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Mortality and survival of African Penguins *Spheniscus demersus* involved in the *Apollo Sea* oil spill: an evaluation of rehabilitation efforts

LESLIE G. UNDERHILL[1]*, PETER A. BARTLETT[2], LUKAS BAUMANN[3], ROBERT J.M. CRAWFORD[4], BRUCE M. DYER[4], ANDRE GILDENHUYS[5†], DEON C. NEL[5], TERENCE B. OATLEY[1], MEREDITH THORNTON[1], LEISHA UPFOLD[4], ANTHONY J. WILLIAMS[5], PHILIP A. WHITTINGTON[1] & ANTON C. WOLFAARDT[5]

[1]*Avian Demography Unit, Department of Statistical Sciences, University of Cape Town, Rondebosch, 7701 South Africa*

[2]*National Marine Information and Research Centre, PO Box 912, Swakopmund, Namibia*

[3]*Department of Synecology, Zoological Institute, University of Berne, Switzerland*

[4]*Sea Fisheries Research Institute, Private Bag X2, Roggebaai, 8012 South Africa*

[5]*Cape Nature Conservation, Private Bag X9088, Cape Town, 8000 South Africa*

The bulk ore carrier *Apollo Sea* sank near Dassen Island, South Africa, on 20 June 1994 during a period of winter storms. Approximately 10 000 African (Jackass) Penguins *Spheniscus demersus* were oiled, collected and transported to the SANCCOB rescue centre; 5213 were released after cleaning, 4076 with flipper bands. We believe that most of the penguins oiled during this incident reached an island or the mainland alive, and that there was no mass mortality in the wild at the time of the oil spill. Birds from all parts of the breeding range were oiled, but most were from Robben and Dassen Islands. The overwhelming majority of released birds made the transition from the rescue centre to the wild successfully; 2652 had been resighted at breeding colonies within two years of their release; the cumulative number of birds was increasing steadily and an asymptote had not been reached by August 1996. There was a wide dispersal of released penguins, with recoveries and resightings over 1800 km of coastline between Algoa Bay and Walvis Bay.

Sharp (1996) analysed the effectiveness of programmes to rescue oiled seabirds in North America and reviewed similar efforts worldwide. He concluded that cleaning and treating oiled seabirds could not be justified because the overall median survival period after release was six days. He was aware of successful rehabilitation efforts for only one species, the African (Jackass) Penguin *Spheniscus demersus*. We examine post-release survival of penguins cleaned after an oil spill incident near Cape Town, South Africa; about 10 000 African Penguins were oiled, precipitating the largest seabird cleaning operation to date.

The African Penguin, endemic to South Africa and Namibia, is a globally 'near-threatened' species which has suffered a 90% decline in population during the last 60 years (Crawford *et al.* 1990, Collar *et al.* 1994). Factors contributing to this decline were reviewed by Brooke (1984) and updated by Crawford *et al.* (1994). One important factor has been the incidence of oil spills in the inshore marine environment of the African Penguin; as a flightless, swimming bird, it is especially susceptible to any impairment of the waterproofing and insulative properties of its plumage (Erasmus *et al.* 1981).

The replacement of coal by oil as a fuel accelerated from the 1930s, and the first serious recorded oiling incidents involving penguins in southern Africa were in November 1948 and August 1952 (Green 1950, pp. 203–204, Rand 1952). There appear to have been no further major oil spillages on the South African coastline until after 1967, when the closure of the Suez Canal forced oil tankers travelling from the Persian Gulf to Europe (650 per month on average) to take the route around southern Africa (Rand 1969, Westphal & Rowan 1969, Randall *et al.* 1980, Morant *et al.* 1981). A major oil spill near Cape Town in April 1968 resulted in the establishment of the South African National Foundation for the Conservation of Coastal Birds (SANCCOB) with suitable facilities and an organized

*Corresponding author.
Email: lgu@maths.uct.ac.za
†Deceased.

programme for cleaning oiled seabirds, especially penguins (Westphal & Rowan 1969, Morant *et al.* 1981, Moldan & Westphal 1994). The need to monitor the effectiveness of these procedures, the conservation value of which was doubted by Frost *et al.* (1976), resulted in the design of a flipper band of an appropriate size and shape for African Penguins (Jarvis 1970, Cooper & Morant 1981).

