Rehabilitation of oiled African Penguins: a conservation success story

Edited by Deon C. Nel and Phil A. Whittington
Rehabilitation of oiled African Penguins: a conservation success story

Edited by
Deon C. Nel¹ and Phil A. Whittington²

¹BirdLife International Seabird Conservation Programme, BirdLife South Africa, PO Box 1586, Stellenbosch, 7599, South Africa;
²Avian Demography Unit, Department of Statistical Sciences, University of Cape Town, Rondebosch, 7701, South Africa

BirdLife South Africa and the Avian Demography Unit, Cape Town
2003
Foreword

The south-western coasts of South Africa are a global hotspot for oil pollution. This is not due to unusual local negligence but is caused by structural failure of foreign vessels in passage between the Atlantic and Indian oceans. Other than pollution of shores, the prime result of these spillages is the oiling of the endemic African Penguin Spheniscus demersus.

The first sighting of an oiled African Penguin was as early as the 1920s (Kearton 1930) but oiling only became a severe threat after the Arab–Israeli conflicts closed the Suez Canal to tanker traffic. This led to the re-routing, around Africa, of tankers taking oil from the Arabian Gulf to Europe. Generally the tankers kept well offshore, but as they rounded South Africa the vessels came close to the coast to reduce transport costs and pick up fresh supplies. Small enough to pass through the canal, and previously sailing largely in the enclosed Red and Mediterranean seas, these vessels were unsuited to the rougher fully oceanic conditions off South Africa’s coast. The result was a series of tanker wreckings and oil spillages. To reduce the costs of crewing large numbers of small tankers, new super-tankers were developed. These reduced the number of tankers, but significantly increased the potential magnitude of oil spills if these tankers were damaged.

A series of spills on the South African coast in the late 1960s led Mrs Althea Westphal to establish SANCCOB (the Southern African National Foundation for the Conservation of Coastal Birds). Initially based on Mrs Westphal’s backyard swimming pool, SANCCOB grew to become an organisation with its own dedicated cleaning station and, at its peak, a banked reserve worth several million US Dollars. This volunteer organisation, though caring for any sick, injured, or polluted seabirds, was dedicated largely to the de-oiling of penguins. During its first 20 years SANCCOB handled some 9,000 penguins as well as smaller numbers of other seabirds. In the 1980s there were few large spills and SANCCOB ran at a very amateur level.

The sinking of the Apollo Sea in June 1994 heralded a phase of renewed penguin oiling, largely the result of fuel oil spills due to inadequate maintenance of cargo vessels. The 10,000 penguins oiled in the Apollo Sea spill led to radical improvements in SANCCOB, notably more professional bird treatment. This culminated in the Treasure spill of June 2000 in which some 20,000 penguins were oiled, captured, de-oiled and released whilst an additional 19,000 non-oiled penguins were caught, and relocated 800 km away. This enabled them to feed for themselves whilst travelling back to the Atlantic over a two-week period during which the spill dispersed and beach cleaning was undertaken. Handling oiled penguins in this spill was an international effort but made possible by having SANCCOB’s facilities, expertise and volunteer support upon which to build.

The five papers in this booklet assess the present situation in the light of these spills. Les Underhill stresses the fortunate resilience of the African Penguin which, seemingly far better than any other bird, is able to cope with the stresses of oiling as well as the multiple handling during de-oiling. Deon Nel, Rob Crawford and Nola Parsons review the conservation status of the African Penguin and the impact oiling is having on this species. Phil Whittington presents results, from his doctorate, which evaluate the post-release survival of de-oiled penguins. Anton Wolfaardt and Deon Nel report on the subsequent breeding productivity and annual cycle of de-oiled penguins. Their report is based on a study initiated, immediately after the Apollo Sea spill, in order to assess whether de-oiling was worth the cost and effort in terms of penguin future reproductive contributions. Peter Ryan estimates the demographic impacts that de-oiling has had upon African Penguins and indicates that, as a result largely of SANCCOB’s efforts, the population is 19% larger now than if there had been no de-oiling.

Readers are urged to consider these documents in the light of wider contexts. First the impact of oil pollution upon African Penguins must be considered against this species’ significant population decrease, reduced from some 1.5 million adults in 1900 to about 150,000 in 2002. Oiling is not the prime cause of this decrease. Penguins have suffered from massive habitat disruption through removal of fossil guano caps at breeding islands in the mid-1840s. Subsequently there was major commer-
cial over-exploitation of penguin eggs. Since the late 1940s penguins have had to compete for food – mainly shoaling sardines and anchovies – within penguin swimming range (c.20 km) of breeding islands against the less constrained commercial purse-seine fishery and also against Cape Fur Seals *Arctocephalus pusillus*. In addition, these seals, whose population has risen from some 100,000 in 1900 to over two million in 2001, displace penguins from some breeding localities, and may be substantial predators of the penguins themselves.

The other contextual situation for these papers is that faced by SANCCOB, the prime organisation responsible for the rescue and de-oiling of African Penguins. When SANCCOB was initiated the exchange rate between the South African Rand and the US Dollar was near parity and affluent South Africans had more disposable income for the support of NGOs. The exchange rate is now nine Rands (and has been as high as 13) to the Dollar, and disposable income has fallen radically. SANCCOB’s financial reserves have been depleted severely through depreciation, during a period when provision of adequate care for penguins has risen markedly in cost. The result is that an increasingly cash-strapped NGO is having to react to oiling resulting from international trade between more affluent nations. The South African government, at its several levels, is prepared to assist SANCCOB in terms of manpower and logistical support during significant spills (involving oiling of 500+ penguins). However, the government lacks funds to divert to penguin cleaning when so many of its people remain trapped in poverty exacerbated by the AIDS epidemic. These factors have forced SANCCOB to adopt a more business-like structure. In the short term, this has led to a loss of penguin treatment expertise without significant gain in income. It is difficult to see how in the medium (5-year) term SANCCOB can continue to provide a high level of service to the African Penguin without substantial funding (in Rand terms) from the international community. Its value in terms of helping to preserve this Vulnerable species is amply demonstrated by the results presented in this book.

*Tony (A.J.) Williams
Avian Scientist
Western Cape Nature Conservation Board
(SANCCOB Executive Committee member 1994–2001)*

---

Dedication

To Althea Westphal, whose vision and determination saved thousands of seabirds, and to Charl van der Merwe, who loved penguins and whose generosity made this publication possible.

Acknowledgements

The publication of this booklet was made possible by means of a donation by the Charl van der Merwe Foundation to BirdLife South Africa.

The digital images were edited by René Navarro and desktop publishing was done by Felicia Stoch, both of the Avian Demography Unit.

The rescue of African Penguins is facilitated by staff of Western Cape Nature Conservation Board, South African National Parks, Marine and Coastal Management, the Avian Demography Unit, Robben Island Museum and SANCCOB, as well as numerous volunteers. Substantial input at rescue and rehabilitation centres has been provided by the International Bird Rescue and Research Centre, New England Aquarium, Philip Island Nature Park, Royal Society for the Protection of Birds, BirdLife South Africa, the Wild Bird Federation of Taiwan, Tri-State Bird Rescue and Research Inc., The World Wide Fund for Nature (WWF), The Green Trust and the International Fund for Animal Welfare.
About the authors

Deon Nel is the Scientific Coordinator for BirdLife International’s Seabird Conservation Programme. Following the Apollo Sea oil spill, Deon spent 18 months on Dassen Island studying the reintegration of rehabilitated African penguins into their wild population. Since then he completed his doctorate on “The effects of longline fishing on the seabirds breeding on Marion Island”. Deon also holds a MSc in Conservation Biology from the FitzPatrick Institute, University of Cape Town.

Phil Whittington completed his doctorate on “Survival and movements of African Penguins, especially after oiling” at the Avian Demography Unit at the University of Cape Town. He spent ten years as an ornithologist with the British Trust for Ornithology before embarking on a period of travel that eventually led him to South Africa and his doctoral research. Phil holds a BSc (Hons) degree from the University of London.

Rob Crawford is a Principal Specialist Scientist in the Directorate of Marine and Coastal Management, South Africa. He has conducted research into southern Africa’s seabirds over the past 20 years, including annual monitoring of the breeding populations of all South African seabird species. Rob is a past chairman of SANCCOB’s executive committee.

Nola Parsons is the Bird Rehabilitation Manager at the SANCCOB rescue centre. She is a qualified veterinarian from the University of Pretoria and has been working at SANCCOB for the past two years. She is currently registered for an MSc degree at the University of Cape Town, studying the breeding productivity of African Black Oystercatchers at Koeberg Nature Reserve.

Anton Wolfaardt is a Regional Ecologist for the Western Cape Nature Conservation Board. Anton’s experience with seabird research and conservation began on Marion Island, where he conducted field studies of various sub-Antarctic seabirds. He then spent two years studying rehabilitated penguins from the Apollo Sea oil spill and a further three years as the Reserve Manager for Dassen Island. Anton is currently working towards his doctorate on “The impact of oiling and rehabilitation on the breeding biology of African Penguins” at the Avian Demography Unit, University of Cape Town.

Peter Ryan is a Senior Lecturer in the Percy FitzPatrick Institute for African Ornithology, University of Cape Town, where he coordinates the MSc programme in Conservation Biology. He has a long-standing interest in seabird conservation, dating back to his MSc research on the impacts of plastic ingestion on seabirds, conducted during the mid-1980s. Peter has worked intermittently on African Penguins since his undergraduate days and has advised conservation agencies on management of penguin–human interactions at Boulders and Dassen Island.

Les Underhill is the Director of the Avian Demography Unit at the University of Cape Town, and serves on the board of SANCCOB. Seabirds and shorebirds form a major research area for the Avian Demography Unit and Les has supervised numerous MSc and doctoral research projects on the effects of oil on seabird populations.
## Contents

**Executive summary** ........................................................................................................ viii

**The conservation status and impact of oiling on the African Penguin**

Deon C. Nel, Robert J.M. Crawford & Nola Parsons ......................................................... 1

**Post-release survival of rehabilitated African Penguins**

Phil A. Whittington ............................................................................................................... 8

**Breeding productivity and annual cycle of rehabilitated African Penguins following oiling**

Anton C. Wolfaardt & Deon C. Nel ................................................................................... 18

**Estimating the demographic benefits of rehabilitating oiled African Penguins**

Peter G. Ryan ....................................................................................................................... 25

**Are African Penguins tough enough? A perspective on the rehabilitation of oiled birds**

Les G. Underhill ................................................................................................................ 30

**Plates**

- Rescue and transport ........................................................................................................ 11
- Stabilisation and cleaning ................................................................................................ 12
- Rehabilitation and release ............................................................................................... 13
- Reintegration and follow-up research ............................................................................ 14
Executive summary

The African Penguin Spheniscus demersus population has decreased greatly over the last century. The population at the start of the 21st century is about 10% of what it was at the start of the 20th century and is largely confined to two areas, both located close to major shipping ports.

The first documented oil spill affecting African Penguins occurred in 1948 and since then more than 47,000 penguins have been admitted to the Southern African Foundation for the Conservation of Coastal Birds (SANCCOB). However, there has been a dramatic increase in the number of birds oiled since 1990. This is largely due to two catastrophic oil spills that oiled more than 30,000 birds: the Apollo Sea spill in 1994 and the Treasure spill in 2000. At present more than 80% of oiled birds that are admitted to SANCCOB are cleaned, rehabilitated and released back into the wild in a healthy condition. The cost of rehabilitating a penguin in a catastrophic oil spill is less than US$ 100, making this the most cost-effective rehabilitation centre for seabirds worldwide.

After their release from the centre, rehabilitated African Penguins appear to survive just as well as unaffected birds. At least 87% of rehabilitated African Penguins return to their breeding colonies and post-rehabilitation annual survival rates are no different from those of unaffected penguins. Some of the oldest known surviving African Penguins are birds that had been rehabilitated at SANCCOB. Furthermore, at least 60% of rehabilitated birds that were resighted at their colonies have been recorded breeding. Overall, breeding success of rehabilitated birds was no different from unaffected birds although during times of extreme food shortages rehabilitated birds appeared to fare less well than unaffected birds.

