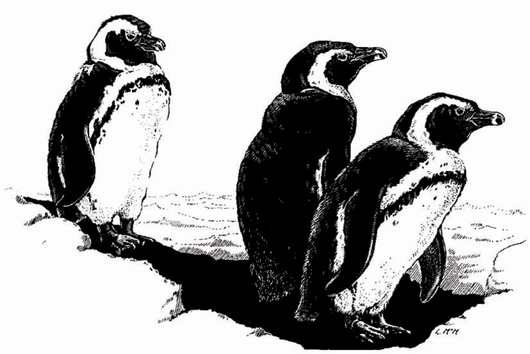
African Penguin
Population & Habitat Viability Assessment



21-24 April 1999
Cape Town, South Africa

Final Report

A Collaborative Workshop

BirdLife International Seabird Conservation Programme,
Avian Demography Unit, University of Cape Town
Conservation Breeding Specialist Group, IUCN/SSC

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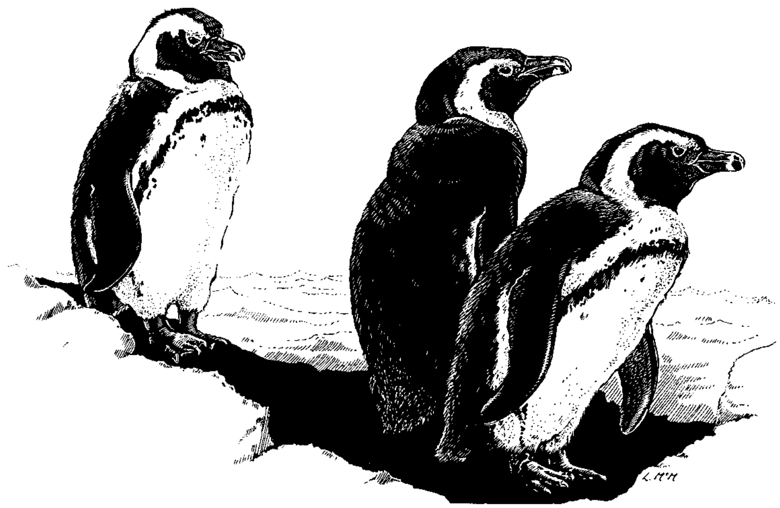

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Final Report

Edited by
Philip A. Whittington, Robert J.M. Crawford, Onno Huyser,
Dieter Oschadleus, Rod Randall, Peter Ryan, Lynne V. Shannon, Anton Woolfardt, John Cooper, Robert C. Lacy and Susie Ellis

Compiled by the Workshop Participants

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A contribution of the IUCN/SSC Conservation Breeding Specialist Group.

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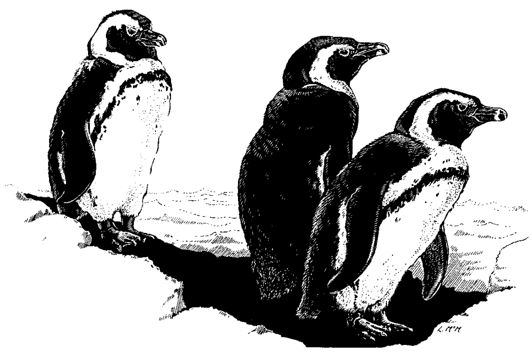

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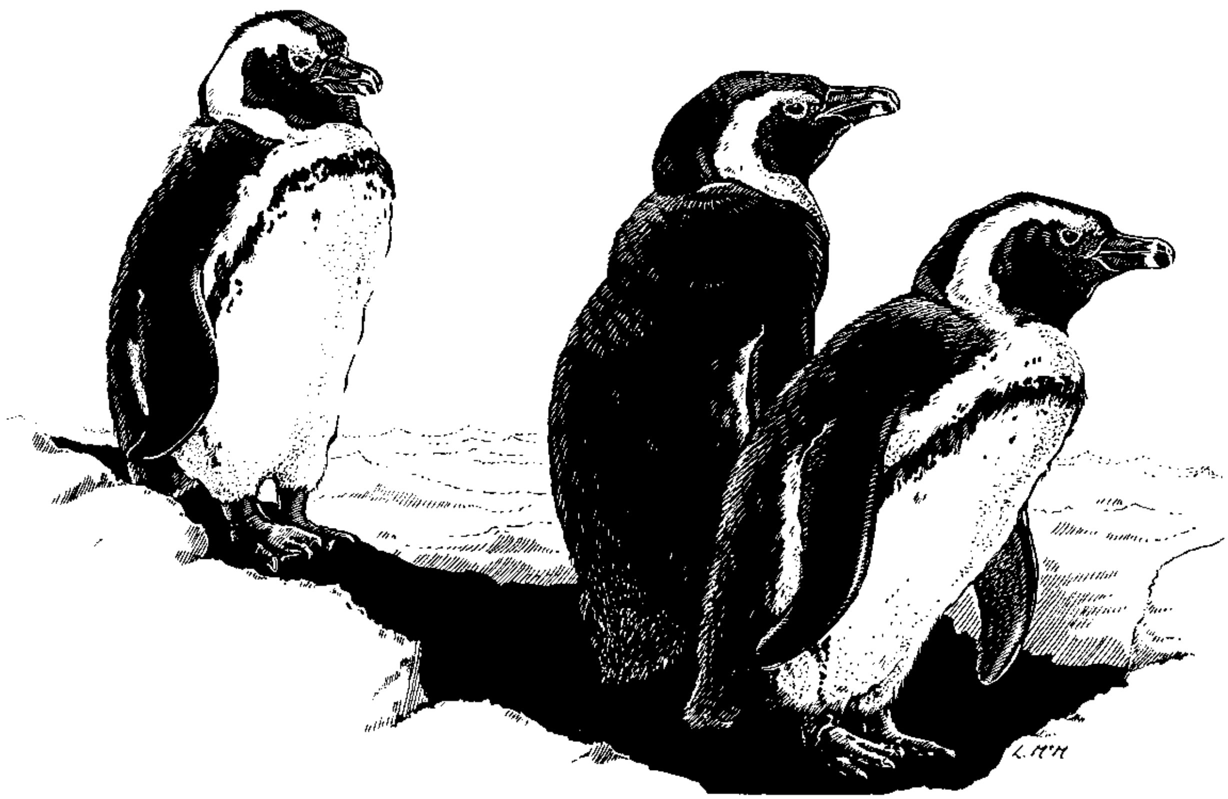

Section 1

Introduction and Summary

African Penguin (*Spheniscus demersus*) Population and Habitat Viability Assessment

BACKGROUND

In 1996, a Conservation Assessment and Management Plan (CAMP) workshop for penguins was held in Cape Town, South Africa, facilitated a substantive review and updating of an earlier penguin CAMP document, produced in 1992. Thirty-seven people from 10 countries participated in the two-day event, during which 24 penguin taxa were evaluated on a taxon-by-taxon basis in terms of their current and projected status in the wild (Ellis *et al.* 1998). Each taxon was assigned a new IUCN Red List Category of Threat, and priorities were set for conservation action.

The results of the CAMP assessments were alarming. Of all the penguin species, only those in the Antarctic do not seem to be facing grave, documented declines or other problems that put them at serious risk. Even Antarctic species are not secure in perpetuity -- the threats that have put the other penguin species at risk appear to have spread to the boundaries of the Antarctic Circle. Whereas the 1996 IUCN Red List (IUCN, 1996) considered only five penguin species to be threatened, penguin biologists at the 1996 CAMP workshop considered 11 taxa (nine species) to fall under one of the IUCN Categories of Threat; two were listed as Near-Threatened.

AFRICAN PENGUINS

Of the taxa designated as threatened in the CAMP document, the African penguin is of particular conservation concern. The African penguin's breeding range is from Hollams Bird Island, Namibia, to Bird Island, Algoa Bay, South Africa. In 1910, there were probably 1.4 million adult birds in one population (Dassen Island) alone (Shannon and Crawford, in press). In the mid–1950's, the overall population was estimated to be about 300 000 adults, including 145 000 at Dassen Island (Shannon and Crawford, in press). In the late 1970's, there were an estimated 222 000 adult African penguins, 194 000 in the late 1980's and 179 000 in the early 1990's (Crawford *et al.* 1995), indicating a mean annual rate of decrease between the late 1970's and early 1990's of 1.3%, and between the late 1980's and the early 1990's of 1.5%. Adult survival is estimated to be about 0.90 per annum (Randall 1983; Crawford *et al*. in press).

The annual loss of birds has not slowed as the population has decreased (Crawford *et al.* 1995). If the present rate of loss (40 000 adults in the last 15 years) continues, CAMP participants predicted that extinction in the wild will occur within 70 years (Ellis *et al.* 1998).
Currently there are 27 breeding colonies: eight islands and one mainland site along the coast of southern Namibia; 10 islands and two mainland sites along the coast of Western Cape Province, South Africa; and six islands in Algoa Bay, Eastern Cape Province, South Africa (Crawford *et al.* 1995). Penguins no longer breed at nine locations where they formerly bred or were suspected to breed (Crawford *et al.* 1995) – Neglectus, Seal, Penguin, North Long, North Reef, and Albatross Islands in Namibia and Jacob's Reef, Quoin, and Seal (Mossel Bay) Islands in South Africa. The total area available for nesting by African penguins is less than 1 000 ha (about 16 km^2). Only 14 of the 27 breeding colonies contain more than 1 000 adults. In the 1980's, breeding began at two new mainland sites in South Africa (Boulders and Stony Point). A third site, Robben Island, where African Penguins had been previously exterminated, was re-colonised in the 1980's as well. However, even these new colonies may not have offset the loss of birds elsewhere.

Primary threats to African penguins include competition for food with seals and commercial fisheries, predation by seals, oiling, and loss of habitat from of interspecific competition for nesting sites. Commercial purse-seine fisheries off South Africa and Namibia catch large quantities of sardine (*Sardinops sagax*) and anchovy (*Engraulis capensis*), important prey for African penguins. Sardine stocks off South Africa and collapsed in the 1960s and off Namibia in the 1970s, contracting to the southeast and north as they did so (Crawford *et al.* 1987). The subsequent reduced availability of prey was probably the main reason for the large decrease in numbers of penguins from Cape Town to Lüderitz. Within this range, in southern Namibia, penguins at Possession Island declined from 23 000 pairs in 1956 to fewer than 500 pairs in 1987. Recruitment to the colony in this period appeared minimal.

Five of the world's major 50 oil spills in history have occurred off the coast of South Africa (Williams *et al.,* in press). Oil spills have a major impact on African Penguins, especially when the oil washes ashore at breeding areas (Morant *et al.* 1981; Adams 1994; Underhill *et al.* 1999). Catastrophic oil spills occur irregularly, but there also is persistent, chronic oiling which accounts for steady, high levels of mortality. For example, of 689 dead penguins found at St. Croix Island over a 10-year period, oil pollution accounted for more deaths (44 %) than any other factor. There have been six major oil incidents since the early 1970's (Table 1) in which many penguins were oiled, as well as a great many more minor oiling events. Contrary to experience elsewhere, the cleaning of oiled penguins in southern Africa is relatively effective and has been demonstrated to make a contribution to conservation efforts (e.g., Underhill *et al.* 1999).

Competition with Cape Fur Seals (*Arctocephalus pusillus*) for breeding space may be the reason for cessation of breeding at five African Penguin colonies. Expanding seal herds have displaced large numbers of penguins at a number of breeding sites (e.g., Hollams Bird, Mercury, and Sinclair Islands). African Penguins also compete with other seabirds, such as gannets and cormorants, for breeding space. In addition to decreasing the availability of food (Crawford *et al.* 1992), , increasing numbers of Cape Fur Seals also prey on penguins.

Table 1. Selected major events over the past 30 years in South Africa and the number of affected penguins (data presented by P. Whittington at the PHVA workshop).