From 1967 until the *Apollo Sea* oil spill in June 1994, sundry oiling incidents variously resulted in scores or hundreds of oiled penguins being cleaned by the SANCCOB rescue centre and four oiling incidents are known to have involved in excess of 1000 penguins; these major spills were in 1968 (1700 oiled penguins collected alive, 400 birds discharged), in 1971 (1216 collected alive, 724 discharged), in 1972 (1751 collected alive, 885 discharged) and in 1985 (minimum of 1180 oiled, about 1000 discharged) (Morant *et al.* 1981, Randall & Randall 1986, Adams 1994). The 1972 incident was caused by a small slick of unknown origin which washed ashore onto one of the penguin landing beaches on Dassen Island (Fig. 1, which shows localities mentioned in the text); besides the birds collected alive, an estimated 2300 died as a result of oiling before they could be rescued, so that a total of at least 4000 birds was involved (Morant *et al.* 1981).

On 20 June 1994, the bulk ore carrier *Apollo Sea* sailed from Saldanha Bay, Western Cape, South Africa, bound for Hong Kong. Within hours of sailing, the ship broke up and sank southwest of Dassen Island at approximately 33°32′S 17°50′E (Erasmus 1995). The incident took place during a period when a series of severe cold fronts passed the Western Cape, the impact of which on birds was observed as far north as Okavango Swamps, Botswana (Herremans *et al.* 1994). Heavy fuel oil from the sunken ship's bunkers washed ashore on both Dassen and Robben Islands, contaminating 10 000 penguins (Dehrmann 1994a). Most were transported to the SANCCOB cleaning station. There was insufficient space at SANCCOB to handle such large numbers of penguins and many were held at nearby military bases (Erasmus 1995).

The unprecedented scale of the rescue operation and the pressures placed on volunteer helpers in all phases of the cleaning process resulted in penguin casualties (Dehrmann 1994a, Barrett *et al.* 1995, Oatley 1995). About 54% of the oiled penguins died between being collected and their ultimate release; 53% of these deaths took place in the first 48 hours after collection (Williams 1995a). The scale of the operation should be measured against the fact that during the 11-year period 1981–91, 4215 oiled African Penguins had been admitted to SANCCOB (Adams 1994), less than half the number involved in this single incident. This paper is not concerned with the cleaning operation itself (for details, see Dehrmann 1994a, 1994b, Barrett *et al.* 1995); the detail above is supplied to indicate that it took place under adverse conditions.

We report here on a systematic post-release follow-up of cleaned penguins for two years after the incident. Earlier follow-up studies had either been based on small samples, or involved incidental searches for banded penguins (Morant *et al.* 1981). This study therefore sought to answer, in a more precise way and on a larger scale than ever before, the question: 'Do cleaned penguins make the transition back to a wild state successfully?' Given the results of Sharp (1996), a focus on short-term survival is appropriate. Estimating long-term survival of the penguins cleaned after the *Apollo Sea* incident is beyond the scope of this paper. Nor do we compare survival of cleaned penguins with 'normal' penguins; it is not possible to make this comparison because circumstances at the time of the incident did not permit the setting up of a control group. Where relevant to our arguments, we report information obtained from oiled penguins that had been flipper-banded prior to the incident.

METHODS

We define the 'rehabilitation' of an oiled penguin to mean that the bird has made a successful return to the wild after discharge from the rescue station; we regard a bird as rehabilitated if it is subsequently resighted at a breeding colony. We do not consider release of a cleaned bird from the rescue station to constitute rehabilitation. 'Restoration' takes place once a rehabilitated bird breeds. In this paper we mainly discuss rehabilitation.