Initial disruptions to the annual breeding and moult cycles and established pair-bonds were recorded immediately after a catastrophic oil spill. The relocation of clean penguins as a proactive measure for avoiding oiling was shown to be a great success. The proportion of birds recorded breeding was higher for translocated birds, compared to oiled-rehabilitated birds, indicating that this process was far less disruptive to their breeding cycles. A simple deterministic model shows that the rehabilitation of oiled African Penguins has resulted in the present population being 19% larger than it would have been in the absence of cleaning. This excludes the contribution made by translocating clean birds to avoid oiling.

The future cost of ceasing to rehabilitate oiled penguins ranges from 17–51% of the population after 20 years, as the probability of a major spill increases from 5–20% per year. Although the demographic impacts of cleaning oiled penguins were initially modest, this activity is becoming increasingly important for conserving African Penguins. Penguins are impressively tough animals, a quality that enables them to be cleaned when they become oiled. However, in order to be successful, the cleaning operation has to be mobilised rapidly. For this reason, SANCCOB needs to be maintained in a state of readiness for action continuously.
The conservation status and impact of oiling on the African Penguin

DEON C. NEL1, ROBERT J.M. CRAWFORD2 & NOLA PARSONS3

1BirdLife International Seabird Conservation Programme, BirdLife South Africa, PO Box 1586, Stellenbosch, 7599, South Africa, e-mail: dnel@savethealbatross.org.za; 2Marine and Coastal Management, Private Bag X2, Rogge Bay, 8012, South Africa; 3South African National Foundation for the Conservation of Coastal Birds, PO Box 11116, Blouberg, 7443, South Africa

Abstract


The African Penguin Spheniscus demersus population is at present about 10% of what it was at the beginning of the 20th century. Currently more than 80% of the global population breeds in two confined areas. The heart of these areas both lie within 50 km of a major shipping harbour and adjacent to the Cape shipping route, making the population extremely vulnerable to oiling. The first recorded oiling of African Penguins occurred in 1948 and the South African Foundation for the Conservation of Coastal Birds (SANCCOB) was established in 1968 following the grounding of the Esso Essen. Since then more than 47,000 oiled African Penguins have been admitted to SANCCOB. However, there has been a dramatic increase in the numbers of birds oiled during the last decade (1991–2000). This was mainly due to two catastrophic oil spills. In 1994, a bulk ore carrier, the Apollo Sea, sank near Dassen Island, oiling 10,000 penguins. Four years later, almost 20,000 oiled penguins were rescued when another bulk ore carrier, the Treasure, sank close to Robben Island. The incidence of oiling from smaller slicks of unknown origin has also increased during the last decade. However, efforts to rescue, clean and rehabilitate oiled African Penguins have been highly successful and have continued to improve over the last three decades. Currently more than 80% of oiled African Penguins that are admitted to SANCCOB are released back into the wild in a healthy state. The cost of rehabilitating African Penguins during a catastrophic event such as the Treasure oil spill is less than US$ 100 per bird released back into the wild in a healthy state, making this by far the most cost-effective seabird rehabilitation effort in the world. However, these successes rely heavily on the SANCCOB rehabilitation facility and expertise being maintained in a state of readiness between oil spills.

Conservation status

The African Penguin Spheniscus demersus is the only penguin species that breeds in Africa. Breeding is restricted to southern Africa from Algoa Bay on the south-east coast of South Africa to central Namibia on the west coast of Africa (Figure 1), although non-breeding birds regularly disperse as far as KwaZulu-Natal and southern Angola. African Penguins currently breed at 27 colonies, having disappeared as a breeding species at 10 localities1. However, 77% of the population currently breed on just four islands. Furthermore, more than 80% of the population breed in just two small and distinct geographic areas (with a radius of <50 km). More than 40% of African Penguins breed on the islands between Saldanha Bay and Cape Town, with almost another 40% breeding within Algoa Bay near Port Elizabeth (Figure 1).

The present population is about 10% of that at the start of the 20th century when it was estimated at over 1.45 million adult birds2 (Figure 2). In the 1950s the population had declined to 300,000 adults and by the late 1970s to only 220,000. By the late 1980s, the population was down to 194,000 adults and in the early 1990s only 179,000 adults remained1. Given the large decrease in the 20th century, there is considerable concern about the long-term viability of the African Penguin in the wild. It is listed as Vulnerable in the South African Red Data Book for birds3, is considered Vulnerable in terms of the IUCN threatened species categories4 and is listed in Appendix II of both the Convention on Trade in Endangered Species (CITES) and the Bonn Convention for the conservation of migratory species5.

The initial decline in numbers of African Penguins was driven by direct exploitation by humans. An average of almost 500,000 eggs were removed annually from Dassen Island alone between 1900 and 19306. Furthermore, massive disturbance and habitat alteration were caused by the collection of guano during this period7. More recently, reduced availability of pelagic fish prey, resulting from competition with commercial fisheries, has been responsible for the ongoing declines8. Through the years, other factors have included mortality in oil spills9, competition for space on breeding islands with the burgeoning population of Cape Fur Seals Arctocephalus pusillus10, predation11 and entanglement in fishing gear and other marine litter12.

It is clear that the African Penguin has experienced a torrid time in the 20th century, resulting in a severely reduced population with an insecure future. As populations of wild animals
Figure 1. Extant breeding colonies of African Penguins. Reproduced with permission from the Directorate of Marine and Coastal Management, South Africa.
The impact of oiling on African Penguins

The earliest known incident in which African Penguins were affected by oiling was the grounding of the Esso Whelkling near Dyer Island in 194816. Another major oil spill on Robben Island in 1953 affected 1,200 penguins17. However, oil pollution incidents prior to 1967 were poorly documented and their effect on seabird populations were not assessed.

The first attempts to clean oiled penguins were reported in 196318. Attempts to rehabilitate oiled seabirds on a large scale followed the grounding of the Esso Essen of Cape Point in 1968 when about 1,700 oiled penguins were collected19. Subsequently 400 cleaned penguins were released. The Esso Essen incident led to the establishment of the South African National Foundation for the Conservation of Coastal Birds (SANCCOB) in November 196820.

Between 1970 and 2000 there have been at least 14 major oiling incidents that have threatened large numbers of African Penguins (Table 1). It is interesting to note that the incidents involving the largest amounts of oil did not necessarily have the greatest impact on the penguins (Table 1). The two incidents resulting in the most penguins being oiled (the Apollo Sea and the Treasure) involved relatively small amounts of fuel oil from bulk ore carriers, whereas the incident involving the largest amount of oil, the sinking of the tanker Castillo de Bellver, did not oil any penguins. The location of the spill and prevailing weather conditions are far more important than the actual amount of oil that is spilled. Although the Castillo de Bellver sank relatively close to major penguin colonies, fortunately a strong south-easterly wind moved the oil further offshore21. Both the Apollo Sea and Treasure, on the other hand, sank close to large penguin colonies during typical Cape winter storms, with prevailing north-westerly winds causing the oil to remain close inshore and/or drift onto the landing beaches of major penguin breeding colonies on Robben and Dassen Islands. The unseasonally calm weather that followed immediately after the sinking of the Treasure allowed oil to remain even longer inshore, causing maximum damage.

Nine of the eleven major oiling incidents involving more than 500 penguins occurred between March and August. However, it is not only the major oil spills that occur predominantly during the winter months. Smaller oiling incidents of unknown origin, presumably resulting from vessels illegally washing out their bilges, also occur more frequently during the winter months in the Western Cape. This is presumably also due to predominant onshore north-westerly winds moving oil slicks closer inshore and within the foraging range of penguins breeding at major colonies.

Incidence of oiling

A total of about 47,000 oiled African Penguins have been admitted to SANCCOB over for past three decades, at an average of about 1,500 birds per year. The incidence of oiling has varied greatly over this time and 77% of birds have been oiled between 1991 and 2000 (Figure 3). Prior to 1990 most oiled penguins admitted to SANCCOB were from incidents of unknown origin.

The biology of African Penguins

Feeding ecology

African Penguins forage mostly during the day, feeding on pelagic schooling fish such as anchovies and pilchards. Although dives of up to 130 m have been recorded, most prey are captured in the upper 30 m of the water column15. Most birds are found within 20 km of the coast13 and their distribution matches that of pelagic shoal fish, which typically occur within the 200 m depth contour12. Adult penguins typically forage in groups, working together to concentrate schools of fish. By comparison, juveniles tend to forage singly, preying on more sluggish fish prey.

Moulting

As with all penguins, African Penguins replace all their feathers at once during an annual moult. Old, worn feathers have to be replaced by new feathers to maintain the bird’s insulation and swimming speed; old feathers have greater drag. During the moult birds are landbound at their breeding islands for about 21 days and have to rely on fat reserves built up during a five-week pre-moult period (which is spent at sea, overnighting at the feeding grounds). By the time a bird returns to sea after the moult, it has lost almost half of its weight when it came ashore. After the moult, the penguins spend an uninterrupted period of about six weeks at sea, to recover from the moult fast.

Breeding

After returning to their breeding colonies following the post-moult feeding period, breeding birds take ownership of their nesting sites. African Penguins show high fidelity to their mates and their nesting site. Many pairs have bred together for ten years or more at the same site. A two-egg clutch is laid about three weeks after returning, and incubation lasts about 41 days. Both members of a pair participate equally in incubation, with one bird feeding at sea while its mate is incubating. At hatching the chicks are helpless and cannot be left alone owing to their inadequate thermoregulatory abilities and their vulnerability to predation by Kelp Gulls Larus dominicanus. At about 15 days they develop the ability to thermoregulate, but they remain vulnerable to predation until about 30 days old. Parents share feeding and guarding duties equally. Chicks fledge at an average weight of about 2.6 kg and it normally takes about 90 days and 26 kg of fish to raise a chick to this stage! Parents feed chicks right up to the day of their departure from their breeding islands, when they will enter one of the most critical phases of their lives.

Juveniles

Juvenile penguins stay away from their natal colonies for long periods, spending much of this time at sea. Only about 32% will survive their first year at sea2. Over the years they will begin to spend more time at their natal colonies, until they reach sexual maturity. Most birds breed for the first time between the ages of three and five years12, and only about 27% of juvenile birds will reach this age3.
However, since 1990, 78% of all oiled penguins were victims of just two catastrophic oil spills. The sinking of the Apollo Sea in 1994 resulted in approximately 10,000 penguins being oiled. Four years later, the greatest single oiling disaster event struck the African Penguin population when the bulk carrier Treasure sank close inshore and just north of Robben Island. Approximately 20,000 oiled penguins (12% of the global population) were rescued and transported to rehabilitation centres in the days that followed.

Even in the absence of these two catastrophic oil spills, it appears that the incidence of oiling has increased during the last decade. Between 1990 and 1999, an average of 925 penguins (0.5% of the global population) were admitted annually to SANCCOB from incidents other than the Apollo Sea and the Treasure spills. This is far greater than the annual average of 343 between 1980–1989 and 547 between 1970 and 1979. Although very large catastrophic oiling events are the most important immediate threat to the population, smaller spills and oil slicks of unknown origin (presumably due to ships illegally washing their bilges) are also increasing and constantly chipping away at the population.

Table 1. Some of the major oil spills along the southern African coast, 1968–2000. Taken from Whittington (2002) and references therein.

