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Results of the 2001 census of African penguins *Spheniscus demersus* in South Africa: first measures of the impact of the *Treasure* oil spill on the breeding population

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The *Treasure*, a bulk ore carrier, sank between Dassen and Robben islands on 23 June 2000. Subsequently, more than 19 000 African penguins *Spheniscus demersus* were oiled. A further 19 500 unoiled penguins were caught at Dassen and Robben islands and relocated to Cape Recife in the Eastern Cape to prevent them from becoming oiled. Despite concerns about the negative impacts of the incident on the penguin breeding population, especially on Dassen and Robben islands, the number of penguin breeding pairs in South Africa increased by 14% between 2000 and 2001. The increase appears to be related to an abundance of the two most important prey items of the African penguin, anchovy *Engraulis capensis* and sardine *Sardinops sagax*, in 2001. A larger proportion of clean penguins that were relocated to Port Elizabeth bred in 2001 than penguins that were oiled and cleaned. The results highlight the importance of oiling and rehabilitation and availability of food, especially of anchovy and sardine, for the future conservation of the African penguin.

INTRODUCTION

The African penguin *Spheniscus demersus* is a "Vulnerable" species (Ellis *et al.*, 1998; BirdLife International, 2000), endemic to southern Africa (Crawford & Whittington, 1997; Crawford, 2000). Its breeding range extends from Hollamsbird Island, Namibia, to Bird Island, Algoa Bay, South Africa. The total breeding population decreased by at least 90% during the 20th century. It is estimated that, at Dassen Island alone, some 1.45 million adult penguins inhabited the island in the 1930s (Shannon & Crawford, 1999). The total population size during the early 1990s was estimated to be about 180 000 penguins, and to be decreasing at a rate of 2% per year (Crawford *et al.*, 1995; Ellis *et al.*, 1998; Whittington *et al.*, 2000).

Factors implicated in the decline of the African penguin include egg exploitation and habitat alteration and disturbance associated with commercial exploitation of guano (Whittington *et al.*, 2000). These activities have largely ceased and so do no longer pose a significant threat to the species. More recently, reduced availability of pelagic fish due to competition with commercial fisheries has been responsible for persistent declines in numbers breeding off southern Africa's west coast (Crawford *et al.*, 1990; Crawford *et al.*, 2001). Other factors include mortality in oil spills, competition with Cape fur seals *Arctocephalus pusillus* for breeding space, predation by feral cats *Felis catus* and kelp gulls *Larus dominicanus*, and entanglement in fishing gear and other marine debris. The two major current threats to African penguins are marine pollution, at both chronic and crisis levels, and competition with commercial fisheries for food (Whittington *et al.*, 2000).

Low-level oiling events occur nearly continuously, and are caused mainly by illegal bilge pumping and accidental spillage from ships (Adams, 1994). Occasional crisis events affect thou-

sands of penguins over short periods. After nearly two decades without a major oiling incident, the African penguin population experienced two such events in six years. The bulk iron-ore carrier *Apollo Sea* sank south-west of Dassen Island on 20 June 1994 and resulted in the oiling of approximately 10 000 penguins (Underhill *et al.*, 1999).

The *Treasure*, also a bulk ore carrier, sank between Robben and Dassen islands on 23 June 2000. The ship was carrying about 1400 tons of heavy fuel oil (Crawford *et al.*, 2000). When the *Treasure* sank, the annual breeding census on Dassen and Robben islands had recently been completed. The results indicated that these two islands held the largest and third largest colonies of African penguins, respectively. In the spill following the sinking of the *Treasure*, more than 19 000 penguins were oiled; in addition, a further 19 500 unoiled penguins were collected at Dassen and Robben islands and were evacuated to Cape Recife in the Eastern Cape, to prevent them from becoming oiled. The *Apollo Sea* and *Treasure* incidents represent the two worst oil spill events in South Africa in terms of the numbers of seabirds known to have been affected (Crawford *et al.*, 2000).