A total of 4076 of the African Penguins involved in the *Apollo Sea* oil spill was discharged with flipper bands after treatment by the SANCCOB rescue station (Table 1). Most (87%) of the cleaned penguins were released at Silwerstroomstrand, an isolated beach resort, almost deserted in winter, which is on the mainland about halfway between Robben and Dassen Islands (Fig. 1, Table 1). About 1600 penguins were released at Silwerstroomstrand on 26 July 1994; of these, about 70 returned to the beach within 24 h (Dehrmann 1994b), mostly because they had not yet acquired adequate waterproofing after cleaning; they were released again on subsequent dates. After the 26 July operation, inspections for readiness for release

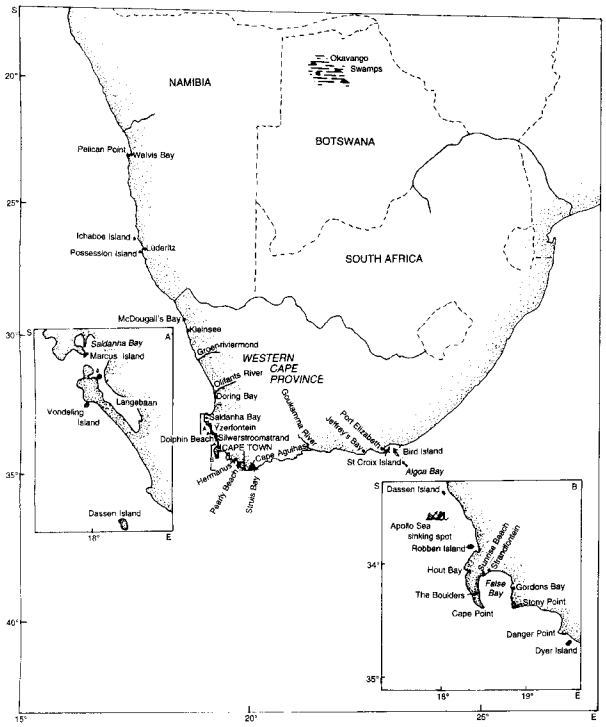

Figure 1. Southern Africa, showing localities mentioned in the text.

were more thorough, and most penguins were released at Silwerstroomstrand in batches of fewer than 200 birds. One batch of 426 birds, mainly immatures, was released from Robben Island (see Table 1 of Underhill *et al.* 1995); another batch of 88 birds, found oiled on the islands in Saldanha Bay, was released from Langebaan on 27 August. The last birds were released on 11 September 1994.

Four searches for penguins ashore, covering the beaches from 10 km south of Silwerstroomstrand to Yzerfontein, were made in August and September 1994, during and shortly after the period in which penguins were being released after cleaning (Table 1). Searches were made for both dead and live penguins. Searches for banded penguins at breeding colonies were made from the time of release until August 1996. The most intensive searches were on Dassen Island, where one or two people (out of A.G., L.B., D.C.N., A.W., P.A.W.) were stationed almost continuously. At Robben Island, where the Sea Fisheries Research Institute (SFRI) has a long-term penguin study site, searches were made by L.B., R.J.M.C., B.M.D., L.U. and P.A.W.; the search effort was less intense than at Dassen Island, but visits were made at least fortnightly throughout the study period. Searches for banded penguins were also made at the colonies on the Saldanha Bay islands, on Dyer Island, on Bird and St Croix islands in Algoa Bay (N.T.W. Klages *in litt.*) and at the mainland colonies at The Boulders and at Stony Point (Fig. 1). The only Namibian colony at which intensive searches were made was Ichaboe Island (P.A.B.). We produced three series of cumulative totals of the number of different banded penguins resighted, based on (1) birds that survived at least one month after release, (2) birds that had survived at least until 1 January 1995 and (3) birds that survived until at least 1 July 1995.