<table>
<thead>
<tr>
<th>Name of vessel/incident</th>
<th>Type of incident</th>
<th>Locality</th>
<th>Year</th>
<th>Oil split (tonnes) and type</th>
<th>Number of penguins oiled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esso Essen (tanker)</td>
<td>Struck submerged object</td>
<td>Cape Point</td>
<td>April 1968</td>
<td>15,000 crude</td>
<td>3,000</td>
</tr>
<tr>
<td>Kazimah</td>
<td>Ran aground</td>
<td>Robben Island</td>
<td>Aug 1970</td>
<td>1,000</td>
<td>559</td>
</tr>
<tr>
<td>Wafa (tanker)</td>
<td>Ran aground</td>
<td>Cape Agulhas</td>
<td>Feb 1971</td>
<td>6–10,000 crude</td>
<td>1,216+</td>
</tr>
<tr>
<td>Unknown</td>
<td>Unknown</td>
<td>Dassen Island</td>
<td>Mar 1972</td>
<td>Unknown</td>
<td>4,000</td>
</tr>
<tr>
<td>Oswego Guardian</td>
<td>Collided</td>
<td>Ystermark Point</td>
<td>Aug 1972</td>
<td>10,000 crude + fuel</td>
<td>1,600</td>
</tr>
<tr>
<td>Tecla (tankers)</td>
<td>Run aground</td>
<td>Struisbaai</td>
<td>Jul 1974</td>
<td>200 fuel</td>
<td>488+</td>
</tr>
<tr>
<td>Oriental Pioneer</td>
<td>Collided</td>
<td>Cape St Francis</td>
<td>Dec 1977</td>
<td>31,000 crude + fuel</td>
<td>47+</td>
</tr>
<tr>
<td>Venus/Kenoil (tankers)</td>
<td>Run aground</td>
<td>Near Vondeling Island</td>
<td>Mar 1978</td>
<td>300 fuel</td>
<td>27</td>
</tr>
<tr>
<td>Pantelis A. Lemos</td>
<td>Broke up and sank</td>
<td>West of Saldanha Bay</td>
<td>Aug 1983</td>
<td>160–190,000 crude</td>
<td>0 (5,000+ Gannets)</td>
</tr>
<tr>
<td>Castillo de Belver</td>
<td>Sank</td>
<td>Cape Recife</td>
<td>Aug 1985</td>
<td>1,011 fuel</td>
<td>1,180</td>
</tr>
<tr>
<td>(tanker)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kapodisria (bulk carrier)</td>
<td>Ran aground</td>
<td>South-west of Dassen Island</td>
<td>Jun 1994</td>
<td>up to 2,400 fuel</td>
<td>10,000</td>
</tr>
<tr>
<td>Apollo Sea (bulk ore carrier)</td>
<td>Sank</td>
<td>Dassen Island</td>
<td>Jan 1994</td>
<td>Unknown</td>
<td>1,332</td>
</tr>
<tr>
<td>Unknown</td>
<td>Chronic</td>
<td>Dyer Island</td>
<td>Aug 1995</td>
<td>Unknown amount of fuel</td>
<td>1,200+</td>
</tr>
<tr>
<td>Cordeiliera</td>
<td>Broke apart</td>
<td>Eastern Cape</td>
<td>Nov 1996</td>
<td>150 in harbour + 5 in Table Bay</td>
<td>563</td>
</tr>
<tr>
<td>Cape Town Harbour spill</td>
<td>Burst pipeline</td>
<td>Cape Town Harbour</td>
<td>May 1998</td>
<td>1,400 fuel</td>
<td>19,000</td>
</tr>
<tr>
<td>(bulk ore carrier)</td>
<td>Sank</td>
<td>North of Robben Island</td>
<td>Jun 2000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Rescue and rehabilitation success

Rehabilitation procedures at the SANCCOB centre have changed over the years and are constantly being refined. Over the past three decades about 74% of sick and oiled African Penguins that were admitted to SANCCOB were released back into the wild in a healthy condition. However, release rates have improved greatly over the years (Figure 4), increasing from an annual average of 52% in the 1970s to 78% in the 1990s. Between 1996 and 2000, 84% of penguins admitted were released into the wild in a healthy condition. What makes this even more remarkable is the fact that release criteria have become a lot more stringent over the years. Currently, birds must pass the following tests before being released into the wild: a) the waterproofing ability of the bird’s plumage is inspected after swimming for about one hour; b) birds must weigh over 2.8 kg; c) red and white blood cell counts must be normal; and 4) blood smears are taken to ensure the bird is free of any infection.

A comparison of the rescue operations for the two largest oil spills tells a story of lessons well learnt. Prior to the sinking of the Apollo Sea in 1994, the greatest number of penguins rescued was probably the 1,751 penguins collected from Dassen Island during 1972.20 It is therefore no wonder that conservation organisations were ill prepared for the 10,000 African Penguins that were oiled when the Apollo Sea sank near Dassen Island. The lack of sufficiently aerated containers for transporting oiled birds and the overloading of boxes resulted in more than 1,700 birds dying during transportation from the island to the rehabilitation centre (mostly due to asphyxiation and stress).22 Inability to adequately stabilise the large number of birds arriving at the rehabilitation centre resulted in a further 1,200 birds dying during their first 24 hrs in the centre. Of the 6,900 birds that survived their first 24 hrs in captivity, 75% were released back into the wild in a healthy condition.

Lessons learnt from the Apollo Sea spill were well heeded, and when the Treasure sank almost exactly four years later, rescue teams were far better prepared. This despite the fact that the number of potentially affected birds was more than four times that of birds oiled in the Apollo Sea spill, or almost 25% of the global population. Of the 20,000 oiled penguins that were rescued from Robben and Dassen Islands, incredibly more than 90% survived to be released back into the wild in a healthy condition.23 A further 19,500 clean penguins were evacuated from the island and transported to Algoa Bay (some 800 km by road) in an effort to prevent them from entering the polluted waters around their breeding islands. This too was a great success and only 241 birds died during transportation.23 The first birds completed the 900 km swim home in only 11 days, whilst the median time was probably a week longer. By this time the oil had cleared, allowing these birds to escape almost certain oiling.

The cost of penguin rescue and rehabilitation

Real costs of rescue and rehabilitation operations are difficult to determine owing to the voluntary nature of much of the work. The best available estimates of costs incurred are insurance claims placed by organisations involved in rescue and rehabilitation operations.

The total insurance claim for the rescue and rehabilitation of seabirds during the Apollo Sea oil spill was 2,149,375 South African Rands24 (equivalent at the time to some US$ 589,000).

How does oil affect penguins?

Being flightless and spending most of their time at sea, at or near the surface of the ocean, African Penguins are particularly susceptible to marine oil pollution. If oil covers their feeding grounds or gets onto their landing areas at the breeding colony, it is inevitable that penguins will become oiled. Oil causes the birds’ feathers to clump, breaking down their natural insulative and waterproofing properties. Oiled penguins tend to come ashore and, having lost their insulation and waterproofing, will not return to sea to forage. If not rescued, they will ultimately die from hypothermia, dehydration, or starvation. Furthermore, oiled penguins will attempt to remove the oil from their feathers by preening themselves. This only results in birds ingesting oil, which in turn can lead to ulceration of internal organs, anaemia and petro-chemical poisoning.
The cost per penguin rescued, rehabilitated and released back into the wild in a healthy condition was thus R412 (US$112). The seabird rescue and rehabilitation insurance claim for the *Treasure* spill was 10,166,544 Rands (equivalent to about US$1,459,000 at the time), or R628 (US$90) per penguin released back into the wild in a healthy condition. The decrease in the US$ cost per released bird in the *Treasure* spill, compared to the Apollo *Sea* spill, was probably attributable to the higher release rate during the *Treasure* spill (i.e. more rescued birds survived to be released).

Efforts to rehabilitate seabirds in other parts of the world have been extremely expensive. The rescue and rehabilitation of the 800 seabirds that survived to be released during the *Exxon Valdez* spill in Alaska cost some US$41 million (US$51,000 per bird).

There are two main reasons for the low cost for the rehabilitation of African Penguins. Firstly, African Penguins are physically very tough and robust and thus able to deal with the rescue, cleaning and rehabilitation process far better than other species. Secondly, the existence of a well-managed rehabilitation facility with trained and experienced staff and volunteers greatly reduces the initial setup costs and increases rehabilitation success. Although SANCCOB has been able to reclaim costs from the insurers of vessels involved in the two major spills, the cost of keeping this facility in a state of operational readiness between spills is large. Furthermore, smaller spills that are constantly chipping away at the penguin population are mostly of unknown origin and costs are therefore not recoverable.

**Conclusions**

Currently oiling is one of the principal threats to the threatened African Penguin. Although the best solution would be to avoid oil spills, the frequency of both catastrophic as well as chronic oil spills has increased during the last decade. Without efforts to rescue and rehabilitate African Penguins, a third of the global population could have been lost between 1994 and 2000. However, rehabilitation efforts by SANCCOB in collaboration with international seabird rescue experts and local conservation agencies have been highly successful and currently more than 80% of oiled birds are released back into the wild in a healthy state. Returns for investments by conservation-minded donors are thus very good, with costs of less than US$100 to rescue a penguin from certain death by oiling. But the continued success of cleaning oiled penguins requires that the rehabilitation facilities and the expertise of SANCCOB be maintained in a state of readiness between oil spills.

**References**


25. SANCCOB. Personal communication.


Post-release survival of rehabilitated African Penguins

PHIL A. WHITTINGTON

Avian Demography Unit, Department of Statistical Sciences, University of Cape Town, Rondebosch, 7701, South Africa, e-mail: pwhit@adu.uct.ac.za

Abstract


The efficacy of SANCCOB’s rehabilitation of oiled African Penguins was tested by conducting intensive searches for flipper-banded penguins at breeding colonies between 1994 and 1999. The survival of rehabilitated birds was investigated by assessing the proportion of released penguins that return to breeding colonies, the length of time between release and death, estimation of survival rates using the computer package MARK, and an analysis of penguins that were known to have attained an age of 20 years or more in the wild. Attempts to clean oiled African Penguins and rehabilitate them back to the wild have been largely successful. Post-release monitoring of African Penguins from four different oil spills revealed that up to 87% of rehabilitated penguins returned to breeding colonies. An analysis of recoveries of penguins that had died within a period of ten years after banding or release showed that the median number of days survived by rehabilitated penguins after release was similar to that survived by penguins unaffected by oiling incidents. The mean annual survival rate of rehabilitated adult African Penguins was found to be 0.79 (79%), similar to the figure of 0.81 (81%) for non-oiled adult penguins banded at Robben or Dassen Island. The six oldest birds known from the wild include four that had been treated by SANCCOB, one of which had been oiled and cleaned. The latter bird is the world’s oldest known survivor from an oiling incident, having been at least 24 years old when last sighted alive. An assessment was made of the success in hand-rearing chicks that had been orphaned at Dassen Island by an oil spill in 1994. The proportion of the hand-reared chicks that survived to breeding age was found to be similar to that of naturally fledged chicks from Dassen Island in the same year.

Post-release monitoring of rehabilitated African Penguins

After days and weeks of cleaning, feeding and nursing African Penguins that have been oiled, it is a wonderful experience to see them regain their freedom. They usually hurry down the beach, stop to find their bearings and then take their first plunge back into the ocean. But what happens to them afterwards? Do they return to their breeding colonies? Do they live out a normal life-span? Or do they fail to make that crucial transition back to the wild?

These are questions that can only be answered by intensive monitoring work following an oil spill. The ecological and economic value of cleaning oiled birds has been questioned by some. Frost et al. considered that it contributed “little to conservation in real terms”, whereas Randall et al. were of the opinion that cleaning oiled African Penguins does serve a conservation function. Sharp pointed out that in North America and Europe, available data lead one to the conclusion that cleaned and treated seabirds do not successfully make the transition back to the wild. In fact, the whole question of whether cleaning oiled birds serves any useful function or is merely a human “feel-good” exercise, but really an expensive waste of time, effort and resources, has been raised. The only way to approach this question is with a sound analysis of scientific data and this has been achieved with SANCCOB’s work on African Penguins.