Year	Incident	Type	Location	Spillage	# Penguins Oiled	Reference
1971	Wafra	Ran aground	Cape Agulhas	6,000-10,000 tons crude	1,216+	Morant et al. 1981
1977	Venpet/ Venoil	Collision	Cape St. Francis	31,000 tons crude+ fuel	47+	
198___	Kapodistrias					
1994	Apollo Sea	Sank	Dassen Is.	$\leq$2,400 tons fuel	c. 10,000	Underhill et al. 1999
1995	?	Chronic	Dyer Is.	?	1,200+	
1996		Broke apart			1,300+	
1998	Harbour Spill	Burst Pipeline	Cape Town Harbour	150 tons	525+	

During the CAMP assessment process, the African Penguin was assigned an IUCN Red List Category of "Vulnerable," based on the declines in population size described above as well as changes in population structure over the past decade. The species information from the CAMP is included as Appendix II. In recognition of the severity of the situation facing this and many of the other penguin species, CAMP workshop participants prioritised recommendations for action. A high priority was conducting a Population and Habitat Viability Assessment (PHVA) workshop for the African Penguin.

THE AFRICAN PENGUIN PHVA WORKSHOP

To address the concerns outlined above as well as other problems facing the African Penguin, a Population and Habitat Viability Assessment (PHVA) workshop was held at facilities of the Chief Directorate of Marine and Coastal Management (formerly Sea Fisheries Research Institute) in Cape Town, South Africa from 21-23 April 1999. Thirty-five people attended the workshop (Appendix I), which was hosted by the BirdLife International Seabird Conservation Programme at the Avian Demography Unit of the University of Cape Town, and facilitated by the Conservation Breeding Specialist Group (CBSG) of the IUCN Species Survival Commission. Participants included South African biologists, researchers, wildlife managers, and fisheries experts. Sea World, Inc. generously supported the workshop. The primary aim of the PHVA was to develop a conservation action plan to improve the status of African Penguins.

THE PHVA PROCESS

At the beginning of each PHVA workshop, there is agreement among the participants that the general desired outcome is to prevent the extinction of the species and to maintain a viable population(s). The workshop process takes an in-depth look at the species' life history, population history, status, and dynamics, and assesses the threats putting the species at risk.

One crucial by-product of a PHVA workshop is that an enormous amount of information can be gathered and considered that, to date, has not been published. This information can be from many sources; the contributions of people with a wide variety of expertise as well as a stake in the future of the species are considered. Information contributed by wildlife managers, scientists, field biologists, private landowners and others all carry equal importance.

To obtain the entire picture concerning a species, all the information that can be gathered is discussed by the workshop participants with the aim of first reaching agreement on the state of current information. These data then are incorporated into a computer simulation model to determine: (1) risk of local extinction under current conditions; (2) those factors that make the species vulnerable to extinction; and (3) which factors, if changed or manipulated, may have the greatest effect on preventing local extinction. In essence, these computer-modelling activities provide a neutral way to examine the current situation and what needs to be changed to prevent local extinction.

Complimentary to the modelling process is a communication process, or deliberation, that takes place throughout the workshop. Participants work together to identify the key issues affecting the conservation of the species and then work in small groups to discuss these issues, which can range from predator management, disease, human-animal interactions, or other emerging topics. Each working group produces a brief report on their topic, which is included in the document resulting from the meeting. A successful PHVA workshop depends on determining an outcome where all participants, coming to the workshop with different interests and needs, "win" in developing a management strategy for the species in question. Local solutions take priority. Workshop report recommendations are developed by, and are the property of, the local participants.

PROCESS FOR THE PRESENT WORKSHOP

At the beginning of the African Penguin PHVA workshop, the 35 participants worked together in plenary to identify the major issues and concerns affecting the conservation of the African Penguin (Table 2). These identified issues centred around five main topics, which then became the focus of four topic-based working groups: Colony Management; Predation/Oiling; Fisheries Issues; and Modelling/Monitoring and Data Needs.

Each working group was asked to:

- Examine the list of problems and issues affecting the conservation of the species as they fell out under each working group topic, and expand upon that list, if needed.
- Identify, amplify, and prioritise in text the 3-5 most important issues.
- Identify, amplify and prioritise in text the most important needs pertaining to each of the priority issues.
- Develop, elaborate, and prioritise between three and five priority strategies to address the needs listed under the key issues.
- Amplify and specify the priority actions needed to implement the identified strategies, including developing time lines and assigning people to assist in implementation.

Each group presented the results of their work in daily plenary sessions to ensure that everyone had an opportunity to contribute to the work of the other groups and to ensure that each group's work was reviewed and discussed by all workshop participants. Recommendations coming from the workshop were accepted by all participants, thus representing a consensus. Working group reports can be found in Section 2 of this document.

SUMMARY OF WORKING GROUP RECOMMENDATIONS

The Colony Management Working Group recognised six main issues: habitat management; human access; legal control; communication; disease; and captive populations. The group made a number of recommendations pertaining to habitat management, including exclusion of other species that compete for space, such as seals, improving nest site quality and identifying suitable alternative nesting sites for re-establishing or expanding colonies and ensuring that penguin populations are considered when EIAs are undertaken for coastal and adjacent developments.

Recognising the need to balance human access to penguins through tourism and research, recommendations were made to restrict tourism to breeding localities which operate under appropriate and regularly updated management plans and which have appropriate educational programs and materials to aid in minimising the impact of tourism on the populations. Recommendations also were made to minimise the exploitation of penguins at breeding sites, specifically to discontinue guano, egg or live animal collection unless it is for approved research and/or management purposes. It was suggested that an advisory body be established to assess and approve research proposals in terms of their conservation significance, ethics and impacts on birds.

In recognition of the need to protect penguin populations as well as their habitat, the group recommended that breeding locations should be formally managed by a management plan as well as legally protected by enforcement of existing legislation and increasing staff, including wardens and enforcement personnel.

Mortality of African penguins, including eggs and chicks, needs to be halted by protecting them from mammalian predators (see also the report by the Working Group on Threats to African Penguin Populations below and in Section 2). This could be accomplished by introducing measures that keep terrestrial predators out of or provide for their removal from breeding localities, both on the mainland and on islands. The working group also addressed predators, recommending several measures that could be used to increase the number of nest sites (e.g., artificial burrows) or to protect them (e.g., monofilament lines to keep Kelp Gulls away from nests, limiting human disturbance to nest sites).

Public awareness needs to be increased in order to meet the African penguin's conservation needs. The working group suggested that an intensive effort should be made to train personnel in nature conservation organisations and tour companies to communicate the need for African penguin conservation to the general public, as well as using such personnel to give lectures, run workshops and to guide tourists and other groups. It was suggested that interpretative materials be provided at breeding locations and tourist information centres. Conservation management will be enhanced if communication with a wide range of stakeholders can be made more effective, including not only the general public but also groups such as nature conservation personnel, researchers, managers and policy makers.

The group noted the need to increase knowledge of health factors affecting penguins, not only by reviewing the current state of knowledge, but also undertaking systematic necropsies on fresh corpses and monitoring the relations between environmental parameters and disease outbreaks. A range of recommendations for disease prevention was generated, including the need for quick diagnosis and treatment, when feasible, when disease outbreaks occur.

The final priority issue discussed by the Colony Management Working Group was the need to ensure for the continued survival of the penguin in the wild by maintaining breeding zoo populations. It was suggested that this could be facilitated by continuing to conduct research, maintaining regional and international studbooks, using zoo populations to increase awareness concerning African penguin conservation, and utilising the captive populations to assist with fund raising.

The Working Group on Oiling and Predation Issues prioritised oiling into four main components: prevention, enforcement, rehabilitation and impact of rescue operations.

Oiling

For prevention of oiling events, the group recommended increasing awareness (i.e., policy makers and the public and private sectors) through media and educational campaign efforts. It also was suggested that incentives / penalties be created and legislation improved to deter potential polluters. Enforcement recommendations included increasing the level of lobbying to sensitise government to the need for marine resource management and to ensure adequate funding appropriations, improving enforcement of existing legislation and approaching the private sector, especially oil companies, for financial support to increase policing, staffing and equipment needs.
The group agreed that the process and techniques involved in rehabilitation, including post-release monitoring, need to be investigated in order to ensure that the most effective system is in place. The group recommended that a scientific method be adopted to test different rehabilitation techniques, and that communication be increased domestically and internationally regarding appropriate techniques. As monitoring of penguin colonies to ensure early

detection of oil spills is essential, it was recommended that funding be secured to hire additional personnel to ensure early detection of oil spills and also to cover the costs of "mystery" or uninsured oil spills. Finally, awareness of the rehabilitation process needs to be raised in order to increase public support of rehabilitation efforts and also to raise public awareness as to effects of oiling. The group recommended enhanced communications efforts, both in the media and in more formal education programmes.

To ensure effective management of rescue operations, contingency plans adaptable to all colonies and oil spill scenarios need to be developed, detailing necessary equipment, techniques and procedures to be followed with regard to capture, stabilisation and transport, appropriate staff training and other factors. It was recommended that these plans be continuously tested, adapted and revised. An example of a contingency plan is included as Appendix IV of this document.

Predation
Predation on African penguins was divided into two components: predation on land and predation at sea. In order of priority, predation threats to penguins are: seals, gulls, cats, rats, sharks, indigenous terrestrial mammalian predators, mole snakes and dogs. The group agreed that a broadly consultative workshop should be held to develop a policy and implementation plan to deal with penguin-seal interactions. A number of topics to be covered in said workshop were recommended.

There is a considerable need to reduce human disturbance in penguin colonies, which can unsettle nesting birds and thereby expose eggs and chicks to predation by gulls. The group recommended several ways to address this problem, including campaigns to create awareness of problems caused, improving human refuse disposal and minimising fisheries by-catch and disposal. The group also pointed out that there is a need to determine whether gull populations can and should be directly controlled.

There was consensus that feral cats must be eradicated in locations where it is feasible or necessary to do so. The group recommended that this should be undertaken in a time-concentrated, high intensity effort, rather than in an ongoing, low-level effort, and also pointed out that there is a need to determine the relationship between feral cats and potential prey species, especially rats, since with the eradication of cats populations of prey species may increase.

The Working Group on Fishery-Related Issues focused on five key questions:

1. Is there sufficient food availability for the penguin population?
2. Is there sufficient food available in the vicinity of the breeding islands during the breeding season?
3. Competition from other predators such as seals and gannets.
4. Are there direct penguin/fishery interactions?
5. Can long-term population fluctuations in forage-fish abundance be used as an estimator of carrying capacity for the penguin population?

With respect to the availability of sufficient food, both in general and in the vicinity of breeding islands during the breeding season, the group recommended several actions. These primarily focused on refining our knowledge of the food requirements and foraging areas of the current and projected penguin populations annually, seasonally, and colony-wise, and refining our understanding of the demographics of prey populations. The group also believed that an emphasis needed to be placed on improving our knowledge of the energy content of prey items and the energy cost for capture of different prey species in different age classes. To determine ways of improving post-fledging survival, it was recommended that energy requirements at this critical life stage be determined. Along with this, the group pointed out the need to determine the implications for changed management strategies, if recommended, for the commercial fisheries, as well as setting up a model for adaptive management to test the effects of a fisheries exclusion zone.

The growth in the populations of other anchovy and pilchard predators (e.g., seals and gannets) could negatively impact the penguin population through increased competition for food. The group recommended that the interactions between penguins and other predators of small pelagic fish needs to be modelled using ECOPATH (Christensen and Pauly 1992) in order to predict their potential effect on the penguin population.

Considering the importance of minimising penguin mortality through direct fishery interactions (e.g., entanglement in nets, incidental mortality by longlines (and the use of penguins as bait), the group noted a need to accurately identify the fisheries where there are direct interactions of this type, proposing a series of actions to obtain the needed information. Identified investigation targets include set net, lobster (and the use of penguins as bait, seine, longline, recreational, and purse seine fisheries, as well as scientific surveys and activities. Once interactions are determined, the group suggested that management options should be identified and implemented and, if needed, legislation modified.

The Working Group on Monitoring and Modelling reviewed the threats affecting African Penguin survival and ranked them in order of priority: fishery interactions; colony management; predation; oiling; multi-species approach; disease; global climate change; fire; human disturbance and exploitation; and other issues pertaining to modelling. The first priority for the group was to decide the spatial and temporal scales over which to model the population. Given the lack of robust demographic parameters for different colonies or regions and the limit on maximum population size by an individual-based model like VORTEX, the group decided to focus on a single colony, initially using parameters from Robben Island as the best-known colony in terms of demography.