The overall recovery rate (the percentage of bands ultimately reported to the banding office) can only be determined after a cohort of banded birds has all died. The oldest series of SAFRING flipper bands was used on 9393 penguins between 1972 and 1978 (SAFRING unpubl. data). Between 1990 and 1996, there were eight recoveries of these penguins (SAFRING unpubl. data). The intensive monitoring of penguin colonies since the *Apollo Sea* incident produced seven of these penguins alive, all more than 20 years after banding (Whittington *et al.* in press). However, the overwhelming majority have died; the number of future recoveries from the small number still alive will be negligible. A total of 219 of the 9393 banded penguins was recovered dead, yielding a reporting rate of 2.33%. The 4076 penguins discharged from SANCCOB after the *Apollo Sea* incident may therefore be expected to generate 95 recoveries (4076 × 0.0233) over a period of 25 or more years.

We can further refine this assessment of the effectiveness of cleaning by comparing the observed and expected numbers of recoveries on an annual basis using average survival rates of free-living wild African Penguins. The estimated annual average survival rate of

Table 1. Dates of release of 4076 banded African Penguins discharged from SANCCOB at three localities after the *Apollo Sea* oil spill.

Date (1994)	Silwerstroom-strand	Robben Island	Langebaan
26 July	1527[a]		
27–31 July	248	82	
1–10 August	915	169	
11–20 August	488	77	
21–31 August	349	26	88
1–11 September	35	72	
Totals	3562	426	88

[a]This figure excludes about 70 birds that came ashore within 24 hours of this release, were readmitted to SANCCOB and released again later (see text).

penguins older than one year is 91% at St Croix Island, Algoa Bay, and 62% at Marcus Island (Randall 1983, La Cock *et al.* 1987). Numbers at St Croix Island were stable when the estimate was made, but those at Marcus Island were decreasing. The annual survival rate of the congeneric Magellanic Penguin *S. magellanicus* is estimated to be 85% and that of the Galapagos Penguin *S. mendiculus* to be 87% and 82% for males and females, respectively (Williams 1995b). Assuming an average survival rate for African Penguins of 85% per year, 2.33% of the 15% that die would be reported as recoveries each year. Given a total of 4076 banded penguins, the predicted number of recoveries to be reported to SAFRING during the first year after release is $4076 \times 0.15 \times 0.0233 = 14.2$, and during the second year is $4076 \times 0.85 \times 0.15 \times 0.0233 = 12.1$. If the number of recoveries within a few weeks of release exceeded 95 (4076×0.0233), it would point to a failure of the cleaning operation; if it were close to 14 in the first year, it would point to success.

The 'normal' recovery rate of 2.33% may be biased low for two reasons. First, a small number of penguins with old bands are still alive and may be recovered. Secondly, the penguin rescue operation, including the banding, received extensive media coverage in the weeks between the *Apollo Sea* oil spill and the first release of cleaned penguins. The direction of both potential biases is the same; the prediction of 95 recoveries in total, 14 in the first year and 12 in the second, may be underestimates. The direction of the bias increases the likelihood of the cleaning operation being assessed a failure.

An 'abnormal' bias to the recovery rate was the search effort of the research team. We therefore exclude recoveries made by the research team itself from the count of recoveries because, if the intensive monitoring had not taken place, these penguins would not have been reported to SAFRING.

A further oil spill or spills, not observed at sea and of unknown origin, occurred in late-winter 1995, about one year after the release of the penguins involved in the *Apollo Sea* incident. A total of 1332 oiled birds was admitted to SANCCOB over the period July–September 1995, with a peak in late-August and early-September (A. Westphal pers. comm.). Oiled penguins were found on the shoreline between False Bay and Cape Agulhas. From the distribution of finding places it is likely that the spill occurred off Danger Point. The complex system of sea currents in this area would tend to entrap oil in an eddy (Shannon & Chapman 1983), explaining the extended period over which oiled penguins came ashore. The occurrence of penguins banded after the *Apollo Sea* oil spill in this relatively large sample provided a further opportunity to gain information on the success of the rehabilitation effort.

Penguins banded prior to the *Apollo Sea* oil spill were involved. Their banding sites show from how far afield penguins were affected by the spill. Live, oiled penguins with flipper bands were taken to SANCCOB; dead ones were reported to SAFRING as recoveries. The proportion of banded penguins that were reported dead provides an indication of the extent of mortality between the time of oiling and removal to the rescue station.