In order to assess how successful rehabilitation of oiled penguins has been, and thus justify the costs of rehabilitation in time, effort and money, it is necessary to be able to identify rehabilitated individuals in the wild. The most successful method of doing this is to fit a specially designed metal flipper-band to each bird, shortly before they are released from the rehabilitation centre (see box on p. 10). This band will last for the bird’s lifetime and the unique letter/number combination used on the band allows each bird to be individually recognisable. Several years of intensive monitoring are required to assess fully the success of a rehabilitation effort. Southern Africa is fortunate in this respect. African Penguins are not highly migratory birds. Although they may forage away from their breeding colonies and may travel up to 2,000 km in their first year or so of life, adults generally remain within their breeding range throughout the year. Monitoring work is also facilitated by the fact that most of the breeding colonies are easily accessible to researchers.

Scientists have also banded penguins for reasons other than following those involved in oil spills. Adult penguins and chicks have been banded at breeding colonies in order to investigate their movements, breeding success, age of first breeding and annual survival. This means that there is a large sample of banded birds that have not been oiled or cleaned, against which the performance of the oil spill survivors can be measured.

The most intensive period of monitoring penguins began towards the end of 1994, following what had then been the worst oil spill to affect African Penguins. Of the 10,000 penguins oiled...
after the sinking of the bulk ore carrier Apollo Sea, 5,200 died, most within 48 hours of being rescued. However, the remainder were successfully cleaned and released, 4,076 having been fitted with flipper-bands. A joint project of the Avian Demography Unit, Marine and Coastal Management and Western Cape Nature Conservation Board also monitored the breeding success of oiled birds, and Robben Island. Other colonies, such as Dyer Island and the islands in Saldanha Bay, were visited more opportunistically, usually 3–4 times a year. Staff of Port Elizabeth Museum, working on the islands in Algoa Bay, and of the Ministry of Fisheries and Marine Resources from the offshore islands of Namibia also contributed sightings of flipper-banded birds. Other sightings of banded penguins, made by the general public, were forwarded to the South African Bird Ringing Unit (SAFRING) at the University of Cape Town.

During the course of the project, other oil spills occurred. A small spill of unknown origin oiled 1,332 penguins at Dyer Island in August 1995. The Cordigliera sank off the Eastern Cape coast in November 1996, oiling over 1,200 penguins. A burst pipeline in Cape Town Harbour in May 1998 oiled a further 563 penguins. Penguins rehabilitated from these spills were also banded prior to their release and their subsequent progress was monitored. The fieldwork involved painstaking hours of searching in burrows, under rocks and under bushes for flipper-banded penguins and using a telescope to read band numbers of penguins on the shore. The result of these efforts was a database containing 55,800 sightings of 11,800 different penguins.

The assessment of the success of cleaning operations, with regard to survival of the penguins after release, was made in five ways:

1. Short-term: numbers of released penguins recorded back at breeding colonies.
2. Long-term: for penguins that were recovered dead within ten years from banding, the time between banding and death was compared between cleaned birds and non-oiled birds.
3. Estimation of survival rates using the software package MARK.
5. Survival of hand-reared orphaned chicks to breeding age.

Both 2 and 4 relied on data from penguins oiled in incidents prior to 1994, going back as far as the early 1970s.

1. Numbers of rehabilitated penguins recorded back at breeding colonies

Three incidents that occurred between 1994 and 1998 were closely monitored: the Apollo Sea spill of June 1994, the Dyer Island spill of August 1995 and the Cape Town Harbour spill of May 1998. The first of these provided the largest sample of banded penguins and the longest period of monitoring (five years). The first indication that the cleaning and release of penguins from the Apollo Sea spill had been successful was the lack of dead penguins found shortly after release. Had the operation not been successful, we would have expected a larger than average number of penguins to have been found dead. This was not the case. In fact, the proportion of cleaned penguins that were found dead within the first two years after the spill was close to the total that would have been expected from a similarly sized sample of healthy, non-oiled penguins. This was still the case after five years had elapsed. The number of cleaned penguins re-sighted in the wild rose sharply during the first two years following their release before levelling off in subsequent years (Figure 1). Five years after the Apollo Sea spill, a total of 2,962 penguins had been recorded back at breeding colonies; almost 73% of those released after the spill. This is further evi-
Penguins and flipper bands

Bird rings have now been in use for about 100 years and are a tried and trusted method for marking birds so that they can be individually recognised. The rings used on penguins are placed on the flipper and are really ovoid bands, rather than rings. The shape of the band mirrors the cross-section of the penguin’s flipper and is somewhat torpedo-shaped when seen from above. This makes the fit as good as possible and reduces the amount of “drag” caused by the band when the penguin is swimming.

The bands are presently made from stainless steel and have a letter prefix and four or five numbers engraved on one side. They can be read in the field using binoculars or a telescope. On the reverse side of the band is a contact address, so that anyone who finds it can report the details to SAFRING and receive some information on where and when the bird was banded.

If you find a ring or are able to read the number in the field, please inform SAFRING at the Avian Demography Unit, Department of Statistical Sciences, University of Cape Town, Rondebosch, 7701, South Africa, telephone (021) 650-2421, fax (021) 650-3434, e-mail SAFRING@adu.uct.ac.za. They will need to know the ring or band number, the species (if known), date and locality of finding.

The pattern of the other two spills mentioned was similar to that of the Apollo Sea (Figure 1). However, the proportion of penguins re-sighted from the Dyer Island spill is considerably lower than the proportions seen after the other two incidents mentioned. The reason for this is not immediately apparent, although Dyer Island, the colony affected by this spill, does not receive the intensity of monitoring effort that either Robben Island or Dassen Island, the colonies worst affected by the other two spills, receives. This may have reduced the proportion of birds recorded following release. However, Dyer Island is relatively small when compared to either Dassen or Robben Island. It now has fewer penguins than either of these two colonies (Table 1) and they are forced to nest on the surface and are therefore easier to find than the large numbers that nest in burrows, under rocks and under bushes at Robben and Dassen islands.
Rescue and transport

a) Oiled penguins on Robben Island, during the Treasure spill.
b) Catching oiled penguins.
c) Transferring oiled penguins to aerated boxes for transport.
d) Loading boxes of oiled penguins onto a boat, Dassen Island.
e) Loading boxes of oiled penguins into a helicopter, Dassen Island.

Photo credits: SANCCOB archive (a), A.P. van Dalsen (b), A.C. Wolfaardt (c, d, e).
Stabilisation and cleaning

a) Oiled penguins arrive at the SANCCOB rehabilitation centre.
b) Re-hydrating an oiled penguin with an electrolyte solution.
c) Oiled penguin enters the wash.
d) Oil being removed from feathers.
e) Cleaned penguin being fed.

Photo credits: P.A. Whittington (a), A.P. van Dalsen (b, d, e), C. Loch-Davis (c).
Rehabilitation and release

a) Thousands of penguins inside the Salt River warehouse, during the Treasure oil spill.
b) Cleaned penguins in temporary pens.
c) Cleaned penguins stand around a purpose-built pool.
d) Regular swimming of cleaned penguins ensures that feathers are in prime condition for release.
e) Cleaned and fully rehabilitated penguins are released.

Photo credits: A.P. van Dalsen (a, e), S. Petersen (b, c, d).
Reintegration and follow-up research

a) Rehabilitated penguin, from the Treasure oil spill, with two healthy chicks.

b) Searching for flipper-banded rehabilitated penguins along the shoreline, Dassen Island.

c) Following the growth of two small chicks produced by Apollo Sea rehabilitated parents.

d) Two fully feathered chicks, raised by Apollo Sea rehabilitated parents, ready to go to sea.

e) Clean penguins!

Photo credits: L. Upfold (a), H. Ratz (b), J.L. Nel (c, d), A.C. Wolfaardt (e).
Investigation of the database reveals another difference from both the Apollo Sea and Cape Town Harbour spills. In the latter two incidents, the majority of penguins re-sighted were seen at the islands immediately affected by the two spills, i.e. Robben and Dassen islands. However, most (72%) of the penguins oiled in the Dyer Island spill were later re-sighted at Dassen Island, suggesting that they were Dassen Island birds that had been foraging around Dyer Island when they were oiled. This has important repercussions for the release procedure of cleaned penguins. It demonstrates that releasing penguins as close as possible to their point of capture is not always the best policy. Given the ability of penguins to find their way back to their breeding colonies, it would seem to make more sense to release them as close as possible to the rehabilitation centre. This was done following the Treasure oil spill in 2000. These differences between oiling incidents and the rehabilitation success from different spills highlights the importance of monitoring penguins affected by future oil spills.

Only 16 months of re-sighting data were available for penguins oiled in the Cape Town Harbour spill. The number of penguins re-sighted one year after their release (50%) compares favourably with the 45% of Apollo Sea birds seen one year after their release. The signs are therefore good that the rehabilitation effort from the Cape Town Harbour spill will be equal in its success to that of the Apollo Sea. The number of cleaned penguins that were found dead did not exceed the numbers that would be expected from similar-sized populations of non-oiled penguins in any of these three incidents.

The proportions of penguins oiled in adult plumage that were re-sighted following release were greater than those of birds oiled when still juvenile. This was the case in all three of the incidents described above (Table 2), although the proportion of juveniles seen one year after the Cape Town Harbour spill was nearly double the corresponding proportion seen five years after the Apollo Sea spill. This suggests that birds in their first year have a higher mortality rate than those that have attained adult plumage.

The highest proportion of released penguins recorded back at a breeding colony was 87%. This was based on a total of 101 penguins released from Robben Island after being oiled in an incident at St Croix Island, Algoa Bay, in 1979.

### Table 1. Numbers of breeding pairs of African Penguins at Dassen, Dyer and Robben islands, 1995–1999. Data courtesy of Marine and Coastal Management and Western Cape Nature Conservation Board.

<table>
<thead>
<tr>
<th>Year</th>
<th>Dassen Island</th>
<th>Robben Island</th>
<th>Dyer Island</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>9,702</td>
<td>2,279</td>
<td>4,260</td>
</tr>
<tr>
<td>1996</td>
<td>9,502</td>
<td>3,097</td>
<td>3,279</td>
</tr>
<tr>
<td>1997</td>
<td>8,651</td>
<td>3,356</td>
<td>2,746</td>
</tr>
<tr>
<td>1998</td>
<td>10,918</td>
<td>3,467</td>
<td>1,963</td>
</tr>
<tr>
<td>1999</td>
<td>15,155</td>
<td>4,399</td>
<td>2,363</td>
</tr>
</tbody>
</table>

### Table 2. Proportions of African Penguins re-sighted by October 1999 following three oiling incidents.

<table>
<thead>
<tr>
<th>Incident and date</th>
<th>Adults re-sighted (%)</th>
<th>Juveniles re-sighted (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apollo Sea, 1994</td>
<td>79</td>
<td>23</td>
</tr>
<tr>
<td>Dyer Island, 1995</td>
<td>51</td>
<td>19</td>
</tr>
<tr>
<td>Cape Town Harbour, 1998</td>
<td>60</td>
<td>44</td>
</tr>
</tbody>
</table>

### Table 3. Time elapsed (months) between banding and death of African Penguins that were banded when full-grown, truncated to ten years.

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Non-oiled (n = 163)</th>
<th>Cleaned (n = 147)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Months elapsed</td>
<td>Confidence intervals</td>
</tr>
<tr>
<td>50</td>
<td>21</td>
<td>(15, 25)</td>
</tr>
<tr>
<td>75</td>
<td>53</td>
<td>(36, 65)</td>
</tr>
<tr>
<td>90</td>
<td>89</td>
<td>(76, 99)</td>
</tr>
<tr>
<td>95</td>
<td>108</td>
<td>(92, 113)</td>
</tr>
</tbody>
</table>

This analysis was performed on full-grown African Penguins that were found dead within ten years of their having been banded. In this instance, full-grown refers to penguins that had already left their natal colony, i.e. it excludes those banded as chicks. The length of time between banding and death was compared between rehabilitated penguins and those that had never been oiled or treated. If rehabilitation efforts were unsuccessful, one would expect the average time elapsed between banding and death to be shorter for rehabilitated penguins than for non-oiled birds. A randomisation test was performed on the data to test whether rehabilitated penguins survive as long as non-oiled penguins after banding. This test allows different percentiles of the population to be tested and has the advantage that survival rates are not required to conform to a parametric model.