Research conducted on survivors of the *Apollo Sea* oil spill in 1994 indicated that oiled African penguins that are cleaned, treated and released have a survival rate that is as high as that for birds that are not oiled, both in the short and long term (Underhill *et al.*, 1999; Whittington, in press). This can be attributed to the robust nature of the penguin and the world-class rehabilitation facilities and expertise available in South Africa, and specifically at the Southern African Foundation for the Conservation of Coastal Birds (SANCCOB). The research which monitored the penguins oiled in the *Apollo Sea* spill for six years also demonstrated that oiling has an impact on the breeding biology of some penguins. It causes a disruption of

Table 1. Counts of active nests of African penguins at South African colonies in 2000 and 2001. The small colony at Geyser Island was not counted in either year.

	2000	2001	Percentage change
West Coast			
Lambert's Bay	5 June 11	13 August 15	36.00
Malgas Island	19 April 48	11 June 55	14.58
Marcus Island	22 April 96	21 April 114	18.75
Jutten Island	21 April 898	20 April 1338	49.00
Vondeling Island	19 April 528	18 April 649	22.92
Dassen Island	22–27 April 15598	17–24 April 18193	16.63
Robben Island	17 May–14 June 5177	16–23 June 6114	18.09
Total	22356	26478	18.44
False Bay–Southern Cape			
Boulders	12 June 899	21 June 983	9.34
Seal	10 November 52	22 October 56	7.69
Stony Point	12 May 104	20 June 111	6.73
Dyer Island	13 May 2220	19–27 March 2088	–5.95
Total	3275	3238	–1.13
Eastern Cape			
Jahleel Island	30 May 538	No count	
Brenton Island	30 May 32	No count	
St Croix Island	30 May 15211	17 May 16950	11.43
Seal Island	31 May 433	30 May 345	–20.32
Stag Island	31 May 24	30 May 24	0.00
Bird Island	31 May 4093	1 May 5376	31.35
Total	20331	22695	11.63
South African total	45962	52411	14.03

pair bonds, delayed breeding after returning to their colony and, for some (about 40%), not breeding at all during the entire monitoring period. However, de-oiled birds that do attempt breeding are as successful as unoiled birds (Western Cape Nature Conservation Board, unpubl. data).

We predicted that the *Treasure* oil spill would have a negative influence on breeding during 2001, especially on Dassen and Robben islands and that the number of breeding birds would show a decrease (Crawford *et al.*, 2000). This prediction was based primarily on the death of about 2000 penguins during the spill, about 3% of the population on these two islands in 2000. In addition, there was massive disturbance to the colonies at Robben and Dassen islands during the rescue operation and a large proportion of breeding attempts in 2000 was destroyed at either the egg or nestling stage. A more subtle source of reduced breeding success in 2001 was expected to result from birds being separated from their mates during the rescue operation. Unoiled birds were evacuated to Cape Recife, while oiled birds were held in captivity for variable periods during cleaning and treatment. This was likely to disrupt pair bonds, so that many pairs would be breeding together for the first time in 2001, a condition predicted to reduce breeding success (Crawford *et al.*, 2000).

This paper deals with the results of the 2001 census of African penguins in South Africa in the year immediately following the *Treasure* spill. It also considers the re-sightings of two groups of penguins at Dassen Island, which were involved in this spill and which were flipper-banded: penguins that were oiled and cleaned; penguins that were relocated to Port Elizabeth and returned to Dassen Island.

METHODS

Counts of active nest sites of African penguins have been conducted at many South African colonies since the late 1980s, annually or at a higher frequency. Most counts were conducted during the main breeding season, which is February–September in western South Africa (Crawford *et al.*, 1995) or January–June in Algoa Bay (Randall & Randall, 1981). In this paper we compare counts in 2000 and 2001. Where more than one count was made in a year (up to 12 counts were made at some localities), we have used the highest count obtained in that year. Counting methods have been described by Shelton *et al.* (1984) and Crawford *et al.* (1990). A site was considered active if it contained eggs or chicks, if it was defended by an adult bird, or if there were clear signs of recent nest-building activity. Crèching chicks were divided by two to estimate the number of nest sites they represented, with remainders taken to represent an additional site – for example crèches of five and six chicks would both be taken to represent three nests (Shelton *et al.*, 1984). Larger colonies, such as those at Dassen and Robben islands, were divided into well-defined units separated using clearly distinguishable features, such as walls, roads and tree lines. At both localities, nests were marked once counted by making a cross in the sand to prevent recounting. The marks also helped to ensure that all nests were counted. Limited time and capacity did not permit multiple counting necessary to estimate census accuracy but from previous observations we believe that error on counts will be not more than 5%. Disadvantages of using counts of active nest sites to assess trends in populations of African penguins include inter-season variation in the pro-

