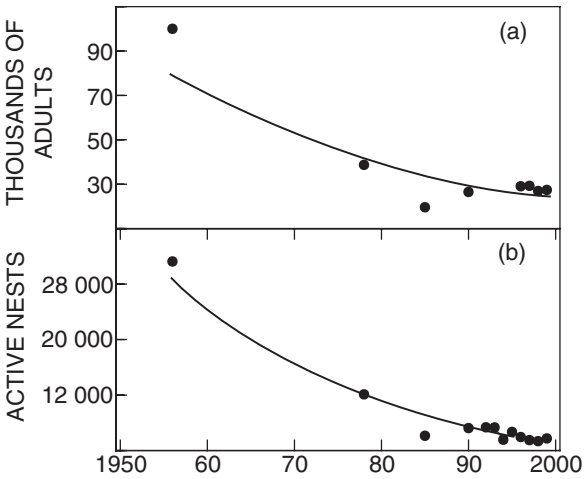

Fig. 4: Trends for the Namibian population of African penguins of (a) number of adults (b) number of active nests at peak breeding, 1956–1999. Historical data are from Rand (1963) and Crawford *et al.* (1995)

Island supports the largest number of African penguins in Namibia. Since 1992, the number of adults has increased by 5 000 (7% per year, Fig. 2d). The colony was stable between 1992 and 1995, and then increased by more than 4 000 adults between 1995 and 1996. It decreased slightly from 17 513 adults in 1997 to 16 453 adults in 1999. Overall, the population of adult penguins at the four most important breeding sites in Namibia decreased by 2.6% per year since 1996, from 29 000 in 1996 to fewer than 27 500 in 1999 (Fig. 2e).

Active nests at peak breeding decreased at Possession Island from a maximum of 750 nests in 1993 to 477 nests in 1999, a decrease of 5.3% per year (Fig. 3a). Numbers fell abruptly in 1994, increased in 1995 and then decreased more gradually. At Halifax Island the peak count of active nests halved during the 1990s, with an annual rate of loss of 9.3% (Fig. 3b). The main decreases were between 1990 and 1992 and in 1995. Subsequently, the number of active nests remained stable. At Ichaboe Island, numbers of active nests at peak breeding decreased at a rate of 3.4% per year between 1990 and 1999, but at a rate of 18.4% per year after 1995 (Fig. 3c). Between 1990 and 1995, numbers increased gradually; there was a rapid decrease after 1995. Peak numbers of active nests at Mercury Island fell from 3 600 in 1992 to 1 600 in 1994. After 1994, the number increased steadily at a rate of 11.2% per year to just over 3 000 nests in 1999 (Fig. 3d). Overall, the number of active penguin nests at peak breeding decreased from 7 200 in 1990, to 5 700 in 1999, a loss of 3.7% per year (Fig. 3e). There was a steep decline in numbers of active nests during 1994, followed by partial recovery in 1995, and then a steady decrease until 1998. Since 1996, trends in the overall counts of adult birds and of active nests have been similar.

Long-term population trends (1956–1999)

Since the 1950s, the population of adult African penguins in Namibia has decreased by about 72%, to fewer than 27 500 adults, or 5 700 active nests at peak breeding (Fig. 4). The decrease in the adult population has been at a rate of 2.8% per year, and of

Table I: Trends for the adult and breeding populations of African Penguins obtained from counts of moulting birds and active nests at breeding (see Fig. 2 and Fig. 3 for trend lines). Observed rates of change ($\bar{r}$), squared correlation coefficients (r^2) and probability values (p) are shown. Only significant trends are reported

Breeding Site	Adult population trend					Breeding population trend				
	Years	n	$\bar{r}$	r^2	p	Years	n	$\bar{r}$	r^2	p
Possession Island	1996–1999	4	–	–	–	1990–1999	9	-0.0527	0.72	0.008
Halifax Island	1996–1999	4	–	–	–	1990–1999	9	-0.0929	0.77	0.004
Ichaboe Island	1992–1999	8	-0.0571	0.78	0.004	1995–1999	5	-0.1841	0.85	0.002
Mercury Island	1991–1999	8	0.0699	0.73	0.014	1994–1999	6	0.1122	0.89	0.027
Total (1990–1999)	1996–1999	4	–	–	–	1990–1999	8	-0.0367	0.66	0.005
Total (1956–1999)	1956–1999	8	-0.0281	0.71	0.009	1956–1999	12	-0.0397	0.92	<0.001

active nests at peak breeding at 4% per year. Both in terms of numbers of adults and active nests at peak breeding, the most severe decrease was between 1956 and 1985. Since then, losses have been more gradual. The two trends do not differ significantly from each other.

DISCUSSION

Since the 1950s, when the Namibian breeding localities supported nearly 100 000 adult penguins, roughly 33% of the global population of African penguins, the adult population in Namibia has been reduced by more than 72% to only 27 500 individuals. This figure now represents about 15% of the global population (Crawford *et al*. 1995, Ellis *et al*. 1998). The severe decrease between the 1950s and 1985 can be attributed mainly to exploitation of eggs and associated disturbance (Frost *et al.* 1976), as well as to scarcity of food (Crawford and Shelton 1981). Although the rate of decrease slowed after 1985, penguin numbers continue to decline.