The median elapsed times between banding and death at four percentiles of the population differed by a maximum of three months between the samples of non-oiled and of rehabilitated African Penguins (Table 3). The 50th percentile represents the youngest half of the population at death. The 95th percentile includes all but the oldest 5% of the sample. From Table 3 it is clear that the test results are not significant and that the null hypothesis of equal elapsed times for the two groups is accepted. This suggests that rehabilitated penguins survive equally well in the wild as penguins that have never been oiled.

This result differs from that found in other parts of the world. The median time elapsed between release and death for three species of North American seabirds that were rehabilitated following an oil spill was less than 10 days, compared to 23 months for the youngest 50% of rehabilitated African Penguins. If the median elapsed times between banding and death are compared for the three North American species, the non-oiled birds survived 36 to 52 times longer than rehabilitated birds. In contrast, non-oiled, full-grown African Penguins survived 1.2 times longer than cleaned penguins; and if the sample is restricted to penguins banded in adult plumage, this ratio is reduced to 1.1. This evidence implies that the North American seabird species did not make a successful transition back into the wild after cleaning. Results from the United Kingdom are equally depressing; the median time which had elapsed between ringing and death for rehabilitated Guillemots Uria aalge was

---

Whittington: Post-release survival
seven days\(^{10}\). Attempts have been made to clean oily Magellanic Penguins in Argentina but none were seen after release and rehabilitation was stated to be “of little use”\(^2\). SANCCOB has by far the best record of successfully returning oiled birds back into the wild.

### 3. Comparison of survival rates from live re-sightings

Live re-sightings of African Penguins banded at Dassen Island or at Robben Island were used to estimate survival rates using the program MARK, which allows various different models to be tested on the data\(^3\). The program uses Likelihood Ratio Techniques to estimate survival between specified periods, in this case a year. The user can specify a variety of models, e.g. survival rates can be set to change over time or be different for different age groups. The most parsimonious model tested is that which best fits the data and gives the most precise estimates of survival and re-sighting rates. Akaike’s Information Criterion (AIC) is used by the program as a guide to selection of the most parsimonious model. See reference\(^1\) for further details.

Using re-sighting data for the years 1989–1999, the average annual survival rate of non-oiled, adult African Penguins banded at Robben Island or at Dassen Island was found to be 0.81 (81%)\(^6\). The same procedure was followed using African Penguins that had been oiled and cleaned. It was rarely known from which colony the cleaned penguins had come prior to oiling, so all the available data for the years 1990–1999 were used. The average annual survival rate of 0.79 was similar to those of non-oiled penguins banded at Robben and Dassen Islands. It is possible to compare the survival rates of rehabilitated penguins with those of non-rehabilitated birds using MARK to see if they differ. This is done by treating the non-oiled birds as one group and the rehabilitated birds as another group. Models can then be tested that apply different survival rates to each group or that apply the same survival rates to both groups. To make this comparison even, the non-oiled group included all penguins banded as adults, i.e. not just those banded at Dassen and Robben islands, over the same span of years (1990–1999).

The most parsimonious model represented a situation where the same survival rates were applied to both groups\(^6\). The fact that this model was chosen suggests that survival rates of rehabilitated and of non-oiled penguins do not differ significantly from each other; another indication that rehabilitated penguins survive equally well after release as those that have not been oiled.

### 4. Longevity of African Penguins

The oldest known African Penguin in the wild was at least 27 years old when it was killed in a traffic accident in Simon’s Town, near the Boulders penguin colony, in 1999\(^{11}\). It is one of 26 African Penguins that are known to have lived for 20 years or more. Of these 26 penguins, five were treated by SANCCOB, at least one of which had been oiled and cleaned. The latter bird was at least 24 years old when last sighted alive and is thought to be the world’s oldest known surviving bird from an oiling incident. The 10 oldest African Penguins in the wild include four that had been treated by SANCCOB (Table 4)\(^1\).

Of the penguins known to have survived into their twenties, 23 were fitted with flipper-bands prefixed by the letter “P”. These bands were used in the 1970s; 7,656 (78%) were fitted to penguins at breeding colonies and 2,209 (22%) to penguins that had been treated by SANCCOB. If rehabilitated penguins survive as well in the wild as non-oiled penguins, we would expect similar proportions to be reflected in the oldest 23 penguins that were fitted with “P” prefix bands. Of these 23 penguins, five (22%) were rehabilitated by SANCCOB, which is identical to the expected proportion. Yet another indication that, as far as survival is concerned, rehabilitated African Penguins do just as well as non-oiled penguins after their release back into the wild.

### 5. Survival of hand-reared orphan chicks

African Penguin chicks are not in immediate danger of being oiled while at the nest, unless brooded by a severely oiled parent. They are, however, impacted by the oil spills if their parents are oiled and die or are taken to a rehabilitation centre for several days or even weeks. In the latter case, the chicks are effectively orphaned and are then likely to be predated or starve to death. Consequently, attempts have been made to hand-rear the larger African Penguin chicks orphaned by oil spills. This was first done in 1994, following the Apollo Sea oil spill\(^12\). Of 507 orphaned chicks that were hand-reared at Dassen Island, 474 were successfully “fledged”, 437 having been fitted with flipper-bands. A further 399 penguin chicks were banded at nests at Dassen Island in 1994 prior to the oil spill, allowing a comparison to be made of the survival of orphaned and naturally fledged chicks.

Between October 1994 and October 1999, 47 of the 437 orphaned chicks (11%) were re-sighted at breeding colonies\(^13\). Six (1%) were recorded breeding and eight (2%) were found dead. Of the 399 naturally fledged chicks, 36 (9%) were re-sighted alive, five (1%) were recorded breeding and four (1%) were found dead. Although relatively few of the hand-reared chicks appear to have survived to breeding age (4–5 years old), the proportion that died so was almost identical to that of the chicks that fledged naturally. The proportions of orphaned chicks recorded breeding and found dead were also similar to those of the naturally fledged penguins, as was their pattern of dispersal after leaving the nest. This suggests that the hand-rear-
ing exercise was successful in producing chicks with an equal chance of surviving in the wild to those reared under natural circumstances.

Of 50 chicks hand-reared after an oil spill at Dyer Island in 1995, nine (18%) had been re-sighted alive by October 1999. No chicks were banded at nests on the island in 1995 with which to make a comparison. It is still too early to assess the result of the survival of the larger number of over 2,000 chicks, orphaned and hand-reared following the sinking of the Treasure in June 2000.

Although hand-reared African Penguin chicks survive as well as naturally fledged chicks in the wild, the proportion that survive to breeding age is low. Priority must therefore go to cleaning oiled adult birds, which have already survived that most critical first year of life and have a much greater annual survival rate. Furthermore, adult birds can potentially commence breeding immediately after release 14, whereas hand-reared chicks are unlikely to breed until they are four to five years old 6,15.

The results of these five investigations are good news for the conservation of the African Penguin, but it is imperative that measures are taken to minimise the risk of oil pollution if our coastal ecology is to remain in a healthy state. As well as being part of our natural heritage, the South African coast and its seabirds attract many tourists and are also of considerable economic importance. The fact that SANCCOB’s work has considerably reduced the numbers of a vulnerable species that have been lost to oil spills, and that the African Penguins they have cleaned, treated and released have survived as well as non-oiled penguins in the wild, is a great tribute to the dedication of their staff and army of volunteers. However, this is not the whole story. Even if cleaned penguins survive in the wild, it is of little consequence if they are unable to breed and contribute to the growth and stability of the population. So how does oiling, cleaning and treatment affect the breeding performance of the African Penguin? This question is tackled in the next paper 14.

References

Breeding productivity and annual cycle of rehabilitated African Penguins following oiling

ANTON C. WOLFAARDT¹ & DEON C. NEL²

¹Western Cape Nature Conservation Board, Private Bag X5014, Stellenbosch, 7600, South Africa, e-mail: awolfaardt@kingsley.co.za; ²BirdLife International Seabird Conservation Programme, BirdLife South Africa, PO Box 1586, Stellenbosch, 7599, South Africa

Abstract


The success of rehabilitation efforts is often measured by the number of individuals that survive to return to their breeding colony. However, little is known about the effect of the oiling and the subsequent rehabilitation on the breeding productivity and annual cycle of rehabilitated birds that return to their breeding colony. At Dassen Island in the south-western Cape, a monitoring study was initiated soon after the first rehabilitated African Penguins were released following the Apollo Sea oil spill in June 1994. Six years after the Apollo Sea spill at least 60% of the rehabilitated penguins had been recorded breeding. The breeding productivity of the rehabilitated birds was, on average, no different to that of other penguins that were not affected by the oil spill. However, in a couple of the nest cohort comparisons, when both the Apollo Sea rehabilitated birds and birds unaffected by the oil spill fared poorly owing to adverse feeding conditions, the rehabilitated birds did notably worse than the unaffected birds. These differences were restricted to only a couple of comparisons within the first two years of the study, highlighting the short-term nature of this impact. Other subtle and short-term impacts of oiling and rehabilitation on African Penguins following the Apollo Sea oil spill included the disruption of annual moult and breeding cycles, and breaking of pair bonds owing to the death or prolonged absence of a partner. In the recent Treasure oil spill about 19,500 penguins were taken off Dassen and Robben islands to prevent them from becoming oiled. They were released 800 kilometres away at Cape Recife in the Eastern Cape province. Interim results indicate that the relocation of these birds was a remarkable success and that relocated birds recover more rapidly than rehabilitated birds. Relocation and rehabilitation are not mutually exclusive processes. Relocation of birds should be seen as an additional management tool, which can be utilised when large numbers of birds are known to be threatened by oil pollution.

Introduction

Rehabilitation of African Penguins is of little conservation value if these birds do not go on to breed and thus contribute to the future of the species. The overall success of the rehabilitation process should therefore also take into account the reproductive productivity of birds after release. This does not mean that rehabilitated birds need to breed immediately after release, but if they never produce offspring again, they are essentially redundant to the population. It can even be argued that rehabilitated birds that never produce viable offspring actually have a potentially negative impact on the breeding population by competing for limited food and other resources. It is therefore important to determine how many of the birds that survive to make it back to their colony attempt breeding, and whether the oiling and rehabilitation have any effect on their subsequent breeding success.

Oil contamination, and specifically oil which is ingested or inhaled by birds while preening contaminated feathers or while consuming contaminated food or water, has a number of effects on birds that may affect their subsequent breeding success. It has been shown that ingestion of oil can have a negative impact on the endocrine system, interfere with the circulation of reproductive hormones and lead to a suppression of egg-laying. Oil contamination may also lead to thinning of eggshells and reduce the viability of eggs, embryos and chicks. It can suppress the bird's immunity to infection and may also cause behavioural anomalies resulting in reduced chick provisioning or nest abandonment. Furthermore, it has been found that chicks of birds that have ingested oil may develop physiological abnormalities or show lowered growth rates and survival.

Most of the studies of the effects of oil exposure on birds have been investigations of laboratory or captive birds, and have focused mostly on the short-term effects of oiling on breeding biology. Very little information is available on the longer-term impacts of oiling on the breeding productivity of penguins that have been oiled, rehabilitated and released back into the wild.

Two catastrophic oil spills have affected the south-western coast of South Africa during the last decade. The Apollo Sea, a bulk ore carrier, sank south-west of Dassen Island in June 1994,
and the *Treasure* sank between Dassen and Robben islands in June 2000. Approximately 10,000 and 20,000 African Penguins were oiled during these two events respectively. Ongoing follow-up studies of African Penguins oiled and cleaned after these two spills, as well as smaller spills and chronic oil pollution, have allowed a detailed study of the short and long-term effects of oiling and rehabilitation on the breeding productivity of African Penguins.