Table 2. Summary of results from the monitoring of *Treasure* oil spill penguins at Dassen Island. Figures are cumulative.

	Until 10/12/2000	Until 27/03/2001	Until 31/05/2001
Total number of banded birds evacuated from Dassen Island to Cape Recife	1130	1130	1130
Total no. of banded evacuees retrapped at Dassen Island during period	478	550	625
Percentage of total	42.3%	48.6%	55.3%
Total number of banded evacuees recorded breeding during period	205	274	376
Percentage of total	18.1%	24.2%	33.2%
Total number of oiled adult penguins removed from Dassen Island for cleaning	2744	2744	2744
Number of adult rehabilitees retrapped during period	644	920	1234
Percentage of total	23.5%	33.5%	44.9%
Total number of adult rehabilitees recorded breeding during period	17	78	195
Percentage of total	0.6%	2.8%	7.1%

portion of birds that breed (Crawford & Dyer, 1995) and undercounting as a result of birds being absent from nest sites for various reasons (Randall *et al.*, 1986).

An intensive programme to re-sight flipper-banded penguins was instituted on Dassen Island immediately after the *Treasure* oil spill. All areas of the island where penguins breed were covered, as well as the sections of shoreline where penguins congregate. Each flipper band has a unique number, which can be read from a distance of over 50 m with a telescope. When each banded penguin is re-sighted, its activity (breeding, moulting or "loafing in colony") is noted and entered into a database for further analysis.

RESULTS

The information from all South African colonies that were surveyed indicates that 2001 was a good breeding year for African penguins, with an overall year-on-year increase in the number of breeding pairs of 14% (Table 1). Based on counts of active nest sites, the number of breeding pairs at Dassen Island, presently the largest African penguin colony, increased from 15 598 counted in April 2000 to 18 193 in April 2001, an increase of about 17%. At Robben Island, where most oiled penguins were found in 2000, the number of breeding pairs in 2001 showed an 18% increase on the count in 2000. All of the penguin colonies on islands in Saldanha Bay (Marcus, Malgas, Jutten and Vondeling islands) had larger numbers of breeding pairs in 2001 compared to 2000, and Bird Island in Algoa Bay had the largest number of penguin breeding pairs ever recorded there (Table 1). The number of penguins breeding at St Croix Island in Algoa Bay, the second largest colony of African penguins, also increased in 2001 (Table 1).

Just less than a year after the *Treasure* oil spill, 55.3% of the total number of flipper-banded penguins that were evacuated from Dassen Island had been re-sighted on the island, while 44.9% of flipper-banded de-oiled penguins had been re-sighted during the same period (Table 2). The proportions of evacuated

and de-oiled penguins that were flipper-banded recorded breeding by the end of May 2001 were 33% and 7%, respectively (Table 2).

DISCUSSION

Against the background sketched in the Introduction, the results of the 2001 African penguin census were surprising. The increase in the number of penguins breeding in 2001 can be attributed to several factors.