The VORTEX simulation model examined projections for an African Penguin population with an initial size of 5 000 birds, with a carrying capacity of 25 000 (representing the approximate size and also perhaps the approximate carrying capacity of Robben Island in 1990). The modelling began with a baseline scenario with demographic characteristics as estimated for Robben Island and then varied key parameters to determine the sensitivity of model projections to variables that were uncertain, that may vary among breeding populations, or that may change over time. Models were developed for three levels of juvenile survival, two levels of adult survival, three levels of reproductive success and four scenarios with respect to catastrophes (see Modelling Working Group Report, Section 2 for details).

The group identified as a priority the need to develop specific goals for monitoring programs, guided by the modelling exercise (for example, modelling indicated that age at first breeding is not as important as juvenile and adult survival). Once the aims and objectives have been defined, it is recommended that tasks should be re-identified and ranked in order of importance, identifying human and other resources.

The group identified various needs for monitoring: for follow-up on re-sightings; pooling relevant parameter data both from South Africa and Namibia; developing a written protocol for fieldwork to ensure data accuracy and collection of identified critical data even in adverse conditions; and obtaining funding to enter into a computer database all the penguin ringing data (~50 000 records) to provide more accurate survival estimates. It also was noted that any protocols for methodology should be consistent yet flexible enough to allow for colony-specific needs (because of island differences). Additionally, stronger emphasis needs to be placed on obtaining critical information on Namibian colonies. Other discussions centred on acquiring specific data that is desirable from ongoing monitoring efforts, such as general monitoring requirements including collection of potential covariates of breeding productivity and survival, and publication of results both in a Penguin Monitoring Handbook and on an annual basis.

Post-PHVA Workshop

To date, a formal, comprehensive action plan for the conservation of this species does not exist. The primary objectives of the PHVA workshop were to assist managers and policy makers to: 1) formulate priorities for a practical management program for survival and recovery of the African Penguin in wild habitat; and 2) develop a risk analysis and population simulation model for the African Penguin which can be used to guide and evaluate management and research activities.

This document is an important starting point that can be used by managers and scientists in southern Africa, setting directions and priorities for management and research, catalysing conservation actions, and assisting with funding endeavours. It also will serve as a model for similar processes for other species of penguins identified as requiring PHVAs by the 1996 CAMP workshop (Ellis *et al.* 1998) and/or for other species in the region.

Table 2. Themes, issues, and problems affecting the conservation of African Penguins, as identified by workshop participants.

Colony Management
- Colony establishment
- Human disturbances, including tourism
- Habitat management
- Habitat preservation
- Habitat quality
- Seabird legislation
- Human population growth
- Human movement within the colony
- Public relations
- Perception of local communities
- Public perceptions
- Education
- Tourism Disease
- Captive population management

Modelling/Monitoring/Data Needs
- Data quality
- Data collection
- Juveniles – the missing year(s)
- Temperature changes
- Global climate change
- Is there a carrying capacity?
- Disease
- Population monitoring requirements
- Multi-species approach

Predation/Oiling
- Impact of seals
- Seal threat
- Predation by fur seals
- Competition with seals
- Seals

- Predation (at sea)
- Feral cats predation on chicks
- Gulls vs. penguins (predation by gulls)
- What kills juveniles?
- Oiling
- Role of rehabilitation

Fisheries Issues
- Food supply prediction
- Prey encounter rates: spatial and temporal predictability
- Fishing within the penguin colony
- Fishery exclusion zones
- Competition for food resources
- Competition/interaction with fisheries
- Overfishing
- Food availability
- Food resources
- Fishery/food supply problems
- Competition for food (humans and seals)

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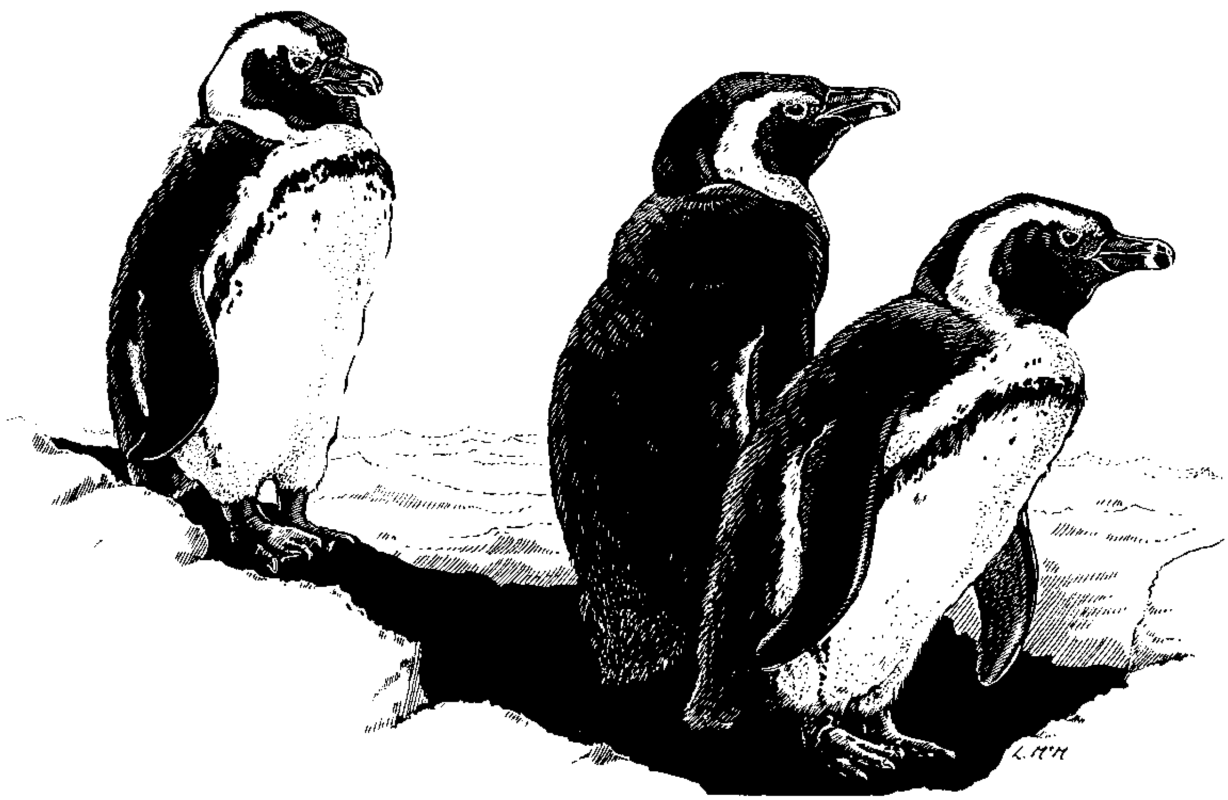


Section 2

Working Group Reports

Working Group Report: Colony Management

Participants: J.-J. Brossy, Justin Buchman, John Cooper, Bruce Dyer, Kolby Foss, José de Oliveira, Meredith Thornton, Tony Williams. Student observers: Verna Love, Simiao Mahumana, Helian Ratsirarson, Fidele Ruzigandekwe, Frances Taylor, Claire Volchansky, , Andrew Walker

GENERAL

There were 15 issues identified under this topic by the plenary:

- Colony establishment
- Human disturbances, including tourism
- Habitat management
- Habitat preservation
- Habitat quality
- Seabird legislation
- Human population growth
- Human movement within the penguin colony
- Public relations
- Perception of local communities
- Public perceptions
- Education
- Tourism (2)
- Disease
- Captive population management

The group organised these topics and used paired ranking to prioritise the following main issues addressed in its discussions. The number of votes received by each issue is listed in parentheses.

- Habitat management (42)
- Human Access (39)
- Legal Control (33)
- Communication (31)
- Disease (11)
- Captive Populations (0)

ISSUE 1. HABITAT MANAGEMENT (42)

A. Environmental management

Need:

Improve breeding success by maintaining and providing safe and good-quality

breeding and moulting sites.

Strategies:

1. Exclusion and scaring of space-competitors, especially seals, where considered desirable, following identification of localities most at risk.

2. Improve quality of nest sites by provision and maintenance of aesthetically pleasing artificial burrows and nest materials (such as mulch) and by providing shade by planting bushes and artificial structures.

3. Management of fire risk, flooding, including run-off control, erosion and vegetation change, stabilising substratum by planting vegetation and by use of binding agents, and removing artificial materials that potentially can cause injury and entanglements (e.g. plastics, building rubble, etc.).

4. Ensure that materials imported to breeding localities are free of plant and invertebrate propagules, especially those considered to be invasive.

B. Colony (re) establishment and extension

Need:

Increase population size and breeding distribution by increasing the number of breeding sites.

Strategies:

1. Identify extinct breeding localities and other apparently suitable sites including suitable areas on the mainland (such as headlands), which can be protected, in identified regions that support adequate stocks of prey species.

2. Investigate how to effect the (re)establishment and expansion of colonies (including on the mainland) using, amongst others, rehabilitated birds, *inter alia* by use of decoys, mirrors and recordings to attract birds and releasing (hacking) juveniles as well as temporary captive-rearing of fledglings.

Note: at least one participant/editor strongly disagreed with these strategies to address the need to increase population size and breeding distribution. P. Whittington expressed concern that "we would need to be certain of the reasons why colonies went extinct and know that those circumstances no longer threaten those localities, before we could begin to think about attempting to re-establish them. They may no longer be suitable. Attempting to establish colonies at "apparently suitable" sites would be a dangerous and costly exercise: they are just "apparently suitable" to our judgement. Human beings may be poor judges of what constitutes a suitable site for breeding: the very existence of the Boulders colony shows that we do not fully understand what makes a site attractive or suitable as a penguin breeding colony. Penguins nest mainly on islands for very good reasons: trying to establish new mainland colonies would seem a costly and unwise philosophy. For instance, the colony at Stony Point may, if not for the regular translocation of indigenous mammalian predators, act as a population sink (Whittington *et al.* 1996). I would much prefer to identify the colonies which appear to be thriving and which have relatively high rates of productivity, and try to maximise the recruitment potential of birds to these colonies. It should be borne in mind, however, that the growing, productive colonies of the present may be declining and less productive in 20 years time, due to the dynamic changes of dominance in prey regimes. This makes trying to establish new or re-establish existing colonies an even more risky proposition. I would personally oppose the use of decoys, rehabilitated birds, mirrors and temporarily captive fledglings to attract birds. If translocation of birds is an option, I feel we should move birds from colonies which are declining and have very low productivity, but until we fully understand what is driving the decline in penguin populations, we should not try to consciously influence their choice of breeding locality. A similar proposal for translocation of chicks and juvenile birds put forward in 1997 was not well accepted by the scientific community. I would not feel comfortable recommending these strategies."

C. Coastal and adjacent developments

Need:
Avoid deleterious effects of industrial developments, such as harbours, in the vicinity of breeding localities.
Strategy:

1. Ensure that nature conservation organisations, NGOs, provincial, regional and local bodies and the concerned public contribute to Environmental Impact Assessments that might affect breeding populations and that such views are taken fully into account in the decision-making process that permits such developments following the EIA procedure.

ISSUE 2. HUMAN ACCESS (39)

A. Tourism

Need:
Encourage tourism and media opportunities while minimising disturbance to penguins and their breeding habitats by effective management.
Strategies:

1. Select and prioritise breeding localities at which tourism should be allowed, by, *inter alia*, considering likely disturbance levels, ease of access, distance from markets, etc.

2. Only allow tourism at islands considered suitable for such a practice, and that have regularly updated management plans which, *inter alia*, cover tourism issues.

3. Provide for tourist needs by provision of guides, signage, hides, look-outs, boardwalks and written materials such as brochures.
4. Provide for a system of fees and other charges that will support conservation needs at breeding localities.

5. Restrict tourism to day visits and control numbers of people allowed at selected breeding localities so that disturbance to colonies may be minimised.