**Proportion of rehabilitated African Penguins attempting to breed following the Apollo Sea oil spill**

Six years after the Apollo Sea spill, approximately 60% of the rehabilitated African Penguins that had been re-sighted in two intensively studied areas on Dassen Island, had also been recorded breeding. This figure is likely to be an underestimate, as it is impossible to capture every breeding attempt on the island. Furthermore, many of the birds re-sighted in these areas may merely have been transient birds from other colonies. However, as can be seen in Figure 1, the proportion of the returned Apollo Sea birds that attempted breeding over the six-year period is similar for two different study areas. Both study areas were sampled intensively over the six-year period. Since the beginning of 1998 the proportion of returned birds attempting breeding has remained fairly constant, and it is unlikely that this figure is going to increase further.

The fact that well over 60% of the rehabilitated penguins re-sighted in these study areas have attempted breeding bodes extremely well for the conservation of the species. However, there does appear to be a small proportion of rehabilitated birds that have not attempted to breed in the six years following the Apollo Sea spill. The cause of this is unclear at present; possible causes include sub-lethal effects of the oil ingestion on the birds’ reproductive physiology and disruption of pair bonds and annual breeding cycles of rehabilitated birds. This is an aspect that requires urgent investigation, and will be the subject of future studies.

**Breeding productivity of Apollo Sea penguins**

The effect of oiling and treatment (cleaning) on subsequent breeding success was studied by comparing breeding parameters of Apollo Sea nests (containing either one or two birds rehabilitated following the Apollo Sea oil spill) and control nests (containing no oiled-rehabilitated birds; i.e. unaffected birds). Breeding success is naturally highly variable in African Penguins, so it is important that the nests being compared are monitored under the same conditions. In order to reduce failure through disturbance, and to maximise the number of nests monitored at the same time (to control for highly variable breeding success), nests were selected during incubation rather than prior to egg-laying. A similar number of Apollo Sea and control nests were monitored for each cohort. Between 1994 and 2000, a total of 17 cohorts of nests were monitored in which the following parameters were compared:

- **Hatching success**: proportion of chicks hatched from the number of eggs laid
- **Fledging success**: number of chicks fledged as a proportion of the total number of chicks hatched; which together give rise to:
- **Overall breeding success**: probability of an egg producing a fledged chick

Until January 2000, the reproductive success of 599 Apollo Sea and 558 control nests had been monitored. The overall breeding success for all Apollo Sea nests was 0.32 fledged chicks per egg laid, compared to 0.30 for control pairs. The mean number of chicks fledged per pair for Apollo Sea birds was therefore 0.62, whereas the mean number of chicks fledged per pair for control nests was 0.58. There were no statistically significant differences in breeding success between the two groups for any of the studies. However, a closer inspection of the data reveals that in some of the study cohorts there are detectable differences between the two groups.
The most noticeable differences in fledging success occurred in the first two years of the study (Figure 2). In the first study that was conducted, in summer 1994, the fledging success of chicks hatched to Apollo Sea pairs was actually higher than that of control pairs. This result is probably due to the Apollo Sea birds, which had just returned from being in captivity, being more habituated to and thus better able to cope with human disturbance than were the control birds. This would enable the Apollo Sea birds to cope better with the researcher disturbance resulting from the study than control birds. This conclusion is supported by a low-disturbance control study that was conducted at the same time, and showed that the researcher impact was greater for the control birds than for the Apollo Sea birds at this time. From the second year of the study, the frequency of nest visits was reduced from daily visits to once every five days, in order to minimise this disturbance.

In a few of the other studies conducted during the first two years (Autumn 1995, Winter 1995 and Winter 1996) the Apollo Sea pairs did substantially worse than control birds. In the autumn of 1995, there was a brief, two-week period of unusually low food availability. This led to widespread and synchronised weight loss and mortality of chicks throughout Dassen Island. On average, chicks of pairs including Apollo Sea birds lost weight and died sooner than chicks of control pairs. The other studies (Winter 1995 and Winter 1996) in which Apollo Sea birds fared comparatively poorly were also conducted during periods when breeding conditions were not favourable. Although both groups of birds had a relatively low fledging success in these studies, the Apollo Sea birds did notably worse.

These results therefore indicate that, when breeding conditions (especially feeding conditions) were average or good, the Apollo Sea birds fared as well, and sometimes better than, control birds. However, in studies conducted during periods of food shortage or unfavourable breeding conditions the Apollo Sea birds were less successful at raising chicks than control birds.

In all studies after Winter 1996 there was no noticeable difference between the fledging success of Apollo Sea and control birds. This indicates that the effects of oiling and rehabilitation on breeding success were short term in nature, being limited to the first two years of the study. However, none of the studies after Winter 1996 were conducted during periods of significant food shortage. A real test of the long-term recovery of Apollo Sea birds would be a future study conducted under poor feeding conditions.

**Chick growth and survival**

Another aspect which requires investigation is the quality (or viability) of chicks produced by Apollo Sea rehabilitated parents. The chick rearing period is the most demanding period of the breeding cycle for the African Penguin. Chick growth is a measurement that integrates aspects of foraging of both parents, and a detectable result at this level suggests underlying differences in provisioning abilities (and therefore fitness) of one or both parents.

Like most seabirds, African Penguins are long-lived and consequently adjust their reproductive output to minimise the risk of adult mortality. By adjusting their investment in breeding activities (provisioning of young) according to their condition, adult birds can maximise the chances of surviving to breed at a later period, when conditions may be more favourable, or when the birds may be in a better condition. Reduced growth rates in the chicks of oiled birds have been reported in a number of experimental studies, where birds have been dosed with oil. The reduced growth rate observed in these studies was thought to result from secondary poisoning of the embryo. However, other studies have shown that oil contamination can also result in more indirect effects, including a disruption to normal parental attendance and provisioning behaviour. One would therefore expect that the energetic demands of chick rearing would impose a greater energetic cost on oiled-rehabilitated birds if they were already energetically stressed owing to the contamination.

The chick growth and survival data from the Apollo Sea...
study tell a very similar story to that of the breeding success data. Detectable differences in chick growth rates were found in only two studies and these were in the early part of the project. During periods of poor food availability, when chicks in both groups showed depressed growth rates, chicks from Apollo Sea rehabilitated birds were more adversely affected (Figure 3). In all studies after Winter 1996 in which chicks were weighed, the growth rates of chicks from the two groups were similar. Overall, there were no detectable differences in the growth rates and fledging masses of chicks from rehabilitated and unaffected birds (Figure 4).

These results indicate that when the birds are already physiologically stressed owing to poor resource availability (typically a shortage of prey), the extra energetic demands of chick rearing impact the rehabilitated birds more than control birds. However, these effects appear to be relatively short term in nature for African Penguins, not persisting beyond the second year after the oil spill.
Effects of removing birds from colonies for cleaning and treatment

Although the aim of SANCCOB is to clean, treat and release oiled birds as quickly as possible, during large oil spills involving thousands of penguins (such as the Apollo Sea and Treasure spills), it may take up to three months to process the bulk of the birds. Apart from the potential health risks of keeping large numbers of birds in captivity for this length of time (such as the contraction of avian diseases), removing oiled birds from the wild may have further impacts, including the disruption of breeding and moult cycles, as well as established pair bonds.

During the first two years following the Apollo Sea spill, the moult cycle of rehabilitated birds was not synchronised with the rest of the population at Dassen Island, but became more synchronous thereafter (Figure 5).

Similarly, the breeding cycle was also slightly disrupted in the period immediately after the release of birds. However, this was not as significantly impacted as the moult cycle and was mostly due to many Apollo Sea birds only attempting to breed for the first time during the second year following the oil spill (Figure 6).

Penguins, like most seabirds, tend to establish long-term pair bonds. Breeding success is generally greater in well-established pairs than it is in recently formed pairs. Under normal conditions, between 80% and 94% of African Penguins will mate with the same partner in the following year. However, only 67% of Apollo Sea rehabilitated penguins retained the same mate in subsequent breeding attempts. The lower mate fidelity in Apollo Sea penguins may be due to the death or prolonged absence of breeding partners during the oil spill. However, even where both partners survive an oil spill, they may be unable to re-unite owing to subsequent asynchrony in their annual moult cycles. This may arise due to differences in the time spent in captivity (and away from the breeding colony) or the amount of time required before the birds are physiologically able to breed again.

Temporary relocation of clean penguins as a new management tool

Prior to the Treasure oil spill, rescue attempts had focused only on oiled penguins. However, owing to the severity of the Treasure oil spill and the likelihood of unmanageable numbers of penguins becoming contaminated, approximately 19,500 clean penguins were evacuated from Robben and Dassen islands, to prevent them from coming into contact with the oil. These “clean” penguins were transported 800 km to Cape Recife in the

Figure 5. Comparison of moult cycles of Apollo Sea and Control group birds for the period December 1994–June 2000.

Figure 6. The number of incubating Apollo Sea birds and the total proportion of burrows containing incubating adults in Area G for the period November 1994–June 1997.
Eastern Cape, where they were released. This was the first time that such an operation had been undertaken for African Penguins.

The return of three relocated penguins to their breeding colonies was monitored by means of satellite transmitters. In addition, over a thousand relocated birds were marked with identifiable flipper bands. Relocated birds started arriving back at Dassen Island a mere 11 days after they were released at Cape Recife, while the bulk probably arrived about a week later.

When comparing data for the relocated and rehabilitated penguins from the Treasure spill, it is clear that the most noticeable difference lies in the proportion of returned birds that have been recorded breeding (Table 1). The much higher proportion of relocated penguins having attempted breeding is likely to result from a number of factors. Firstly, the relocated birds were, on average, away from the island for a much shorter period of time than oiled-rehabilitated birds. This would result in less disruption to breeding and moult cycles, and to pair bonds. Secondly, the relocated birds did not suffer any of the potentially harmful physiological effects of oiling. Another factor that may have influenced these results is the fact that relocated birds were collected from specific parts of Dassen Island, whereas oiled birds were collected from a much wider area. This increases the probability of re-sighting relocated birds and therefore biases the comparison slightly. However, it is clear that relocation of penguins during a large oil spill is an important proactive management tool.

**Conclusion**

This study proves conclusively that African Penguins can be successfully rehabilitated after oil contamination, and that the majority of rehabilitated birds become fully restored back into the active breeding population. Overall, no difference was detected between the breeding performance of rehabilitated birds and unaffected birds. However, this study did detect some subtle impacts of oiling and rehabilitation. These ranged from altered annual cycles of rehabilitated birds to lowered breeding performance of rehabilitated birds during periods when feeding conditions were poor. These effects appear to be restricted to the first couple of years following an oil spill, indicating that they are short term in nature, and that the penguins do recover from them. There is, however, some concern about a majority of birds that have been re-sighted alive and in apparent healthy condition, but have not as yet been recorded breeding. This phenomenon will be the subject of further investigation.

All in all, the rehabilitation of African Penguins after the Apollo Sea oil spill appears to have been a resounding success. The results show that rehabilitation is not only effective at the individual level but also at the population level. Several factors lead to high rehabilitation and restoration rates for African Penguins. These include the body size and robust nature of the bird, the close proximity of most colonies to rehabilitation or stabilisation/initial holding centres, the world-class facilities and expertise available at SANCCOB and the ease with which the penguins can be monitored after they have been released. Rehabilitation of oiled African Penguins is thus an invaluable tool for the management of this threatened species.