An abundance of food for penguins in 2001 clearly contributed towards the increase in numbers. The combined spawner biomass of anchovy *Engraulis capensis* and sardine *Sardinops sagax*, the two most important prey items for African penguins (Crawford & Dyer, 1995), in South African waters in 2001 was double any previous estimate obtained by a direct survey (Figure 1) (van der Lingen *et al.*, 2001). Observations at Robben Island have shown that the number of breeders in the population may vary from year to year according to the availability of food, with up to 30% of the breeding population not breeding in years of food scarcity (Crawford *et al.*, 1999). The abundance of food for penguins in 2001 is likely to have resulted in a large percentage of birds of breeding age attempting to breed (although see results below for de-oiled birds). Increased recruitment over the last few years doubtless has also contributed to the growth in penguin numbers. Penguins recruit to the breeding population at 3–4 years of age, and the past 3–4 years have been markedly better food years than earlier years (Figure 1) (Barange *et al.*, 1999; van der Lingen *et al.*, 2001).

Therefore, the anticipated adverse impact of the *Treasure* oil spill has fortuitously been offset by favourable feeding conditions, which appear to be the result of careful management of the sardine resource over the past two decades with the intent to rebuild it (Beckley & van der Lingen, 1999); and favourable environmental conditions in recent years, which have resulted in good year-classes of anchovy (e.g. van der Lingen *et al.*, 2001).

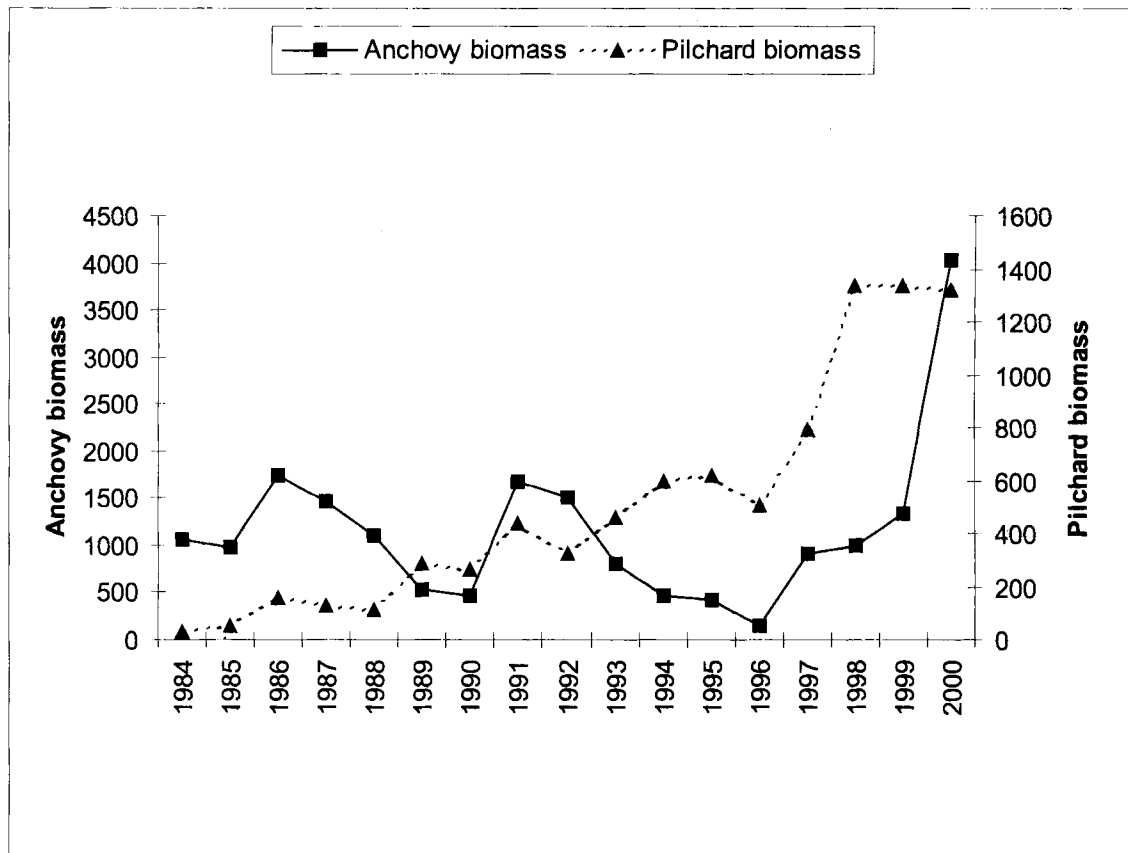


Figure 1. End-of-year estimates of anchovy and pilchard biomass (in thousands of tons) from Marine and Coastal Management surveys.