RESULTS

Survival and dispersal of birds discharged after treatment

No penguins, either dead or alive, were found during the four searches made on the mainland shoreline near Silwerstroomstrand during and after the release of cleaned penguins.

The total number of resightings of banded penguins in the two-year period from release until August 1996

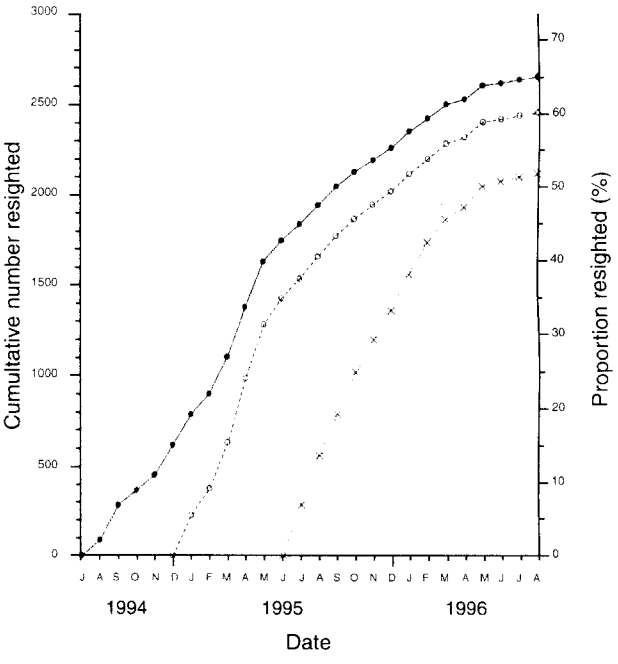

Figure 2. Cumulative numbers of African Penguins banded after the *Apollo Sea* oil spill which were resighted (●) at least one month after release, (○) after 1 January 1995 and (×) after 1 July 1995. The plotted values are the figures attained by the last day of the relevant month. The proportion resighted, as a percentage of 4076 birds, is shown on the right.

Table 2. Recoveries of dead African Penguins involved in the *Apollo Sea* oil spill and reported to SAFRING by members of the public within 24 months of release.

Band number	Age	Place of release	Release date (1994)	Finding locality	Finding date	Distance[a] (km)	Months elapsed	Cause of death
G08540	Imm	RI	29 Jul	Luderitz	18 Sep 1994	855	2	Not oiled
S20529	Ad	SSS	26 Jul	Pearly Beach	24 Jun 1995	158	11	Unknown
S20532	Ad	SSS	22 Aug	Gansbaai	8 Sep 1996	146	24	Unknown
S20596	Ad	SSS	26 Jul	Doring Bay	30 Jul 1995	197	12	Unknown
S20743	Ad	SSS	16 Aug	Stony Point	30 Sep 1994	102	1	Unknown
S20954	Ad	SSS	26 Jul	Cape Agulhas	15 Nov 1994	197	5	Unknown
S21837	Ad	SSS	27 Jul	Dolphin Beach	14 Feb 1996	28	19	Unknown
S21873	Ad	SSS	26 Jul	Strandfontein	26 Feb 1995	59	7	Not oiled
S21893	Ad	SSS	26 Jul	Sunrise Beach	26 Feb 1995	59	7	Not oiled
S21922	Ad	SSS	26 Jul	Hout Bay	5 Dec 1994	54	5	Not oiled
S22046	Ad	SSS	26 Jul	Dyer Island	29 Jun 1996	158	23	Killed by seal
S22485	Ad	SSS	12 Aug	Dolphin Beach	26 Dec 1994	30	4	Unknown
S22945	Ad	SSS	11 Sep	Hermanus	27 Dec 1995	128	16	Unknown
S22508	Ad	SSS	26 Jul	Danger Point	22 Aug 1994	145	1	Oiled
S23301	Imm	RI	16 Aug	Goukamma estuary	1 Jul 1995	418	11	Not oiled
S23534	Ad	La	29 Aug	11 km N of Yzerfontein	3 Sep 1995	44	14	Unknown
S23933	Ad	SSS	11 Sep	Jeffreys Bay	13 Mar 1996	602	18	Unknown
S24101	Ad	SSS	22 Aug	12 km N of Yzerfontein	8 Oct 1994	44	2	Not oiled
S24179	Ad	SSS	26 Aug	Dyer Island	8 Jun 1996	158	22	Killed by seal
S24291	Ad	SSS	27 Aug	Saldanha Bay	11 Feb 1996	64	18	Unknown
S24426	Ad	SSS	30 Jul	Pearly Beach	10 Sep 1995	158	13	Oiled
S24607	Ad	SSS	7 Aug	Fish Hoek, False Bay	26 Feb 1996	63	19	Unknown
S24889	Ad	SSS	5 Aug	Danger Point	12 Jan 1996	145	17	Unknown
S25125	Ad	SSS	4 Aug	Cape Infanta	30 Dec 1995	253	17	Unknown
S25195	Ad	SSS	14 Aug	Walvis Bay	25 Oct 1994	1208	2	Unknown