Although African Penguins can be successfully rehabilitated, prevention of oil contamination in the first place is clearly more advantageous. Temporarily relocating clean penguins during a large oil spill appears to be very successful in that it prevents birds from becoming contaminated and minimises the disruption to breeding and moult activities, by reducing the amount of time the affected penguins spend away from the colony. Results from the Treasure oil spill show very clearly that relocated penguins return to breed more readily than oiled-rehabilitated penguins. This again highlights the fact that avoidance of oil spillage altogether is the best solution. Furthermore, it is far more cost-effective to relocate birds than to wait for them to become oiled. However, relocation can only be used for very large oil spills and normally only after a large number of birds have already become oiled. Most oil spills along the southern African coast are actually first detected by the sight of oiled penguins arriving on landing beaches of their breeding colonies. The extent and movement of the spill is normally only established after this, thus allowing an informed decision to be made on relocating clean birds. Furthermore, the origin of most smaller spills is hardly ever established. Relocation will thus never replace the need for an effective rehabilitation facility capable of handling tens of thousands of penguins. Relocation should rather be seen as an additional and extremely valuable measure for minimising the number of penguins that become oiled, given the appropriate conditions.

**References**

Estimating the demographic benefits of rehabilitating oiled African Penguins

PETER G. RYAN

Percy FitzPatrick Institute, University of Cape Town, Rondebosch, 7701, South Africa,
e-mail: pryan@botzoo.uct.ac.za

Abstract


A simple, deterministic population model was used to estimate the difference rehabilitating oiled African Penguins Spheniscus demersus has made to the current penguin population. The model was parameterized to show the same long-term decrease in African Penguins as that observed since the mid-1950s (approximately 1.5% per year). Using the actual numbers of oiled penguins released from SANCCOB since 1968, the model suggests that SANCCOB’s efforts have resulted in the current (2002) African Penguin population being 19% larger (163,000 adults) than it would have been in the absence of rehabilitation efforts (137,000). Most of the benefits of rehabilitating penguins have occurred since 1994, when there have been two major oiling events, and numerous smaller spills. The estimated benefit to date excludes the almost 20,000 penguins that were translocated to avoid being oiled during the Treasure spill in 2000, as well as the benefits from treating non-oiled birds brought to SANCCOB.

The potential future cost of no longer rehabilitating oiled birds was estimated using the stochastic, individual-based model VORTEX (Lacy 1993). Even without catastrophic oil spills, rehabilitating birds from chronic oiling will result in 5% more penguins over 20 years. Assuming catastrophic spills kill 10% of the population, the average population size after 20 years ranges from 22–61% greater if oiled birds are rehabilitated as the probability of spills increases from 5–20% per year. The results suggest that, although the demographic impacts of rehabilitating oiled penguins were initially modest, this activity is becoming increasingly important for conserving African Penguins.

Introduction

The African Penguin Spheniscus demersus is listed as Vulnerable due to its continued population decrease. After falling to roughly a quarter of its original population size during the first part of the 20th century owing to direct exploitation, African Penguin numbers continued to decrease by approximately 1.5% per year over the last 50 years (excluding the apparent recent increase in the South African population thought to be the result of improved prey availability). Currently, the main factors driving this decrease are thought to be competition with commercial fisheries for prey species, increasing predation by Cape Fur Seals Arctocephalus pusillus, competition for space at breeding islands, degradation of breeding colonies caused by guano collection, and mortality due to oiling. The rate of oiling has increased dramatically over the last decade, from an average of 0.2% of the population oiled each year in the 1970s and 1980s to more than 2% per annum in the 1990s. Even excluding the catastrophic spills that occurred following the sinking of the Apollo Sea in 1994 and Treasure in 2000, the average oiling rate for the 1990s was more than double that in previous decades (0.5% of the population each year).

One way to reduce the population decrease of African Penguins is to rehabilitate oiled birds. Cleaning oiled birds commenced in 1963, but only started on a large scale in 1968 after the Esso Essen ran aground, oiling some 3,000 birds. Of 1,700 birds collected and cleaned, 400 survived and were released. This incident led to the formation of the Southern African Foundation for the Conservation of Coastal Birds (SANCCOB). Between 1968 and 2001 SANCCOB has admitted more than 48,000 oiled penguins. The average release rate of oiled African Penguins (74% overall) has increased over time from 55% in the 1970s, to 67% in the 1980s, 76% in the 1990s, and 86% since 2000. This increase reflects increasing expertise in the handling of oiled birds. Unlike rehabilitation programmes elsewhere, rehabilitated African Penguins have a high survival rate, indistinguishable from non-oiled birds. They also exhibit similar breeding success to control birds, and thus rehabilitation of oiled birds potentially plays an important role in the conservation of African Penguins. Here I estimate the impact SANCCOB has made to the current population of African Penguins, and then explore the potential future benefits of maintaining the infrastructure and expertise necessary to treat oiled penguins, especially following a catastrophic spill that affects a significant proportion of the penguin population.
Table 1. Demographic parameters used to model the population of African Penguins (from Whittington et al. 2000). Variance estimates are given for parameters that were varied in Vortex.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival</td>
<td></td>
<td></td>
</tr>
<tr>
<td>juvenile (0–1 years)</td>
<td>0.53</td>
<td>0.05</td>
</tr>
<tr>
<td>immature (1–2 years)</td>
<td>0.65</td>
<td>0.03</td>
</tr>
<tr>
<td>adult (&gt;2 years)</td>
<td>0.88</td>
<td>0.02</td>
</tr>
<tr>
<td>Maximum age</td>
<td>30 years</td>
<td></td>
</tr>
<tr>
<td>Reproduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fledglings.pair/year</td>
<td>0.8</td>
<td>0.05</td>
</tr>
<tr>
<td>Proportion of birds breeding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 years</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>3 years</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>4 years</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td>≥ 5 years</td>
<td>0.86</td>
<td></td>
</tr>
</tbody>
</table>

Assessing the impacts of cleaning oiled birds to date

The past contribution of rehabilitating oiled birds was estimated using a simple, deterministic, age-structured model of the African Penguin population. The model assumed a constant growth rate with no density dependence. Survival and fecundity parameters (Table 1) were taken from the range of best estimates used in the Population and Habitat Viability Assessment (PHVA) conducted for African Penguins. The parameters chosen were selected to mimic the observed rate of population decrease estimated for the entire African Penguin population: 300,000 adults in the mid-1950s, 220,000 in the late 1970s, 194,000 in the late 1980s, and 178,000 in the early 1990s. This could be closely approximated with a model that had a constant growth rate of −1.35% per year. The model was initiated with the population close to stable age distribution, and with a population of 300,000 adults (i.e. in adult plumage, >1 year old) in 1956. At stable age distribution, adults make up 78% of the total population. Projecting forward, it suggests that the penguin population in 2002 is around 163,000 adults (total population of 203,000 birds), which is perhaps slightly less than the 2001 population estimate, but greater than the 1998 estimate.

The recent population trend of penguins incorporates the effects of cleaning oiled birds since the 1960s, and thus rehabilitation benefits are implicitly included in the standard penguin model. To estimate what the current population would have been were there no rehabilitation, the numbers of oiled birds cleaned and released by SANCCOB each year were removed from the model. Birds were removed from each age class as a function of the proportion of each age class in the entire population. This assumes that rehabilitated birds are a random sample of the population, and is supported by the observed close agreement between the proportions of rehabilitated juvenile penguins (22%, SANCCOB unpubl. data) and their proportion in the model population (21%).

At first rehabilitation efforts had a trivial impact on the population of African Penguins (Figure 1). It took almost 20 years before cleaning oiled birds resulted in a 2% larger penguin population, and it was only after the Apollo Sea spill in 1994 that the impact exceeded the 5% mark. However, rehabilitation made a significant contribution after the disastrous Treasure spill in 2000. By 2002, the African Penguin population was 19% larger (33,000 birds) than if cleaning had not taken place.

![Figure 1](image-url)
since 1968. This excludes the benefits of translocating almost 20,000 birds to prevent them getting oiled during the Treasure spill. The translocation was effective thanks to handling skills learned by SANCCOB, coupled with the disaster management plans put in place after many birds died during initial transport to the rehabilitation centre during the Apollo Sea spill in 1994. The estimate of SANCCOB’s contribution to date also fails to consider the contribution of non-oiled birds treated by SANCCOB; these birds were excluded because their survival and reproductive output following treatment have not been determined.

Estimating the benefits of continued rehabilitation

The individual-based, stochastic Population Viability Assessment (PVA) model Vortex\textsuperscript{13} was used to estimate the potential benefits of continued cleaning of oiled penguins. Vortex is the model that was used to conduct the PHVA of African Penguins\textsuperscript{2}, and for this simulation it was set up in a similar way as for the African Penguin PHVA (a single population, starting at stable age distribution; no density dependence; no inbreeding depression, etc.). The same demographic parameters were used as in the deterministic model, with the addition of some variance around parameter values (Table 1). The model cannot accommodate the full penguin population, so it was run with a starting population of 10,000 birds. This was then rescaled to give a starting population of 163,000 adult birds (total 203,000), the population predicted for 2002. Simple scaling of effects is potentially misleading, because stochastic effects are greater in small populations, but the model starting population was sufficiently large to avoid significant impacts from demographic stochasticity.

The model was used to estimate the impacts of two types of oiling: catastrophic spills and low-level, chronic oiling. Catastrophic spills are spills that typically occur close to breeding colonies and affect large numbers of birds. To date the worst spill resulted from the sinking of the bulk carrier Treasure in June 2000, which threatened more than 20% of the global population of African Penguins. This was perhaps an extreme spill, because it affected birds at two of the largest colonies (Dassen and Robben islands). For the model projection, a catastrophic spill was assumed to reduce survival and reproduction of the entire population by either 10% (roughly equivalent to oiling 10% of birds) or 5%. For the simulations where cleaning oiled birds continued, it was assumed that 80% of oiled birds were released back into the population. This is slightly less than the success rate recorded since 2000 (86%), but rehabilitated birds may not perform quite as well as control birds\textsuperscript{13,10}. The impact of catastrophic spill on reproduction was assumed to be unaffected by rehabilitation, because affected birds are unlikely to breed successfully in the year of the spill\textsuperscript{10}. Because catastrophic spills are unpredictable, they were modelled as stochastic events, with the probability of a catastrophic spill occurring in any given year ranging from 0–20%. For each scenario the model was run 200 times, allowing the estimate of average population performance as well as the range of possible outcomes.

Chronic oiling results from small spills, often of unknown origin, that affect relatively few birds (typically <1000 individuals). The numbers of birds affected by chronic oiling was estimated as the residual number of birds admitted to SANCCOB once catastrophic spills were excluded. Overall this has averaged 600 birds per year, but the numbers have increased over time, and since 1990 the average has been 925 birds per year\textsuperscript{2}. In the model, chronic oiling was simulated by removing 46 birds per year from the starting population of 10,000 (equivalent to 920 birds per year from the global starting population of approximately 200,000 penguins). With rehabilitation, the losses due to chronic oiling were cut to only 8 birds (equivalent to 160 birds per year). Shannon & Crawford\textsuperscript{14} raised concerns about the impact on penguin reproduction that could result from patrolling colonies for oiled birds. This effect was not incorporated in the model, because of uncertainty about the levels of disturbance (most colonies are not patrolled regularly, and most chronic oiling still occurs as discrete events).