6. Produce and provide written guidelines for media visits to breeding localities.

B. Research

Need:
Reduce deleterious effects on penguins by research activities.
Strategies:
1. Establish an advisory body made up of representatives of all authorities that are responsible for managing breeding localities and of qualified individuals to assess and approve research proposals in terms of their conservation significance, ethics and their impacts on birds. This Advisory body should also guide research efforts to ensure that research programmes are broadly comprehensive and co-ordinated.

2. Consider use of supervised "eco-volunteers" to increase research opportunities.

C. Exploitation

Need:
Minimise exploitation of penguins at breeding localities
Strategies:
1. Do not permit guano collecting where it could cause excessive disturbance to breeding birds and/or damage to habitat.

2. Do not allow the collection of penguin eggs unless for approved research and management purposes.

3. Do not permit the collection of penguins from the wild for display purposes in

zoos and museums, including oiled, stranded and injured individuals if they can be successfully rehabilitated and returned to the wild.

4. Limit guano scraping at localities where it still takes place to non-penguin guano wherever feasible and only under the immediate supervision of personnel of the controlling authority based at the island.

5. Monitor impacts of guano scraping at penguin breeding localities and periodically review its allowance.

Issue 3. LEGAL CONTROL (33)

A. Legislation

Need:
Enhance the protection of penguins and their breeding and foraging habitats through legislation.
Strategies:

1. Nature conservation organisations should review all relevant existing legislation and produce new national and provincial legislation and regulations in both South Africa and Namibia by way of an international, interdepartmental working group which enlists the aid of legal experts.

2. Formally protect all breeding localities as nature reserves or equivalents in terms of national and/or provincial conservation legislation.

3. Investigate the value and feasibility of creating marine protected areas (MPAs) around breeding colonies, including the intertidal zone used by penguin beach parties, and in other areas (such as bays important for foraging) by reviewing existing legislation as a first step.

B. Management plans

Need:
Enhance the protection of penguins at individual breeding localities.
Strategies:

1. Nature conservation organisations should produce and implement formally adopted and publicly available management plans tailored for each breeding locality.

2. Review existing management plans at regular intervals.

C. Enforcement

Need:
Enhance the protection of penguins by enforcing existing legislation and regulations.
Strategies:
1. On-site wardening at identified colonies by appointment of qualified nature conservation officials.

2. Training of legal officers and law enforcement personnel, especially prosecutors, magistrates and marine conservation officials.

3. Provision of regulatory and interpretative signage at breeding islands and adjacent launching sites.
4. Regular patrols of unstaffed breeding localities.

5. Informing local communities.

ISSUE 4. PREDATOR MANAGEMENT AT BREEDING LOCALITIES (32)

A. Protection from terrestrial mammalian predators

Need:
Halt the mortality of penguins, including of their eggs and chicks, by introducing measures that keep terrestrial predators out of both island and mainland breeding localities.
Strategies:
1. Erection of adequate barriers extending into the intertidal zone, such as concrete walls, fencing and use of electricity, if appropriate.

2. Consideration of predator problems in EIAs for proposals to construct causeways to breeding islands.

3. Ban the presence of domestic cats and dogs at breeding localities.

4. Make certain that all visiting vessels and materials taken to breeding localities are rodent-free.

B. Removal of mammalian predators

Need:
Assist the decline in mortality of penguins, including eggs and chicks, by monitoring and removing terrestrial predators from breeding localities when they appear.

Strategies:

1. Live trapping and night-hunting of nocturnal viverrids (genets, some mongoose species) and feral cats, where appropriate.

2. Poisoning (e.g., coyote getters) of domestic dogs should be considered if other measures cannot be successfully implemented at penguin breeding colonies. (It should be noted that controls should exist to prevent non-target mortalities and that these measures may be appropriate only for some colonies with severe predation where other measures have failed. For example, domestic dogs can and should be controlled in many areas, such as Boulders Beach. Implementation of these actions should take place only after careful consideration by managing authorities.) Other canids, such as Cape Foxes, should be removed from penguin breeding colonies.

3. At mainland colonies, domestic pets to be impounded and owners informed.

4. Trapping, and investigation of possibilities of poisoning and biocontrol of rodents.
5. All predators trapped to be taken to appropriate humane authorities or, if this is not possible, killed (for South African alien and feral species) or to be marked and removed a sufficient distance so that return is unlikely (for South African indigenous species).

C. Natural predators

Need:
Improve breeding success by minimising predation of the eggs and chicks of disturbed breeding birds by Kelp Gulls and other natural predators.
Strategies:

1. Control human access and reduce disturbance in breeding colonies, including from researchers, managers and tourists.

2. Cover exposed eggs and small chicks with nest materials.

3. Increase the number of protected breeding sites (e.g. artificial burrows).

4. Consider culling of problem Kelp Gulls and other natural predators at selected sites, such as on tourist routes.

5. Attempt to reduce numbers and presence of Kelp Gulls and other natural predators by eliminating artificial food supplies (e.g. exposed coastal dumps).

6. Protect nest sites especially at risk with monofilament lines.

ISSUE 5. COMMUNICATION (31)

A. Public communication

Need:
Increase awareness of the penguin and its conservation needs among the general public.
Strategies:
1. Train personnel (e.g. in nature conservation organisations and tour companies) in communicating with the public via in-house training, and formal courses (e.g. at technikons).

2. Utilise personnel from nature conservation and other organisations (such as environmental NGOs and tour companies) with effective public communication skills to give lectures, run workshops and public meetings, and to guide tourists.

3. Communicate with the public, especially youth, through schools, aquaria, zoos, natural history museums, rehabilitation centres, expos, exhibitions, natural history societies and service clubs by way of organised visits and outings, lectures, press releases, brochures and education packs.
4. Provide interpretative materials, signage, guides and lecturers at breeding localities and at tourist information centres.

5. Use electronic (TV, radio) and printed (newspapers, natural history magazines, etc.) media.

6. Design and regularly update a web site for the African Penguin.

7. Utilise, where sensible, eco-volunteers.

B. Influencing stake-holders

Need:
Improve conservation management by effective communication with stakeholders.
Strategies:
1. Appoint nature conservation personnel with effective management and communication skills, and utilise in-house and formal (e.g. at technikons) training courses to improve such skills.

2. Improve interchange of information between researchers and managers, by use of the Internet, meetings, workshops and other feed-back methods.

3. Influence policy makers within the senior management of nature conservation organisations and the public service at national, provincial, regional and local levels, by way of regular summary reports, invitations to field events, conferences, press conferences, etc.

ISSUE 6. DISEASE (11)

A. Research and monitoring

Need:
Increase knowledge of the health factors affecting penguins.
Strategies:

1. Review the state of current knowledge, including on identification of diseases.

2. Conduct regular monitoring of breeding colonies for sick birds, presence of ectoparasites, vectors and the possibilities of flies and ants killing hatchlings.

3. Undertake necropsies of fresh penguin corpses.

4. Investigate adults, juveniles and chicks for endoparasites, blood counts and chemistry.

5. Monitor the relationships between environmental parameters and disease outbreaks (such as may be caused by presence of stagnant water supporting invertebrate vectors and bacterial infections).

B Prevention of Disease

Need:
Reduce the likelihood of disease outbreaks by controlling the introduction of diseased animals and reducing the presence of invertebrate vectors.
Strategies:

1. Practice vector control where appropriate, such as by draining or sterilising stagnant water.

2. Investigate the possibilities of inoculation of both wild and rehabilitated birds.

3. Prevent the release of rehabilitated and translocated birds into the wild that are not in full health.

4. Investigate the possibilities of indigenous birds, including seabirds and Anatids as carriers of avian diseases to breeding islands.

5. Do not permit the importation and keeping of domestic birds, including poultry and caged birds, to breeding islands.

6. Continue efforts to remove feral Helmetted Guinea Fowl *(Numida meleagris coronata)* from Dassen Island.

7. Incinerate all waste poultry products (including bones and eggshells) at manned breeding localities.

8. Halt the dumping of kitchen and food wastes at breeding localities, including in intertidal and near-shore environments.

C. Diagnosis and reaction plans

Need:
Reduce the effects of disease occurrences by quick diagnosis and treatment when feasible.
Strategies:
1. Educate field staff in procedures for identifying disease outbreaks and collecting materials for diagnosis, including corpses and blood smears.

2. Include monitoring and sample collection methods in management plans.

3. Identify rehabilitation and veterinary experts who can help with diagnoses and treatments.

ISSUE 7. CAPTIVE POPULATIONS

Need:
There is a need to maintain breeding zoo populations to serve as genetic reservoirs and education, research and fund raising resources.

A. Research

Need:
Increase the knowledge of the species by undertaking selected studies on captive birds.
Strategies:
1. Undertake question-driven research on genetics and effects of inbreeding

(where feasible), nutrition, veterinary care (endoparasitology, body temperatures, physiology, blood), band studies, plumage changes, behavioural and ecological studies (of known genetic relationships).

2. Maintain regional and international studbooks for the species.

B. ***Awareness***

Need:
Increase awareness among visitors to captive populations.
Strategies:
1. Provide interpretative material at displays, especially on conservation issues, by ways of signage and brochures in several languages.

2. Give lectures to zoo visitors, including organised groups.

3. Initiate and maintain a web site.

C. Funding opportunities.

Need:
Utilise the existence of captive populations for fund-raising.
Strategies:
1. Run campaigns to fund specific projects for research and management of wild populations, and for rehabilitation centres.
2. Utilise collection points, donations, admissions, gift shops, etc. for obtaining funding.

D. Breeding and release

Need:
Utilise, but only if it becomes necessary, captive populations to maintain numbers and genetic diversity in the wild.
Strategies:
1. Only if it becomes necessary, breed surplus birds in captive populations for release into the wild following full quarantine procedures.

2. Only if it becomes necessary, collect second-laid eggs in the wild and from captive populations if desirable for artificial hatching and rearing and subsequent release into the wild.

Working Group Report: Oiling and Predation Issues

Participants: Mario Leshoro, Anton Wolfaardt, Estelle van der Merwe, Phil Whittington. Student observers: Leticia Greyling, Lyndon Estes

FOREWORD

It should be noted that, while the subject of this PHVA pertains to penguins, issues raised in our workgroup cannot be considered in isolation from other species and processes.

Primary issues identified for discussion by this group were oiling and predation. These topics are discussed in turn in this report.

ISSUE 1. OILING

1. Prevention of oiling:
A problem exists in that legislation aimed at preventing oil spills is possibly sub-standard, and the enforcement of existing legislation is inadequate.

2. Impact of rescue operations:

Rescuing oiled penguins at colonies results in the disturbance of both oiled and non-oiled birds.

a) Disturbance can result in stress to both moulting and breeding birds, which may result in desertions and disturb prospective breeders.

b) The survival of moulting birds may also be reduced.

c) Additionally, the excessive stress suffered by oiled birds during capture operation can reduce their chances of survival.

3. Rehabilitation

a) Rehabilitation plays an important role in penguin conservation.

b) It is necessary to effectively manage the rehabilitation process.

c) There are also concerns that releasing rehabilitated penguins into wild colonies can spread disease.

d) Rehabilitation can raise public awareness about the problems created by oiling.

e) Rehabilitators are forced to carry the costs of "mystery" oil spills.

f) There is a need to assess the effectiveness of rehabilitation through post-release monitoring.

After identifying the components of each of the above oiling-related issues, the group used paired-ranking (Appendix III) to determine the priority of these issues. Results of the ranking were:

- Prevention (17)
- Enforcement (10)
- Rehabilitation (8)
  - *Post-release monitoring (17)*
  - *Responsibility for costs (16), rehabilitation process (16)*
  - *Public awareness (8)*
  - *Disease (6)*
- Impact of rescue operation (6)
  - *Survival (1)*
  - *Breeding success (0)*

Identification of needs associated with oiling (presented in order of priority):

ISSUE 1A. PREVENTION

Need 1:
Increase public awareness as to all implications of oiling. Policy makers, the public and private sectors (and oil companies) should be included in the term "public". (6)
Strategies:

1. Media campaign -- we need to initiate a media campaign to raise people's awareness about the effects of oiling.

2. Information about oil pollution issues needs to be included in education curricula, perhaps as part of a larger environmental education effort (e.g., a package that can be utilised by teachers in class and outings to penguin colonies).