The increased breeding populations observed in 2001 would have been even better if the oil spill had not occurred. Monitoring conducted at Dassen Island indicates that 45% of the oiled birds that had been removed from Dassen Island had been seen by the end of May 2001, and that 16% of these had been recorded breeding at this stage. For unoiled birds that were evacuated to Cape Recife, 55% had been re-sighted and of these 60% had been recorded breeding by the end of May. The proportion of breeders among the unoiled birds was approximately four times larger than that of the birds that had been oiled. This observation is consistent with results obtained from monitoring *Apollo Sea* survivors, where close to 40% of de-oiled birds had not been recorded breeding even six years after the spill. Therefore, it appears that a significant number of the approximately 16 300 birds that were cleaned and released after the *Treasure* spill have not yet attempted breeding, and that the increase in the number of breeding pairs in 2001 is largely due to new recruits to the breeding population and a higher proportion of breeders amongst birds that were not oiled during the *Treasure* oil spill.

It is important to note that all the figures reported above for Dassen Island are minimum figures, and are based on the number of birds that have actually been re-sighted or recorded breeding by observers. Although an intensive effort has been made on Dassen Island to re-sight birds oiled in the *Treasure* spill, only half of the breeding birds are at their nests on the island at any time, and the "off-duty" birds are at sea foraging. In addition the island is large, with 18 193 active nests counted in 2001. Experience after the *Apollo Sea* spill demonstrated that, even after five years of intensive fieldwork, banded penguins were still being encountered by observers for the first time since their release (Underhill *et al.*, 2000). For this reason, the true percentages are larger than those reported above.

The data do, however, highlight the difference between the de-oiled and evacuated birds. The most notable difference between these two groups lies in the proportion of returned birds that have attempted breeding (Table 2). Although a larger percentage of evacuees have been observed back on Dassen Island than de-oiled birds, the percentage of returned birds that have been recorded breeding is disproportionately greater for the evacuated birds. This difference is likely to result from a number of factors.

First, the evacuated birds were, on average, away from the island for a shorter period (two to three weeks) than the birds that were de-oiled (an average of six weeks between being captured oiled and being released after treatment at SANCCOB). This would result in a greater disruption to breeding and moult cycles and to pair bonds for the de-oiled birds. The *Apollo Sea* spill disrupted the moult cycles of de-oiled breeding penguins at Robben Island (Underhill & Crawford, 1999) and a similar disruption occurred after the *Treasure* spill (Hemming, 2001).

Second, the evacuated birds were not oiled and so did not suffer any of the harmful biological effects of oiling. Research after the *Apollo Sea* spill showed that there were short-term effects of oiling on the reproductive biology of penguins, which resulted in, amongst other things, delayed breeding for some penguins (Western Cape Nature Conservation Board, unpubl. data). Another factor that may have influenced the results presented here is that the birds were evacuated from specific areas, whereas the oiled birds from Dassen Island were collected from a much wider area and oiled birds from other colonies may have come ashore at Dassen Island (see Underhill *et al.*, 1999). This makes it easier to re-sight the evacuees, and may therefore bias the comparison. It is still too early to quantify the importance of each of these aspects accurately. It is necessary that monitoring continues so that we improve our understanding of these factors,

and to use this understanding to improve our management of the next oil spill, large or small.

The results reported here highlight the importance of two factors for the future of the African penguin: oiling, and the availability of pelagic fish as a food resource. The results show that wise management of fish stocks aimed at increasing the stock of pelagic fish will have a positive effect on the conservation status of the African penguin. Better management of the oil pollution problem, and specifically reducing the frequency of oiling incidents and the number of penguins becoming oiled, will also have a positive impact on the African penguin. While the increase in numbers of penguins breeding in South Africa in 2001 is encouraging, it is important to note that the African penguin population in Namibia continues to decline (Crawford *et al.*, 2001; Kemper *et al.*, 2001).

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