Clearly predicting future population trends is fraught with difficulty, and requires often unreasonable assumptions. However, the model can be used sensibly to assess the contribution made by rehabilitation efforts by comparing outcomes with and without cleaning of oiled penguins\textsuperscript{6, 15}. Even without any catastrophic spills, rehabilitating birds affected by chronic oiling results on average in a 7% larger population after 20 years (Table 2; Figure 2). With a 5% probability of a catastrophic spill

<table>
<thead>
<tr>
<th>Probability of catastrophic spills</th>
<th>With rehabilitation</th>
<th>No rehabilitation</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>SD</td>
<td>N\textsubscript{20 years}</td>
</tr>
<tr>
<td>No catastrophes</td>
<td>-1.9</td>
<td>4.7</td>
<td>114,000</td>
</tr>
<tr>
<td>Severity of catastrophe 10%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5%</td>
<td>-1.9</td>
<td>4.6</td>
<td>113,000</td>
</tr>
<tr>
<td>5%</td>
<td>-2.0</td>
<td>4.7</td>
<td>110,000</td>
</tr>
<tr>
<td>7.5%</td>
<td>-2.2</td>
<td>4.8</td>
<td>108,000</td>
</tr>
<tr>
<td>10%</td>
<td>-2.2</td>
<td>4.8</td>
<td>106,000</td>
</tr>
<tr>
<td>15%</td>
<td>-2.3</td>
<td>4.8</td>
<td>105,000</td>
</tr>
<tr>
<td>20%</td>
<td>-2.5</td>
<td>4.9</td>
<td>101,000</td>
</tr>
<tr>
<td>Severity of catastrophe 5%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>-1.9</td>
<td>4.7</td>
<td>112,000</td>
</tr>
<tr>
<td>10%</td>
<td>-2.0</td>
<td>4.8</td>
<td>111,000</td>
</tr>
<tr>
<td>15%</td>
<td>-2.0</td>
<td>4.7</td>
<td>110,000</td>
</tr>
<tr>
<td>20%</td>
<td>-2.1</td>
<td>4.7</td>
<td>110,000</td>
</tr>
</tbody>
</table>
each year, the penguin population averages 22% larger after 20 years for "bad" spills (10% impact) or 14% larger for less severe catastrophes (5% impact). The benefit of continued rehabilitation of oil-spilled birds increases rapidly with increasing probability of catastrophic spills, averaging 29%, 44% and 61% larger as the risk of "bad" spills increases from 10% to 15% and 20% (Table 2; Figure 2).

In general, the severity of impact of individual catastrophic spills and their frequency have roughly equal impacts on the projected penguin population size after 20 years (i.e. a 5% annual spill risk affecting 5% of the population has a similar impact to a 2.5% annual spill risk affecting 10% of the population; Table 2). Rehabilitating oil-spilled birds greatly reduces the impacts of oiling, with the predicted population after 20 years being little influenced by the frequency of catastrophic spills (Table 2). The range of possible outcomes varied greatly (Figure 2), but annual average growth rates were more variable when there was no rehabilitation, and variability increased with increasing risk of catastrophic spills (Table 2).

Conclusions
These results suggest that although the initial benefits of cleaning oiled penguins were largely trivial, rehabilitation has become increasingly important for the conservation of African Penguins. Already rehabilitation has resulted in the current population being approximately 19% larger than it would have been had there been no attempt to rehabilitate oil-spilled birds. Predicting the future value of rehabilitating birds depends on the frequency of major and minor oil spills. If conditions experienced during the last decade continue, when there were two catastrophic spills and numerous smaller spills, it is clear that the penguin population will decrease much more rapidly in the absence of a professional rehabilitation programme. Although most of the risk is associated with catastrophic spills, we cannot afford to act only when catastrophes occur, because chronic oiling also makes a significant impact on penguin populations, and because much of the success of cleaning efforts to date results from the maintenance of a dedicated, well-trained rehabilitation team that can act swiftly when catastrophes occur.

Acknowledgements
This exercise was initially conducted by the 2002/03 class of conservation biology masters students at the University of Cape Town. I am grateful for their input to the development of the models.

References
1. Ryan, Demographic benefits of rehabilitating oiled African Penguins

2. IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, MN.


Are African Penguins tough enough? A perspective on the rehabilitation of oiled birds

LES G. UNDERHILL
Avian Demography Unit, Department of Statistical Sciences, University of Cape Town, Rondebosch, 7701, South Africa, e-mail: lgu@adu.uct.ac.za

Abstract


Penguins are impressively tough animals, a quality that enables them to be cleaned when they become oiled. However, in order to be successful, the cleaning operation has to be mobilised rapidly. For this reason, SANCCOB needs to be maintained in a state of readiness for action continuously. Since the Treasure oil spill incident of 2000, SANCCOB has restructured institutionally and has adopted a strategy of long-term sustainability.

One clear message has come through the previous papers. African Penguins are tough. Tough, yet vulnerable.

Anyone who has handled penguins will be aware that they feel more like seals than birds. It is this toughness, above all, that makes it possible for us to clean them when they are oiled. When "normal" flying birds, such as cormorants and gulls, get oiled, it is extremely difficult to clean them. Compared to penguins, these species are delicate and dainty, and are not easily caught until they are really weak. The fact that we do so well at cleaning penguins in South Africa is something we can be particularly proud of – but we also need to share this pride with the beast we are dealing with!

Because penguins are tough, they are cleanable. But being cleanable does not ensure that they get cleaned. To get them cleaned, a whole chain of procedures needs to be in place. Every link in the chain is important.

Oil has two dramatic effects on penguins. On the outside, it ruins the insulation, and allows the cold Benguela water to reach the skin and suck the heat out of the penguin's body. On the inside, oil ingested during preening causes the bird to suffer from petrochemical poisoning, an even greater threat. In spite of this, the penguin is probably tough enough to swim ashore and hardy enough to survive a few days on the shoreline. But that is where its toughness ends. Unless rescued, it will die. It cannot de-oil itself.

Success at war is a consequence of preparedness in times of peace. SANCCOB has been to the battlefield twice in the past 10 years. In 1994, when the Apollo Sea sank, 10,000 penguins were oiled. We suffered 5,000 casualties, with 50% of our "sailors" dying. In 2000, when the Treasure sank, our casualty rate was only 10%, in spite of having twice as many "sailors" in the battle. War for SANCCOB arrives as suddenly as 11 September 2001 arrived for the World Trade Center in New York. The clouds of war do not gather on the horizon for SANCCOB for months, allowing us the opportunity to beef up our plans. One morning we wake up, and discover that there are thousands of oiled penguins on our beaches. On that day, we need to be ready.

Would you fly out of an airport that claims that flying is now so safe that they can dispense with their emergency services? Although every aspect of air safety is continuously being improved, airport disasters still strike.

Likewise, although we can do all in our power to reduce the number of oil spills, we cannot prevent them entirely. It is important that we continue and redouble our efforts to prevent oil entering the sea in the first place. We need to address the twin oil problems:

1. The ongoing, almost continuous, small oil spills, which are caused by carelessness and wilful pumping of bilge water and ballast water exchange. These send a regular stream of oiled penguins to SANCCOB.

2. The spills involving large numbers of penguins caused by headline-grabbing disasters, such as the Apollo Sea spill of 1994 and the Treasure spill of 2000.

Ships do need to be built more safely and designed so that they are less likely to release oil when they sink. They do need to be inspected more regularly and more rigorously. Regulations about bilge pumping do need to be more strictly enforced and ports need to make better and more convenient provision for accepting these pollutants and dealing with them. Procedures for handling crippled ships, which use Cape Town as "port of refuge" and which are likely to become oil pollution risks, do need to be reconsidered. At a more esoteric level, Table Bay could be given some form of "special penguin area" status, with regulations designed firstly to reduce the risk of penguins being oiled in these busy shipping lanes, and secondly to reduce the risk of oil reaching Robben Island, which now hosts the world's third largest African Penguin colony.

But it is also critical to maintain a balance. We need to remember that oiling is only one of a battery of problems facing the African Penguin at the start of the 21st century. We need to bear in mind that during the period from about 1980 to 1994, when there were very few oil spills, we were still losing pen-
guins at a downwards trend of about 2% per year. Most of the factors which caused the ongoing decline are poorly understood. They include things such as interactions with the fishery. How much fish must we leave in the sea so that penguins (and other seabirds) have “enough”? Is it sensible to create “non-fishing zones” around breeding islands? Cape Fur Seals, mostly young males, are known to kill substantial numbers of penguins. But we do not really understand the extent of the problem, or if it is a critical factor. It is clear that African Penguins face many threats, most of which are complex and difficult to mitigate. However, the previous papers have shown that de-oiling and rehabilitating oiled penguins, although treating the symptom rather than the cause, is a way in which we can effectively alleviate some of the immediate pressure on this vulnerable species. If we do not treat oiled birds, we may lose a large proportion of the population before we are able to effectively mitigate the many threats that face this species.

Although SANCCOB has been in existence for some 34 years, it is clear that its role and responsibility changed radically during the last decade, with more than 75% of all African Penguin oilings occurring during this time. SANCCOB needed to adapt, and consequently was restructured during 2001. It changed from being an NGO (non-governmental organisation) and became a Section 21 Company with a board of directors, none of whom are paid. The board is responsible for the overall policy of SANCCOB. Day-to-day operations are controlled by a chief executive officer. One of the board’s chief objectives is to mastermind the long-term sustainability of the operation. The board currently has two major concerns: finance and location.

One of the early decisions that the board had to take was to achieve a closer match between income and expenditure. The alternative was a gradual running down of reserves and inevitable closure. Achieving this match necessitated a major restructuring of the staff complement and resulted in several redundancies. The hard choice was therefore between a medium-sized operation, which was not sustainable in the long term, and a tiny operation that was. At the end of 2002, SANCCOB has a smaller-than-desirable complement of dedicated employees. They shoulder a huge burden.

If an oil spill crisis were to develop at this point in time, the need for volunteer assistance will be as large as in any previous spill. This need would be exhibited at every level: in every aspect of bird care, from veterinarians to bird feeders, and every aspect of the management of the logistics, from organizing volunteers to purchasing fish and medicines. In spite of this, the new SANCCOB structure, with an appropriately qualified chief executive officer, has placed the organisation in a better position than ever before to play the key overall management role in a future crisis.

The present location of SANCCOB on the edge of Rietvlei in Tableview is not ideal. Problems with avian malaria recur, especially during summer, and this is associated with the super-abundance of mosquitoes close to a body of fresh water. In addition, SANCCOB has the site on a fixed-term lease. Various options for new locations are being considered continuously by the board. One vision is to make the new SANCCOB a tourist destination in its own right – a place where visitors can come and see penguins and other seabirds, and learn about their lifestyles and the factors which threaten them.

The contribution that SANCCOB has made to penguin conservation is significant and measurable. Peter Ryan, in his paper in this booklet, has estimated that the African Penguin population is 19% larger in 2002 as a result of SANCCOB’s existence than it would have been otherwise. If Peter’s mathematical models don’t convince you of SANCCOB’s impact, take a stroll through the penguin colony on Robben Island. Peer at the groups of birds huddling under the alien rooikrans trees on the island. You cannot but fail to be impressed by the proportion of these birds bearing the distinctive “Treasure-model” flipper bands that were produced for us by Schuurman Engineering during the spill. In many of these little huddles, 60–80% of the penguins have Treasure bands. You have to pinch yourself to remember that these birds would all have been dead had it not been for the existence of SANCCOB at their time of need.

This is the appropriate point to highlight the contribution which the flipper-banding of African Penguins has made to our understanding of the life history of this species in general and especially to measuring the effectiveness of SANCCOB. Flipper bands make penguins unique and recognisable to researchers, and thus the lives of individual birds can be followed. The database generated by the bands is huge and consists of the original banding data, the dates and places of resightings of those penguins alive and details of birds found dead. This database is curated by the South African Bird Ringing Unit (SAFRING), one of the core projects of the Avian Demography Unit at the University of Cape Town. The information in this database has been used for many purposes: for example, to determine the age at first breeding, to estimate survival from fledging to that first breeding attempt, to estimate adult survival, and to unravel movement patterns. In the context of this booklet, flipper-banding results have enabled us to estimate and compare the survival rates and breeding success of SANCCOB graduates in relation to penguins that have never been oiled. In fact, many of the papers in this booklet could not have been written without the insights delivered by the bands.

When the next oil disaster strikes the African Penguins, there is not a week of time to get an organisation up and running. It simply has to be in place. It has to be operating, year in and year out, waiting and in readiness. It has to be training a core group of loyal “peace time” volunteers who will rapidly be able to multiply their skills on the “war time” volunteers who are absolutely critical to SANCCOB’s success in emergencies.

Underhill: Are African Penguins tough enough? 31
“Contrasting fortunes”