Need 2:
Create incentives to deter potential polluters. (6)
Strategies:

1. Increase penalties for illegal flushing of tanks and bilges. The method of approaching this strategy needs to be investigated. Discussions should be held with the relevant authorities and stakeholders.

2. Lower harbour costs for vessels coming in to flush tanks and bilges. Approach as above.

Need 3:
Improve legislation in order to deter potential polluters. Raising safety standards for ships can be one method whereby this goal is achieved. (5)
Strategies:

1. Review current legislation to investigate possible improvements. Appoint a working group to review current legislation.

2. Oil marking -- the above working group can investigate the feasibility of marking oil as a means to trace oiling offenders.

ISSUE 1B. ENFORCEMENT

Need 1:
Increase political "will" to take subject seriously and ensure adequate funding allocations. (4)
Strategies:

1. Increase the level of lobbying. Pressure on policy makers can be achieved through lobbying by relevant conservation authorities, public interest groups and the public in general.

2. Highlight the inadequacies of the enforcement of current legislation. This might be achieved by emphasising the importance of marine resources to policy makers, while pointing out the current abuses happening despite legislation.

Need 2:
To ensure more effective policing, staffing and equipment needs to be increased. (1)
Strategies:

1. Approach the private sector, especially oil companies, for financial support to increase policing, staffing and necessary equipment.

2. Persuade government to attach more importance to the need for marine resource management and budget accordingly.

ISSUE 1C. THE ENTIRE REHABILITATION PROCESS

Need 1:
The process and techniques involved in rehabilitation need to be investigated in order to ensure that the most effective system is in place. (12)
Strategies:

1. Adopt a scientific methodology for testing different rehabilitation techniques.

2. Communicate with rehabilitation organisations world-wide. This will enable rehabilitation organisations to keep abreast of the latest advances in the field, and to disseminate information. A possible solution is to establish an automatic e-mailing list or list-server.

3. Increase communication between personnel at colonies and SANCCOB. This will ensure a sufficient level of communication between SANCCOB and conservation authorities responsible for the various penguin colonies. Such communication will facilitate the establishment of procedures for rehabilitation, rescue and training.

Need 2:
Post-release monitoring is necessary to constantly determine the success of rehabilitation efforts. (12)
Strategies:

1. Divert monies from an established funds. Post-release monitoring should be made part of the rehabilitation effort, and should therefore receive a share of any monies allocated to rehabilitation.

2. We need to ensure that there is an adequate number of personnel trained and suitably equipped to carry out post-release monitoring.

Need 3:
Rehabilitation costs need to be recovered in cases where the source of pollution is unknown. (12)
Strategies:

1. Seek funding.

2. Increased personnel are necessary to ensure the early detection of oil spills. We must first investigate which colonies must be permanently staffed, and determine, for those which do not need staffing, how frequently they must be visited and by whom. This will determine how much funding is necessary, and where such funding should be applied.

Need 4:
To provide warning of emerging oil incidents, some form of monitoring is essential at all African penguin colonies. (10)
Strategy:

1. Establish fund: A fund should be established to cover the costs of "mystery" or uninsured oil spills. Such a fund could be established by obtaining money from the following sources, each of which should be investigated as a possibility:
   a) A levy on oil barrels
   b) A portion of fines extracted from oil spill offenders
   c) Contributions from oil companies
   d) Shipping taxes

Need 5:
Awareness of the rehabilitation process needs to be raised in order to:
a) increase public support of rehabilitation efforts.
b) raise public awareness of the effects of oiling. (4)
Strategies:

1. A media campaign should be organised to raise awareness of the need for seabird rehabilitation. Successes and challenges should also be highlighted. This campaign perhaps could be incorporated as part of the general campaign to raise awareness about the general effects of oiling.

2. Suggest to SANCCOB that their professional image could be enhanced and increase public relations as well as public participation in the rehabilitation process. Encourage membership of SANCCOB. The volunteer base could be increased, along with training sessions for volunteers.

3. Increase educational visits to rehabilitation centres, and encourage the rehabilitation centres to visit schools. Centres should prepare materials for use in schools.

ISSUE 1D. IMPACT OF RESCUE OPERATIONS

Need:
We need contingency plans to ensure effective management of rescue operations. Such plans will detail the techniques and procedures to be followed with regard to the capture, stabilisation and transport of oiled birds, and the levels and expertise of manpower required to handle different sized oil spills. Contingency plans must also contain:
a) provision for sufficient and appropriate equipment.
b) a code of conduct dictating minimal disturbance to all birds during rescue operations.

It was decided not to rank the issues within the contingency plan since all the issues have been included as part of a procedure.

Strategies:
Contingency plans adaptable to all colonies and oil spill scenarios should be developed. These plans should be continuously tested and revised, and should include an underlying code of conduct that aims to minimise the disturbance caused by rescue operations. The plans will detail the procedures and techniques to be used, the levels of manpower required, and transportation and equipment needs. Appendix IV of this document (a seabird rescue plan in the event of an oil spill at Dassen Island) serves as an example.

Additional, important issues raised in plenary sessions:

- The impact of rescue operations should perhaps be a higher priority than any of the others as there is not much scope for improving oiling prevention or enforcement, and rehabilitation has been quite effective.

- The broad category of oiling should perhaps include other forms of pollution. An example is plastic pollution.

ISSUE 2. PREDATION

Predation on African penguins was broken down into two basic components: predation on land and predation at sea.

Land predation

- Gulls, whose numbers are being bolstered by forage obtained from landfills and fishery by-products, feed on penguin eggs and chicks.

- Indigenous mammalian terrestrial predators, such as Water Mongoose (*Atilax paludinosus*) and Cape Fox (*Vulpes chama)*, are a different case than introduced predators, and therefore should be treated differently. At present, this group does not impact the penguins as severely as other predators.

- Feral cats prey on penguin chicks. If the local populations of cats increase, this could reduce penguins' reproductive success.

- Mole snakes are egg predators that have a minor impact on the penguin population.

- Domestic dogs, if not controlled, can cause penguin mortalities. This problem is confined largely to mainland penguin colonies.

- Rats could pose a problem to penguin colonies, particularly those close to human habitation. Where cat and rat populations occur together, care should be taken develop plans to eliminate both in such a way that monitors the balance between the two.

Predation at sea

- Sharks are known penguin predators. Chumming and cage diving may increase the number of sharks in the area, and therefore increase penguin predation. This effect tends to be isolated.

- An expanding fur seal population could have a serious impact on some penguin populations, both in terms of predation and competition for a limited food resource.

The group then ranked the threats posed to African penguin populations by various predators. The results of this ranking were:

1. Seals (39)
2. Gulls (35)
3. Cats (22)
4. Rats (17), Sharks (17)
5. Indigenous terrestrial mammalian predators (15)
6. Mole snakes (7)

7. Dogs (3)

Note: predators 4-7 were not further expanded because of time constraints.

SEALS

Need 1:
We need to draw up a policy and implementation plan dealing with the management of seals and, more specifically, penguin-seal interactions. (7)
Strategy:

1. Organise a broadly consultative workshop to investigate seal-seabird interactions and to produce a policy and action plan to guide the management of such interactions. For example, the workshop should identify areas where control of seal numbers might be necessary. The authorities responsible for the various colonies will be the ultimate authors of the plan.

Some additional important topics to be covered in such a workshop are listed below.

Need 2:
We may need direct (eliminating seals known to specialise in penguins and general culling) and indirect control measures (reducing fisheries by-catch) to combat the negative effects of penguin-seal interactions. (6)
Strategies:

1. Discuss, develop and implement scientifically-based control measures to test the efficacy of various methods.

2. The possibility of controlling seals as part of a sustainable use programme should be discussed as part of a broader initiative to address the negative effects of penguin-seal interactions.

Need 3:
We need greater research into the growth of seal populations and their impact on penguin colonies. (It should be noted that the delay in action whilst research is being conducted could result in the local extinction of some penguin colonies, while others may experience significant reductions.) (5)
Strategies:

1. A monitoring programme of penguin survival rates in relation to seal-control measures should be initiated.

2. Monitoring of the seal population should continue in order to determine the effects of any control measures on the seal population.

GULLS

Need 1:
We need to reduce human disturbance in penguin colonies. Human activity can unsettle nesting birds, thereby exposing eggs and chicks to predation by gulls. (10)
Strategy:
1. Gulls follow humans in penguin colonies in anticipation of feeding opportunities arising from nest disturbance. As such, we need to ensure minimum disturbance in penguin colonies, especially where kelp gulls reside in close proximity to penguins. Such restrictions should apply to all people, including researchers.

Need 2:
We need to address the sources of gull subsidisation, such as improving waste management. (7)
Strategy:
1. Address sources of subsidisation: gull populations are possibly being bolstered by increased foraging opportunities caused by human activities, such as the disposal of fisheries by-catch and refuse dumping. Such activities are widespread, and as such it is difficult to propose specific strategies to tackle the problems. The following general suggestions have been made:
   a) Create awareness of problems caused.
   b) Improve human refuse disposal.
   c) Minimise fisheries by-catch.

Need 3:
We need to establish whether there is a need to directly control gull populations. (5)
Strategy:
1. Determine whether it is necessary to control gull populations: it is not entirely clear whether gulls have a significant impact on penguins, or if they are being significantly bolstered by human subsidisation. As such, the following strategies have been recommended:
   a) Continue to monitor the abundance and breeding success of gulls.
   b) Encourage specific research into the nature and effect of gull predation on penguins.

FERAL CATS

Need 1: We need to eradicate all feral cats.
Strategies:

1. Identify localities where it is feasible or necessary to eradicate feral cat populations. At a colony such as Boulders, for instance, it may not be feasible to control feral cats due to the proximity of human habitation, where domestic cats may be indistinguishable from feral cats.

2. Time-concentrated, high intensity eradication efforts should be undertaken. Such an approach is preferable to ongoing low-level efforts, which tend to suppress rather than eradicate cat populations. Continuous programmes can also create disturbance in penguin and other seabird colonies.

Need 2:
There is a need to determine the relationship between feral cats and potential prey species, especially rats.
Strategy:
1. Colonies where cats have been eradicated must be monitored to detect possible rises in prey species. For instance, if rats were to experience a boon due to the elimination of cats, they could present a significant threat to penguin populations.

Important issues raised in plenary during discussion of this working group's report were:

- Great white sharks are considered to be more important predators than seals in certain areas. It should be noted that predator priorities should be evaluated on a colony to colony basis, as the relative importance of predators can vary.

- In regulating the impact of gulls on penguins, do individual problem gulls need to be controlled, or is a general decrease of the gull population necessary? (There is some degree of localised predation on gull chicks by pelicans.)

- Pelicans have potential to become serious predators of penguin chicks.

- An M.Sc. project has been launched regarding the interactions between seals and penguins.

- There was a concern raised about mentioning sustainable use of seals as a method of managing penguins. Negative public outcries could result from such an approach.

Working Group Report: Fishery-Related Issues

Participants: Johan Augustyn, Robert Crawford, Onno Huyser, Rob Leslie.
Student observers: Adnan Awad, Lauren Waller

GENERAL
There were 11 issues identified under this topic by the plenary. A central theme to all the issues is the question of whether the fishery for small pelagic fish (anchovy and pilchard) is leaving enough fish in the sea to satisfy the food requirements of the penguins.

- Over-fishing
- Food Availability
- Food Resources
- Fishery/food supply problems
- Prey encounter rates: spatial and temporal predictability
- Food supply prediction
- Competition for food resources
- Competition/interaction with fisheries
- Competition for food
- Fishing adjacent to the penguin colonies
- Fishery exclusion zones

We initially tried to group the issues under different themes, but found that the issues were so inter-related that this was difficult. Instead we used the ideas behind the issues to pose five key questions, without trying to assign the initial 11 issues to any of the key issues.

KEY ISSUES IDENTIFIED

1. **Is there sufficient food available for the penguin population?**

2. **Is there sufficient food available in the vicinity of the breeding islands during the breeding season?**

3. **Competition from other predators such as seals and gannets.**

4. **Are there direct penguin/fishery interactions?**

5. **Can long-term population fluctuations in forage-fish abundance be used as an estimator of carrying capacity for the penguin population? (Note: this last issue was not discussed in detail because of time constraints.)**

ISSUE 1. IS THERE SUFFICIENT FOOD AVAILABLE FOR THE TOTAL PENGUIN POPULATION?