SSS, Silwerstroomstrand; RI, Robben Island; La, Langebaan; Ad, adult; Imm, immature.
[a]The direct distance between release and recovery localities.

was 10 412 (unpubl. data). This total included 2652 different penguins (65% of those banded) that had survived at least one month after release (Fig. 2). Of these, 1940 had been seen by August 1995, so that 712 penguins were observed for the first time during the final year of this study. The number of different penguins observed after 1 January 1995 was 2454 (60%), and after 1 July 1995 was 2117 (52%).

Resightings were made at colonies near the extremities of the breeding range of the African Penguin. By August 1996, 11 penguins discharged from SANCCOB after the *Apollo Sea* oil spill had been resighted on Ichaboe Island, Namibia. Two were seen on St Croix Island on 27 and 28 August 1996 (B.M.D. pers. obs.); this island, the largest African Penguin breeding colony, is monitored infrequently. None was seen during monitoring on Bird Island, Algoa Bay (N.T.W. Klages *in litt.*).

Of the 4076 penguins discharged from SANCCOB with flipper bands, 37 were recovered within one year of release. Of these, 24 were found on Robben, Dassen and Dyer Islands by the monitoring team. Thirteen recoveries were reported to SAFRING in the normal way between release and 12 months thereafter, and there were a further 12 such recoveries 13–24 months after release (Table 2). These observed counts are close to the expected numbers of recoveries in the first (14.2) and second (12.1) years. None of the recoveries made in the first year provides evidence of death immediately after release (Table 2).

In the SFRI study area on Robben Island, evidence of rapid rehabilitation included a discharged penguin incubating two eggs on 30 August 1994, and four other birds holding territories. These penguins can probably be considered to have been 'restored' within a month of their discharge. The penguin with band T0764 was observed to be the mate of S1309 at nest 207 in the SFRI study area on Robben Island on 20 April 1994. T0764 was taken off the nest on 26 June covered with oil. Two small downy chicks were left in the nest; it was presumed that they would die of exposure. T0764 was released at Silwerstroomstrand on 26 July. The following day, it was at nest 207 with the two chicks, by then large and downy (L.U. pers. obs.). S1309 had

not been oiled and had reared the chicks alone; it was subsequently seen with a completely feathered chick.

Of the 1332 penguins admitted to SANCCOB between July and September 1995, 28 had been discharged after being oiled during the *Apollo Sea* spill (SAFRING unpubl. data). These 28 birds were thus treated twice at SANCCOB within a period of 14 months and 15 of the 28 birds (54%) had been resighted during surveys of the islands before being re-oiled.

Penguins banded prior to the *Apollo Sea* oil spill

A total of 215 oiled penguins taken to SANCCOB alive had been flipper-banded prior to the oil spill. Their places of banding ranged from Bird Island, Algoa Bay, 730 km to the east, to Ichaboe Island, Namibia, 900 km to the north (Table 3). This indicates that birds from almost the entire range of the species were involved in the oil spill. However, the majority (131 out of 215: 61%) had been banded on Dassen or Robben Islands (excluding cleaned birds that had been released on the latter). Because banding effort was uneven through the breeding range, no quantitative analysis of the proportions of birds from the various breeding islands was made.