In the 1950s, Possession Island supported the largest population of African penguins in Namibia, with an estimated 46 000 adults (Rand 1963). Currently, Possession Island has just 2 000 adults, which contribute fewer than 500 nests in the main breeding season. Numbers are still declining. At Halifax Island, which supported an estimated 10 000 adults in 1956 (Rand 1963), numbers have decreased by 75%. At both these islands, some breeding colonies have become extinct, whereas others have shrunk and are fragmented (Cordes *et al*. 1999). The steep decrease of penguin numbers at Ichaboe Island since 1995 is of concern. Mercury Island appears to be the only Namibian breeding site where numbers of penguins are increasing.

Differences in population trends between islands appear related to abundance and distribution of food. Overharvesting caused the collapse of sardine *Sardinops sagax* stocks in the late 1960s and early 1970s (Crawford and Shelton 1981). Remaining stocks of sardine off Namibia are now well to the north of the penguin breeding localities. At colonies north of Lüderitz, penguins switched their diet to pelagic goby *Sufflogobius bibarbatus* (Crawford *et al*. 1985). South of Lüderitz, they now feed mainly on cephalopods.

The sudden decrease in numbers of moulting penguins and of active nests at most breeding sites during 1994 and 1995 may be linked to oceanographic anomalies in 1994 and 1995 off Namibia. Unusually low levels of oxygen off central Namibia in 1994 caused fish mortalities and changes in fish distribution (Hamukuaya *et al.* 1998, Kristmannsson 1999). In 1995, an event known as the Benguela *Niño*, characterized by abnormally high sea temperatures, brought about further decreases in fish abundance off northern and central Namibia (Gammelsrød *et al*. 1998). In Peru, a sudden decrease in fish stocks during the 1982–1984 *El Niño* caused large-scale mortalities of a variety of seabirds, including Humboldt penguins *Spheniscus humboldti*. Birds were forced to disperse much farther from colonies in search of food, and there was complete breeding failure of Humboldt penguins (Hays 1986, Duffy 1989). The low numbers of active nests at peak breeding in 1994 at most Namibian breeding sites, particularly Possession and Mercury islands, may be the result of breeding failure or absenteeism during that year, as has been reported for Robben Island by Crawford *et al*. (1999). If oceanographic anomalies in 1994 and 1995 only affected breeding success at the time, the numbers breeding should have increased again in following years. However, numbers of active nests at peak breeding did not recover to pre-1994 levels at any of the four islands considered. The incomplete nature of

trends in numbers of adult penguins precludes consideration of any trend between 1990 and 1995.

Data are too few to detect an overall decrease in adult numbers after 1994/95, but there was a marked change in trend after 1995, when penguin numbers simultaneously dropped at Ichaboe Island and rose at Mercury Island. Therefore, it appears that climatic events in 1994 and 1995 not only caused breeding failure, but possibly emigration of individuals from southern Namibian islands to Mercury Island. However, immigration to Mercury Island was insufficient to offset losses elsewhere and the Namibian population of African penguins is still decreasing, suggesting lower adult survival after 1995 or emigration south of Namibia.

Crawford *et al*. (1995) concluded that penguin populations south of Lüderitz were decreasing, whereas populations north of Lüderitz appeared stable. However, the most recent trends show that the range of decreasing colonies has extended farther north, with numbers decreasing at all breeding sites south of Mercury Island. Apart from a small mainland breeding site at Sylvia Hill (42 breeding pairs in November 2000), and Hollamsbird Island, which possibly supports one breeding pair of African penguins (Crawford *et al*. 1995), Mercury Island represents the northernmost breeding site for the species. However, owing to its small size (3 ha) and steep topography, it is doubtful whether it can support many more penguins than it does now.

Trends obtained from active nest counts were generally similar to those of moulting adults. Interpretation of the trend in counts of active nests as reflecting the trend in the population depends upon the degree of synchrony in breeding, nest failure before the count and the proportion of adults breeding remaining the same between seasons. Whereas large breeding colonies may have synchronous breeding, breeding at small or fragmented breeding colonies is potentially less synchronized (Kemper *et al*. in prep.). Counts of active nests could therefore underestimate the true breeding population. However, while serial moult counts conducted throughout the year tend to give more accurate estimates of penguin populations, application of this technique is more laborious and often not feasible at unstaffed, remote breeding sites. Further, recent information indicates that some birds in adult plumage, perhaps pre-breeders, may not always moult at the same locality (Crawford *et al*. 2000). Therefore, counts of active nests are still widely applied. The definition of an active nest tends to vary, making counts not strictly comparable. Effort should be made to standardize counting techniques throughout the range of the African penguin.

Conservation management

Small, fragmented colonies have a higher edge to centre ratio. As edges are more exposed, they tend to be more susceptible to disturbance and predation. Nests at the edge of a colony have been shown to have lower breeding success than nests in the centre of a colony (Siegfried 1977, van Heezik *et al*. 1995). Further, there is less synchrony in breeding at sites with small, fragmented colonies, such as at Possession and Halifax islands, than at sites with large, relatively continuous colonies, such as at Ichaboe and Mercury islands (Kemper *et al*. in prep.).

Conservation efforts to date centre mostly on protecting breeding colonies by restricting access and thus limiting further human disturbance. However, stronger management measures need to be identified and implemented to ensure the long-term survival of the species. As prey abundance is unlikely to recover, at least in the short term, efforts will need to concentrate on improving breeding habitat, for example by providing suitable, artificial shelters on the islands to encourage breeding and to boost breeding success. The possibility of re-establishing breeding colonies at historical breeding sites should be considered. Measures need to be put in place to prevent further fragmentation of colonies and to encourage already fragmented colonies to merge, for example, by linking colony fragments with artificial shelters. The effects of oceanographic variability on prey availability in southern and central Namibia clearly warrants further investigation.

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