The issue is whether the current fishery management takes sufficient cognisance of penguin food requirements. The fishery is managed on a "constant escapement" basis. The key question is whether this escapement is sufficient to meet the needs of all natural predators, including penguins. Although this issue could be seen as a part of Issue 2, it has been separated because of the fishery management. A change in the total amount of food available will require a change in the size of the fishery, i.e., change in the level of escapement and total allowable catch (TAC). Issue 2 addresses changes needed to the fishery strategy to ensure that the food is available at the right time and place.

Issue 2 is more directly important for the survival of penguins, but Issue 1 is a necessary precursor for addressing problems in Issue 2.

Need 1:

We need to know how much food the current (and projected) population requires in order to maintain or allow the population to grow. How is this allocated among migratory juveniles and sub-adults, breeding and post-moult (pre-breeding) adults?

Strategies:

1. Conduct a literature search to construct relationships of energy requirements with different life stages. Combine this with the demography of the penguin population to estimate the total energy requirement of the population.
2. Some functional relationships relating performance of penguins (e. g. chick production per pair per year, proportion of adults breeding in a year, breeding population in a year) at colonies to biomass of fish prey stocks are available. Others should be developed.
3. Demographic parameters that will enable target penguin populations (e. g. no further decrease in penguin population) to be achieved should be determined from models of the penguin population.
4. Models of prey populations should be linked with demographic models of penguins using the empirical functional relationships to determine strategies for management of fish stocks that will permit penguin performance (on identified parameters) to achieve desired goals.

Need 2:

We need to know the sizes of prey populations, and how they fluctuate over time and space, in order to determine the contribution per prey species to the food requirement.

Strategies:

1. Use existing fisheries information and models to estimate the current biomass per prey species.
2. Use the existing fisheries information to determine the distribution of the prey species in time and space.

Need 3:
We need to know what impacts a change in Total Allowable Catch (TAC), or other mitigating options, will have on the commercial fishery.
Strategy:
1. Modelling – fit required escapement into existing fisheries models.

Need 4:
We need to know the optimum population of penguins and other species to set a target for ecosystem management
Strategy:
1. This is a general population issue. Essentially this needs to be set as a goal by a "penguin management group", or in a workshop environment where managers and responsible conservation agencies set a target population. We can then try to adapt fisheries management to ensure that sufficient food is available to attain this.

ISSUE 2. IS THERE SUFFICIENT FOOD AVAILABLE IN THE VICINITY OF THE BREEDING ISLANDS DURING THE BREEDING SEASON?
The key issue is that there may be sufficient escapement to meet the food requirements of the penguin population, but the food is not available at the right time and place for successful breeding. It has been shown that there is a strong correlation between food availability and breeding success. Therefore it is important to ensure that there is enough food within the foraging range of the breeding islands during the breeding season. Management options and changes in fishing strategy (e.g. closed areas, seasons, MPA's around colonies, fishing-free corridors when fish are migrating past a colony) need to be investigated in order to achieve this. Food quality should also be considered, i.e. do some species provide better quality food than others?

Needs (per colony):

Need 1:
We need to know the food requirement over time for each colony in order to determine the critical periods and requirements during these periods.
Strategies:
1. Synthesise existing information on numbers of birds, timing of breeding and moult at each colony.

2. Collect missing information.
3. Use this to build a model on colony demands; construction of a graph describing total colony requirements per month over an entire year might be a good way to present the results.

Need 2:
We need to know the foraging area per colony.
Strategy:
1. Synthesise existing data for Algoa Bay, Robben Island, Dassen Island and Saldanha Bay islands.

Need 3:
We need to know energy costs for different foraging distances, prey types, prey density and predictability of encounter rates. A good way of collecting this information and testing the hypothesis that food availability is enhanced by a fisheries-exclusion zone adjacent to the penguin colony would be to compare colonies in increase and decrease. A project for one colony (increasing) is described:
Strategies:
1. Conduct a pilot study at Boulders Beach, relating aspects of fish abundance in False Bay with breeding of penguins at Boulders.
2. Acoustic surveys of False Bay fish densities; short-term and long-term data sets:
3. Long term: mean abundance of fish in False Bay and breeding success;
4. Short term: sustained presence of fish in False Bay, and chick growth and adult trip length.

Need 4:
We need to know the energy content and energy cost of capture for different prey species and age classes in order to determine the energy return of different prey.
Strategies:
1. Literature search to find known energy content of different species.
2. Estimate energy content for those species where published information is not available.
3. Metabolic studies on penguins to measure energy requirements (stomach sensor, compass on back of penguin, use of weigh bridges, transponder)
4. These questions could be well-addressed by large collaborative research projects.

Need 5:
For penguins immediately post-fledging, we need to know their energy requirements, preferred prey and the required prey density in order to determine ways of improving survival rates during this critical stage in penguin life cycle.
Strategies:
1. Literature (energetics) and laboratory experimentation: juvenile and adult penguins introduced into tanks with different species and age-classes of prey fish, and comparison of prey preference and catch rates.
2. Aquarium assistance (captive populations).

Need 6:
Implications for the commercial fisheries of changed management strategies for addressing food availability problems for penguins in the vicinity of the colonies during the breeding season, need to be considered.
Strategies:
1. Estimate costs to fishing industry of maintaining fishery exclusion zones, MPAs, corridors, closed seasons.
2. Feasibility assessment: costs to management of monitoring and enforcement.

Need 7:
We need to consider an adaptive management approach for testing the effects of a fisheries exclusion zone.
Strategies:
1. Select sites where minimal impact from closure of an area adjacent to the colony will result.
2. Monitor foraging and breeding parameters before and after closure.

ISSUE 3.
COMPETITION WITH OTHER PREDATORS SUCH AS SEALS AND GANNETS.
The issue is that growth in the populations of other anchovy and pilchard predators could negatively impact the penguin population through increased competition for food. The point is that a multi-species model that considers the needs of the fishery and penguins only may not be sufficient. Competition among penguins and other predators, and the population dynamics of the other predators must also be considered.

Need:
We need use EcoPath (Christensen and Pauly, 1992) the interactions between penguins and other predators of small pelagic fish (e.g. seals, gannets, hake, squid, snoek, cormorants and humans) in order to predict their potential effect on the penguin population. To do this we need to know:
a) the population trends of the other predators;

b) the food requirements for these predators;
Existing knowledge on diets, (using the literature) are available for: seals, gannets, cormorants, squid, hake and snoek.
c) if the food requirements and species interactions change over time.
By modelling multi-species interactions, the EcoPath model allows us to test ecosystem effects of introduced or increased harvesting of various ecosystem components.

Strategies:

1. Continue existing monitoring studies, extend where necessary (particularly to obtain biomass estimates of e.g. snoek).

2. Consider using surrogate indices for biomass of the large pelagic species (CPUE) (e.g. tuna, cetaceans).

ISSUE 4. ARE THERE DIRECT PENGUIN/FISHERY INTERACTIONS?

The key issue is that penguin mortality through direct fishery interactions must be minimised. Examples of possible mortality due to direct fishery interactions are: entanglement in nets; incidental mortality by longlines; and the use of penguins as bait in the lobster fishery. This must also include the effects of ghost fishing, i.e. entanglement in discarded fishing gear and the effects of general pollution.

Another possible interaction would be if a fishery in the vicinity of a breeding island caused enough disturbance to affect breeding success. In this case the fishery (for example collection of intertidal organisms) may appear to be harmless to the penguins in that there is no direct mortality or competition for resources, but there is a hidden cost. This question must be carefully considered when expanding current fisheries or introducing new fisheries.

Needs:

We need to identify the fisheries where there are direct penguin/fishery interactions (i.e. , direct mortality or disruption of breeding). For each of these fisheries we need to know:

a) How many birds are being affected and at what rate? Where and when do these interactions occur?
b) What management options (e.g. mitigating devices or closed seasons/areas) are available to reduce these interactions?
c) Iin order to determine the effects on the penguin population demography, we need to determine which penguin age-classes are being affected.

Strategies:

1. Potential interactions in all fisheries must be investigated. The following fisheries should be investigated first (in order of importance): set net, lobster (the use of penguins as bait), beach seine, longline, recreational, purse seine, and scientific surveys and activities

2. Where penguin/fishery interactions are identified, management options (e.g., changes to conditions on fishing permits) must be identified and implemented.
3. Set nets are an immediately obvious problem, and an obvious solution is to prevent setting of nets in the vicinity of islands (say no closer than 200 m).
4. Legislation must be enforced and its effect assessed through monitoring and, if necessary, legislation should be modified.
5. Scientific surveys need a code of conduct, and need to be vetted by an "ethics board", or at MCM by the Biodiversity Working Group.

References

Christensen, V. and Pauly, D. 1992. ECOPATH II - a software for balancing steady-state ecosystem models and calculating network characteristics. *Ecological Modelling* 61:169-185.

Monitoring and Modelling Group Report

Participants: Bob Lacy, Norbert Klages, Dieter Oschadleus, Rod Randall, Peter Ryan, Lynne Shannon, Les Underhill

A. ISSUES - POTENTIAL FACTORS THREATENING PENGUIN SURVIVAL

The group commenced by reviewing the threats affecting African Penguin survival. Ranking of threats confirmed that these accorded with the major areas tackled by other working groups (threats 1-4 ranked significantly higher than other threats).

1. Fishery interactions

Competition with fisheries means that there is likely to be reduced food availability, and a possible change in food quality. Although hard to demonstrate, there is inferential evidence that pelagic fish are a limiting factor (correlations of proportion of adults breeding or breeding success with estimates of pelagic fish stocks).

Penguins may be entangled in nets but we need data on the current rate of entanglement. Much entanglement is likely from 'ghost fishing' by discarded fishing gear or other debris (not necessarily only from fisheries).

2. Colony management - are islands limiting penguin populations?

There are relatively few islands, and they are not uniformly dispersed throughout the breeding range. Growth in seal numbers has reduced the area available to penguins; seals are displacing penguins at some islands. This loss is offset to some extent by formation of mainland penguin colonies, although these may not be desirable (population sinks, sources of disease into penguins from mainland bird populations, human-penguin interactions, disturbance).

Penguin populations on most islands off South Africa (i.e. space is not limiting - e.g., Dassen Island, Robben Island) but there are no new (uncolonised) islands to which the penguins can move in South Africa. However, off Namibia there are several such islands. Mercury Island is problematic because of seals. Degradation of islands, e.g., tourism and harbours, would adversely affect breeding and is cause for concern.

3. Predation

Given the growing seal population, predation by seals likely has increased. Although some seal predation is likely to have occurred previously and should be viewed as 'natural', this is a tractable impact to tackle through control of individual seals that predate penguins at breeding islands.

Kelp Gulls are a similar problem, being a form of natural mortality that is likely to have increased due to human actions. Kelp Gulls cause significant breeding failure at some islands. This typically occurs in conjunction with disturbance of breeding birds (generally by human activities). Therefore, the first priority should be to reduce disturbance at islands. However, gull numbers have probably increased as a result of human activity (increased food availability, both in urban areas and from fishery discards). Counts of Kelp Gulls at Bird Island, Algoa Bay (Norbert Klages) have increased threefold, so there may be some justification in controlling further growth of the Kelp Gull population. During the years of guano collection, Kelp Gull numbers were controlled on the islands.

Terrestrial mammalian predators should be actively controlled at islands where they have been introduced. Alien, terrestrial, mammalian predators (feral cats, rats) should be eliminated at islands (e.g. Dassen and Robben islands) where they have established populations. At former islands that are now linked to the mainland (e.g. Marcus Island), measures to prevent mammalian predators from gaining access should be upgraded and all predators that do gain access should be translocated or eliminated.

4. Oiling

This is an important issue and should be treated in two ways (at least from a modelling perspective): chronic (low level) oiling of small numbers of birds (probably incorporated in current survival estimates) and catastrophic events that affect large numbers of birds.