Table 3. Origins of 215 banded, oiled African Penguins brought to SANCCOB after the *Apollo Sea* oil spill. The fact that a penguin was banded at a locality does not necessarily imply that it hatched there or that it bred there.

Banding place	Number
Bird Island (Algoa Bay)	2
Cape Recife[a]	1
Jeffrey's Bay[a]	2
Dyer Island	7
The Boulders, Simonstown	1
Cape Point[a]	1
Robben Island	71
Robben Island[a]	48
Dassen Island	60
Vondeling Island	1
Marcus Island	1
Possession Island	1
Ichaboe Island	5
No banding details[b]	14
Total	215

[a]Release sites of birds discharged after earlier oiling incidents (SAFRING unpubl. data).

[b]Details of date and place of banding for 14 penguins were not reported to SAFRING. The banding details were irretrievably lost by the research institution to which the bands had been issued.

Fourteen recoveries of dead penguins were reported to SAFRING between 20 June and 26 July 1994, the period between the sinking of the *Apollo Sea* and the first release of cleaned penguins. Ten were east of False Bay and north of the Olifants River estuary, and therefore outside the area affected by oiling; none of these was reported as being oiled. Of the remaining four, one had been entangled in plastic debris (a discarded orange pocket), for one the cause of death was recorded as 'unknown' and two were reported as having died due to being oiled (SAFRING unpubl. data). This contrasts with the 215 oiled birds admitted to SANCCOB alive with flipper bands, suggesting that, during this incident, the mortality rate of oiled penguins before removal from the shore was small.

DISCUSSION

Mortality of African Penguins in the wild at the time of the oil spill

In estimating the impact of past oiling incidents on the penguin population, the number of penguins that died at sea, rather than came ashore alive, was regarded as unknown (Morant *et al.* 1981). Birds that die at sea can either become waterlogged and sink, or be washed ashore. If large numbers of oiled penguins had died at sea after the *Apollo Sea* oil spill, the proximity of the oil spill to the coast line and the prevailing onshore winds would have resulted in dead oiled penguins being washed ashore. However, among banded oiled penguins ashore, two were found dead and 215 alive, suggesting a low mortality rate before removal from the coastline. Our conclusion is that, after the *Apollo Sea* oil spill, most oiled penguins came ashore alive and that most were taken to SANCCOB. In addition, few full-grown penguins died at either Robben or Dassen Islands (A.J.W. pers. obs.). It is improbable that a large-scale mortality of penguins occurred unobserved.

Examining the descriptions of earlier incidents, it seems to be a behavioural characteristic of African Penguins that even quite small amounts of oil on their plumage induce them to make a landfall, either on a breeding island or on the nearest mainland. Oiled penguins are reluctant to return to sea; most starve to death, especially those that are heavily oiled (Rand 1952, 1969, Rowan 1969, Westphal & Rowan 1969, Morant *et al.* 1981).

During surveys for dead seabirds (for methods, see Cooper 1977) along 27 km of shoreline north of

Yzerfontein between 1977 and 1989, 645 African Penguins were found dead and 10 (1.6%) were found to be oiled (G. Avery pers. comm.). The low incidence of oiling among dead beached penguins further supports the view that few African Penguins die at sea as a result of being oiled. Most come ashore alive.

Survival of birds discharged after treatment

The plot of the cumulative numbers of resighted African Penguins (Fig. 2) shows that 1940 and 710 penguins were observed for the first time during the first and second years of fieldwork, respectively, indicating that an asymptote had not yet been reached. Therefore, two years after discharge, banded penguins remain to be observed for the first time since release. Given that a substantial proportion of the oiled birds were from colonies other than Robben and Dassen Islands (Table 3) where the most intensive monitoring was undertaken, further fieldwork at the smaller breeding colonies in the Western Cape and at the colonies in the Eastern Cape would also have revealed more banded penguins; in Namibia only Ichaboe Island was regularly monitored.