5. Multi-species approach

A multi-disciplinary approach incorporates impacts on the ecosystem (multi-species) of competition, predation, management of fisheries, socio-economic factors and politics. Multi-species effects may well be important, but given our current rather poor state of knowledge regarding the impacts of individual threats, it is premature to dwell on effects of these interactions. Firstly, goal-specific models should be developed to address specific interactions (e.g. fishery-penguin interactions using EcoPath modelling – refer to report of fisheries working group.

6. Disease

This does not seem to be a major issue and it could fall under "natural" mortality. The types of diseases are listed in the CAMP document (Ellis *et al.,* 1998). The subject is data deficient - we need to know the extent of disease on penguin populations. Although disease is not a modelling priority at present, it was felt that the subject has not received the research attention it deserves given its potential to cause catastrophic losses of penguins. Therefore, modelling should include impact of diseases once improved data have been collected.

7. Global climate change
Possible predictions of global climate change models show that African Penguins could be affected, including the increased incidence of cyclones (Eastern Cape), extreme rain or temperature events (reducing breeding success), and increased turbidity resulting from storm run-off (reducing foraging efficiency).

8. Fire
Localities where fire is a risk are Robben Island, Boulders and Stony Point, where penguins breed under the cover of alien shrubs (primarily *Acacia cyclops*). The risk of fire increases as tourism increases. In the short term, interim solutions to reduce the risk of fire should be put in place. In the long term, policy should promote the replacement of alien vegetation with artificial burrows.

9. Human disturbance/exploitation
On-going vigilance is required. Disturbance is problematic at many islands, in particular some of the islands in Algoa Bay. The extent of exploitation (e.g. use of penguins as bait in crayfish traps, egg harvesting) may be underestimated because it is illegal.

10. Other issues pertaining to modelling
Additional issues pertaining to modelling are data collection and data quality. Accordingly a sub-group was formed to consider monitoring needs. One of the key concerns is the lack of information on inter-island differences in demographic parameters. One possible approach to overcome this problem is to collect data on putative threat factors at different islands to see if there is a correlation between population trends and these threat factors.

B. MODELLING BACKGROUND - THE VORTEX MODEL

Traditionally, ecologists have used mean age-specific birth and death rates to calculate the expected average rate of growth or decline of a population, ignoring the irregular fluctuations as individuals are born or immigrate, and die or emigrate. For many purposes, such a simplified model of population growth is very useful, because it captures the essential information we might need regarding the average change in population size, and it allows us to make predictions about the future size of the population.

In considerations of the vulnerability of a population to extinction, as is so often

required for conservation planning and management, the simple model of population growth as a constant annual rate of change is sometimes inadequate for our needs. The fluctuations in population size that are omitted from the standard ecological models can cause depression in long-term average growth rates of the population, or even population extinction. In order to understand and predict the vulnerability of a wildlife population to extinction, we need to use a model that incorporates the processes that cause fluctuations in the population, as well as those that control the long-term trends in population size (Shaffer 1981). Many processes can cause fluctuations in population size: variation in the environment (such as weather, food supplies, and predation), genetic changes in the population (such as genetic drift, inbreeding, and response to natural selection), catastrophic effects (such as disease epidemics, floods, and droughts), decimation of the population or its habitats by humans, the chance results of the probabilistic events in the lives of individuals (sex determination, location of mates, breeding success, survival), and interactions among these factors (Gilpin and Soulé 1986).
Models of population dynamics that incorporate causes of fluctuations in population size in order to predict probabilities of extinction, and to help identify the processes that contribute to a population's vulnerability, are used in "Population Viability Analysis" (PVA) (Lacy 1993/4). For the analyses presented here, we used the VORTEX version 8 computer software (Lacy 1993) for population viability analysis. VORTEX is a species and habitat-specific simulation that models demographic events (mate selection, birth, sex determination, and death), metapopulation process (dispersal, extinction, and recolonisation), and changes in genetic variation. In addition to using mean birth and death rates to project population growth, VORTEX models demographic stochasticity (the randomness of reproduction and deaths among individuals in a population), environmental variation in the annual birth and death rates, the impacts of sporadic catastrophes, and the effects of inbreeding in small populations. VORTEX also allows analysis of the effects of losses or gains in habitat, harvest or supplementation of populations, and movement of individuals among local populations.

VORTEX is an individual-based simulation, in which the fate of each animal is tracked as it experiences any of a number of possible demographic events (aspects of reproduction, mortality, and dispersal) in each discrete time step. Users specify mean probabilities of occurrence of each demographic event, and also the extent of annual fluctuation (expressed as SDs) in the rates as a result of environmental variation. In addition, catastrophic events in the simulation model may cause reductions in survival and reproduction, and the user specifies the probability of occurrence of any catastrophes and the severity of the impacts. Carrying capacity of the habitat is modelled as a ceiling population size. When the carrying capacity is exceeded, VORTEX applies an additional risk of mortality to each individual, such that the population size will on average return to the carrying capacity. Demographic rates can be specified to be functions of density, time, genetic diversity, sex, age, and other characteristics of the population and individuals.

In each year of the simulation, VORTEX determines the demographic rates for that year by sampling from the distribution with the specified mean and SD, and then reduces rates for that year if a catastrophe is deemed to have occurred. Stochastic events (catastrophes, inclusion in the pool of mates for a year, mate selection, litter size, sex determination, survival, dispersal) are determined to have occurred if a random number drawn from a uniform 0-1 distribution is less than the probability of occurrence of the event. Because VORTEX requires specification of many biological parameters, it is not necessarily a good model for the examination of population dynamics that would result from some generalised life history. It is most usefully applied to the analysis of a specific population in a specific environment. See Lacy (1993), Miller and Lacy (1999), and Lacy (1999) for further details about the VORTEX model. VORTEX is available at http://www2.netcom.com/~rlacy/vortex.html.

Dealing with uncertainty

It is important to recognise that uncertainty regarding the biological parameters of a population and its consequent fate occurs at several levels and for independent reasons. Uncertainty can occur because the parameters have never been measured on the population. Uncertainty can occur because limited field data have yielded estimates with large sampling error. Uncertainty can occur because independent studies have generated discordant estimates. Uncertainty can occur because environmental conditions or population status have been changing over time, and field surveys were conducted during periods that may not be representative of long-term averages. Uncertainty can occur because the environment will change in the future, so that measurements made in the past may not accurately predict future conditions.

Sensitivity testing is necessary to determine the extent to which uncertainty in input parameters results in uncertainty regarding the future fate of the population. If alternative plausible parameter values result in divergent predictions for the population, then it is important to try to resolve the uncertainty with better data. Sensitivity of population dynamics to some parameters also indicates that those parameters describe factors that could be critical determinants of population viability. Such factors are therefore good candidates for efficient management actions designed to ensure the persistence of the population.

The above kinds of uncertainty should be distinguished from several more sources of uncertainty about the future of the population. Even if long-term average demographic rates are known with precision, variation over time caused by fluctuating environmental conditions will cause uncertainty in the fate of the population at any given time in the future. Such environmental variation should be incorporated into the model used to assess population dynamics, and will generate a range of possible outcomes (perhaps represented as a mean and standard deviation) from the model. In addition, most biological processes are inherently stochastic, having a random component. The stochastic or probabilistic nature of survival, sex determination, transmission of genes, acquisition of mates, reproduction, and other processes preclude exact determination of the future state of a population. Such demographic stochasticity should also be incorporated into a population model, because such variability both increases our uncertainty about the future and can also change the expected or mean outcome relative to that which would result if there were no such variation. Finally, there is "uncertainty" which represents the alternative actions or interventions that might be pursued as a management strategy. The likely effectiveness of such management options can be explored by testing alternative scenarios in the model of population dynamics, in much the same way that sensitivity testing is used to explore the effects of uncertain biological parameters.

Often, the uncertainty regarding a number of aspects of the population biology, current status, and threats to persistence is too large to allow scientifically accurate and reliable projections of population dynamics. Therefore, the predictions made from PVA models should be considered to be projections about what would most likely happen to the population *if* various hypotheses about the status of the populations and the threats are true. Conservation and management decisions must be made based on the most plausible hypotheses about the population status, before sufficient data could be collected to test those hypotheses scientifically. An important advantage of PVA models is that they force systematic consideration and specification of the assumptions and hypotheses that must be made in the absence of adequate data. This facilitates careful reassessment and improvement in the analyses, as better data become available.

C. PARAMETER ESTIMATION

The first need for modelling African Penguins was for the working group to decide the spatial and temporal scales over which to model the population. The current adult population is about 160 000 birds, with five major colonies (or colony clusters) in the Western Cape, two in Algoa Bay (Eastern Cape) and several off southern Namibia. Given the lack of robust demographic parameters for different colonies or regions, and the limit on maximum population size by an individual-based model like Vortex, we decided to focus on a single colony, initially using parameters from Robben Island as the best-known colony in terms of demography, but with comparative comments for other islands where differences are known.

Initial model for Robben Island

Time-frame: 25 years is the approximate period of interest. In the initial simulations conducted at the workshop we considered twice this period to detect clear trends. Subsequently, it was clear that all trends were as apparent in simulations for 25 years. All results presented below are based on 25 year projections.

Number of simulations: At the workshop, 100 repetitions were used for initial simulations. Results presented below are based on 250 iterations that were completed subsequent to the workshop.

Current adult population: 14080 (1999) - obtained by counting active nests (conversion factor is 3.2 x nests, Crawford and Boonstra 1994)

Note on *age structure*: Some parameters measured at Robben Island may be different than those at other colonies. Other colonies may have more old birds while Robben has more young birds, due to immigration by prospecting birds. However this won't affect the modelling exercise as the starting population in Vortex is set to a stable age distribution (but the run period is sufficient to make this assumption not unrealistic).

Note on *maximum breeding count: numbers moulting*: only known for Robben Island. At Dassen Island, there is insufficient data on moulters (penguins nest in burrows at Dassen Island, making it difficult to assess the population).

Inbreeding was ignored, as it is only relevant when the population is very small. *Adult mortality* may be taken as constant (studies by Phil Whittington - mortality not correlated to breeding areas). The only significant inter-year effect is from oiling events, which are treated as catastrophes.

Catastrophes include oiling (which has various effects, depending on location of the oil spill relative to the colony and foraging locations, and timing relative to peak breeding) and disturbance events at colonies (e.g. fires, human disturbance, extreme climatic events).

Parameters used for modelling catastrophes:
Oiling catastrophe

frequency = 1 in 50 years can be expected at a specific colony

population ratio affected = 0.24% (Adams 1994) (compare to Shannon and Crawford in press, for which this level of oiling was considered to be chronic not catastrophic)

effect on reproduction, multiplier = 0.5

effect on survival, multiplier = 0.75

Massive human disturbance (particularly on St Croix), combining all possible types of human disturbance:

frequency = 1 in 10 years

effect on reproduction = 0.5

effect on survival = (no effect) (However, there was some disagreement here; it is possible that disturbance on this scale will lead to breeding failure and replacement laying at a sub-optimal time of year, when there is less food and day length is shorter, causing increased stress to breeding adults. In Adelie penguins, mortality is higher in breeders than non-breeders [Ainley *et al.* 1984] and it is reasonable to expect the same in African penguins, especially where they have to run the gauntlet of seals on a daily basis.)

Age at first breeding for different age classes is listed in Shannon and Crawford (in press). In the absence of evidence to the contrary, we used the same data for males and females.

age 2: 5% breed
age 3: 33% breed
age 4: 74% breed
age 5: 100% breed

These data can be represented as:

% breeding = min(100, [32.6 x Age - 61.1])

Maximum breeding age may be taken as 30 years (= maximum longevity).

Sex ratio of chicks is unknown but it makes a good student project (take blood samples from recently hatched chicks and use sex-specific genetic markers; Bob Lacy can access the genetic probes). Until studied, we will assume the sex ratio is 50:50.

Breeding success (/attempts) is assumed to be density independent.
Fledglings produced - studies at Robben Island indicate that on average (1989-1998), 0.54 fledglings are successfully raised per breeding pair per year (Shannon and Crawford, pers. comm.).