From January 1995 to August 1996, 2454 different penguins were resighted; this is 92.5% of the total number of resightings of penguins that survived at least one month (2652) (Fig. 2). Thus only 198 penguins seen in the first months of monitoring were not confirmed to be alive after January 1995. At least 52% of the penguins survived into the second year after the incident (Fig. 2).

Thirteen recoveries were reported within a year of release, and 12 during the second year after release; this is close to the expected total of 26 recoveries in the first two years, computed assuming an average annual survival rate of 85% and a reporting rate of 2.33%. If the cleaning processes had altered the behaviour of the penguins in such a way that they had lost their ability to find food and live under natural conditions, large numbers of penguins would have died within days or weeks after release and many flipper bands would have been recovered.

Of the 28 banded birds that were readmitted to SANCCOB after the July–September 1995 oiling incident, 54% had previously been resighted. This is close to the proportion of discharged birds resighted during monitoring procedures at that stage, which reached 50% in September 1995 (Fig. 2), and provided an independent calibration of the monitoring process.

All the evidence suggests that there was no post-release mass-mortality of penguins. We conclude that, once discharged after treatment at SANCCOB, most penguins are rehabilitated, successfully making the transition back to the wild.

Critical stages in the restoration of oiled penguins

There are six situations in which death or reduced breeding productivity can occur between oiling and restoration to the breeding population. (1) Oiled penguins do not come ashore, but die at sea. (2) Oiled penguins ashore die before being captured. (3) Oiled penguins die during transport to and initial stabilization at the rescue centre. (4) Penguins die during treatment. (5) Penguins die shortly after release or 'discharge' and thus fail to be rehabilitated, as defined in this paper. (6) Rehabilitated penguins do not breed successfully, or have reduced breeding productivity, and thus fail to be restored. The analyses presented in this paper address mostly situations 1 and 5. Our results are specific to the *Apollo Sea* oil spill, but we believe that they have general applicability to the rehabilitation efforts on African Penguins. Mortality in situations 3 and 4 were documented in relation to the *Apollo Sea* oil spill by Erasmus (1995) and Williams (1995a). Situation 6 is the subject of an ongoing study by D.C.N., A.J.W. and A.C.W.

The mortality rate before removal to the rescue station in the *Apollo Sea* oil spill was about 1%. Most oiled birds came ashore alive (situation 1) and were found and taken to SANCCOB (situations 2 and 3). Given current levels of surveillance of penguin colonies and the shoreline of the adjacent mainland, it is unlikely that a large number of oiled penguins coming ashore anywhere on the southern African coastline or at breeding colonies would go unnoticed (situation 2).

The main thrust of this paper demonstrates that there was minimal post-release mortality of African Penguins cleaned during the *Apollo Sea* oil spill (situation 5). The number of recoveries reported by members of the public was consistent with what would be expected as a result of normal mortality rates. By 31 August 1996, 65% of the banded penguins had been resighted, and an asymptote had not then been reached.

In order to improve the success of penguin rehabilitation procedures over that achieved during the *Apollo Sea* incident, most attention needs to be concentrated on the period from oiling to when the birds have been in the rescue station for about 48 hours; most

mortality took place during this period (situation 3). Priority actions for oiled penguins are prompt capture and emergency stabilization in the field, transport to SANCCOB, and continued stabilization immediately on arrival. These issues were addressed by Williams (1995a).

The treatment processes conducted by SANCCOB include the removal of oil, the provision of adequate diet and of conditions to encourage the development of plumage waterproofing, and tests for readiness for discharge (Moldan & Westphal 1994). Following the *Apollo Sea* oil spill, these processes (situation 4) were conducted in such a way that there was minimal post-release mortality.

The SANCCOB rescue station conducts one of the most successful rehabilitation operations for oiled birds in the world. However, prevention is better than cure. Although we have demonstrated that African Penguins can be successfully rehabilitated, the objective should be to reduce the volume of oil that enters the sea (Morant *et al.* 1981).

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