The coefficient of variation (CV) of breeding success is 30% (Crawford, pers. comm.).
At other colonies success may be higher (e.g. 0.65 fledglings/pair/breeding attempt at Boulders and up to 1.12 fledglings/pair/breeding attempt at Dassen Island - mean ca. 0.8.; [Stony Point ranged from 0.20 – 0.30 fledgling/pair/breeding attempt]. Note that the latter estimates are of breeding success per breeding attempt, whereas the Robben Island estimate is of breeding success per breeding pair over the whole breeding season, i.e. second breeding attempts are included in the Robben Island estimate.

The *breeding proportion* (proportion of mature birds that choose to breed in a year) was calculated to be 83.4 $\pm$ 12.6% (range 70-100%) (Shannon and Crawford in press).
Vortex multiplies this with age class maturity to give actual breeding adults in a year,

i.e. min(100, [(32.6 x Age) - 61.1]) x 0.834 $\pm$ 0.126
mean chicks/pair/year = 0.54 $\pm$ 0.16

Mortality rates:
Adults (> 2 years): 86 $\pm$ 2.8% survival (mean and standard deviation used in Shannon and Crawford's model (in press), based on data presented in Crawford *et al.* in press). This corresponds to annual mortality of 14 $\pm$ 3%.
Immatures (fledging-12 months): 51 $\pm$ 11% survival (model estimate by Shannon and Crawford, in press: survival of juveniles from fledging to the end of the first year (12 months) was estimated as that required to maintain the model population in equilibrium in the absence of egg harvesting. Other population parameters were measured in the field, and the model randomly selected values of parameters from the normal distribution around the measured means. For details see Shannon and Crawford in press.) This corresponds to a mortality of 49 $\pm$ 11% mortality for the 6-9-month post-fledging period.
Immatures (12-24 months): 63% survival (back calculated), corresponding to 37 $\pm$ 6% mortality. Survival was estimated from the annual survival rate of 47% for juveniles aged 6-18 months (Underhill and Whittington, pers. comm.) and the annual survival rate of birds older than 18 months, assumed equal to adult mortality (86%, Shannon and Crawford in press). Calculation: $0.47^{0.5}$ (survival for 6-month period 12-18 months)*$0.86^{0.5}$(survival for period 18-24 months)=0.63.

Note that the above mortality data largely include all sources of mortality. This does not, however, include catastrophes. Also it does not take into account increases in certain causes of mortality.

Not enough is known about *seal predation*. It used to be thought that there were rogue seals that specialised in catching penguins, but from culling we know that over 20 seals at a time can be preying on seabirds at Malgas Island, for example. Are the Kleinsee seals having an effect on young penguins moving north to Namibia?
Observations and ringing recoveries indicate there has been seal predation over the last 20 or so years, so it does need to be included as an additional factor in the model. Seal predation on seabirds was documented as early as the 1950s (P. Shaughnessy, pers. comm.).

Initial population for model of penguins at Robben Island:
5000 adults in 1990

Carrying capacity: The modelling group estimated there to be up to 10000 potential nest sites still available at Robben Island in 1999. Note that other limiting factors (e.g. food availability) would prevent this level being reached.

<u>Summary table of best estimates for Robben island:</u>

Key:
*Shannon and Crawford in press
#Underhill and Whittington pers. comm.
~Crawford *et al.* in press
^Crawford pers. comm.

Chicks /pr/yr	**Adult mortal**	**J <18m mortal**	**%br**	
0.54*	0.14*	0.53#		baseline
0.54*	0.14*	0.53#	0.834*	best
0.32^	0.10~	0.70*	0.7~	low
0.86^	0.18~	0.30*	1.0~	high
1.2				max (Dassen Island, Wolfaardt, pers. comm.)

Note on *juvenile survival*: The maximum value for juvenile survival was assumed to be 0.7, given the estimate of 0.69 at Dyer Island (La Cock and Hänel 1987). Minimum juvenile survival was assumed to be 0.3 (Shannon and Crawford in press), based upon Randall's (1983) estimate for juveniles at St Croix. However, it should be noted that 0.3 may be an underestimate, as Randall's (1983) estimate covered the 12 month period from fledging (at 3 months) to the age of 15 months, whereas juvenile survival in Shannon and Crawford was for the period from fledging to 12 months (i.e. less than one year).

Note on *maximum chick production per year:* 1.12 is the mean number of chicks produced per pair in a single breeding attempt at Dassen Island (Wolfaardt, pers. comm.), so the maximum chick production per pair over the whole year may be even higher than this.

D. MODELLING RESULTS

Using the VORTEX simulation model, we examined projections for an African penguin population with an initial size of 5 000 birds, and a carrying capacity of 25 000. This represents approximately the size, and perhaps also the approximate carrying capacity, of Robben Island in 1990. We started with a baseline scenario with demographic characteristics as estimated for Robben Island, and then varied key parameters to determine the sensitivity of model projections to variables that were uncertain, that may vary among breeding populations, or that may change over time.

We present the modelling results, below, as the mean population growth rate (r, approximately the average proportional change in population size per year), the variation in population growth across years [SD(r)], and the mean predicted population size at year 25. In addition, for each case modelled we list the percent of the population (just before the onset of breeding each year in the model) which would consist of juveniles (one year after fledging). This would be about the percent of the moulting population that would be juveniles. We assessed this percent because the fraction of juveniles in the moulting population can be a useful indicator of the demographic health of the population.

Effects of varied demographic rates

Table 1 shows the model results for three levels of juvenile survival, two levels of adult survival, three levels of reproductive success, and four scenarios with respect to catastrophes. The first line of results in the table represents the best estimate of the current demographic rates at Robben Island, in the absence of catastrophes. The population is projected to be unsustainable without immigration, due to low reproductive success and high mortality.

With 47% juvenile survival through the first year (Table 1A), the population is projected to be self-sustaining only if reproductive success is very much higher (1.20 chicks fledged per nest per year), or if moderately improved reproductive success (0.86 chicks per nest per year) is combined with better adult survival (90%). If catastrophes occasionally decimate the population numbers and/or breeding success, then mean population growth rates are reduced and variation across years in population growth is increased. With catastrophes, the population is expected to be self-sustaining (having an average long-term positive population growth) only if both reproductive success and adult survival are at the higher levels we modelled.

With 60% (Table 1B) or 70% (Table 1C) juvenile survival, the population is often self-sustaining with either improved adult survival (90%) and/or improved breeding success (0.86 chicks per year or better), even when catastrophes occasionally occur.

Depending on the particular combination of demographic rates modelled, the simulated populations that were self-sustaining had percentages of juveniles (1 year after fledging) of about 12%-14% or more. Populations with lower than 11% juveniles (and usually those with lower than 12% juveniles) were in decline. The percent of juveniles needed to sustain a population that experienced catastrophes was higher, because additional reproduction is needed for the population to recover between catastrophes.

Table 1. Mean population growth (r), fluctuations in growth [SD(r)], population size (N) at 25 years, and percent juveniles for African penguin populations of initial size 5 000 and carrying capacity of 25 000; varying rates of reproduction, adult survival, and juvenile survival; and no catastrophes, massive disturbance (frequency of 10%, causing 50% reduction in breeding for the year), oil spills (frequency of 2%, causing 25% mortality and 50% reduction in breeding), or both types of catastrophes. See text for description of other demographic parameters.

A. Juvenile survival = 47%

Chicks/ pair/year	Adult survival	Juvenile survival	Catastrophes	Population growth (r)	SD(r)	N at year 25	%Juveniles
0.54	86	47	None	-0.068	0.051	950	8.6
0.54	90	47	None	-0.026	0.049	2682	8.5
0.86	86	47	None	-0.027	0.060	2654	11.9
0.86	90	47	None	0.016	0.057	7633	11.7
1.20	86	47	None	0.010	0.068	6729	15.5
1.20	90	47	None	0.049	0.065	17589	14.4
0.54	86	47	Disturbance	-0.072	0.052	849	8.5
0.54	90	47	Disturbance	-0.028	0.050	2562	8.3
0.86	86	47	Disturbance	-0.032	0.062	2349	11.9
0.86	90	47	Disturbance	0.011	0.060	6850	11.4
1.20	86	47	Disturbance	0.005	0.070	5956	14.6
1.20	90	47	Disturbance	0.043	0.068	15227	14.2
0.54	86	47	Oil spill	-0.073	0.069	847	8.6
0.54	90	47	Oil spill	-0.031	0.066	2463	8.4
0.86	86	47	Oil spill	-0.032	0.076	2408	12.5
0.86	90	47	Oil spill	0.009	0.073	6680	11.6
1.20	86	47	Oil spill	0.003	0.083	5849	15.2
1.20	90	47	Oil spill	0.042	0.085	15124	15.2
0.54	86	47	Oil & Disturb.	-0.077	0.070	776	8.6
0.54	90	47	Oil & Disturb.	-0.036	0.067	2141	8.1
0.86	86	47	Oil & Disturb.	-0.038	0.081	2057	12.0
0.86	90	47	Oil & Disturb.	0.003	0.076	5725	11.6
1.20	86	47	Oil & Disturb.	-0.004	0.088	4838	14.6
1.20	90	47	Oil & Disturb.	0.037	0.085	13437	13.8

B. Juvenile survival = 60%

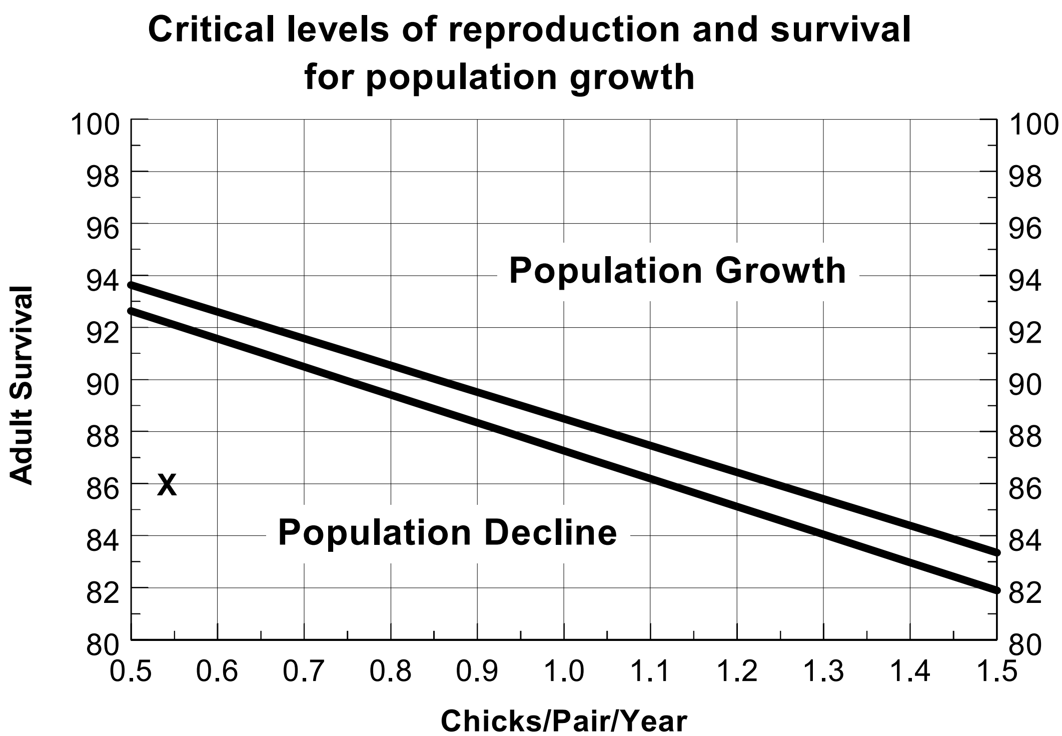
Chicks/ pair/year	Adult survival	Juvenile survival	Catastrophes	Population growth (r)	SD(r)	N at year 25	%Juveniles
0.54	86	60	None	-0.047	0.051	1604	10.4
0.54	90	60	None	-0.004	0.048	4585	10.4
0.86	86	60	None	0.001	0.059	5245	14.3
0.86	90	60	None	0.040	0.057	13947	13.9
1.20	86	60	None	0.039	0.068	13762	17.9
1.20	90	60	None	0.080	0.065	24668	16.8
0.54	86	60	Disturbance	-0.052	0.053	1408	10.1
0.54	90	60	Disturbance	-0.009	0.051	4100	9.8
0.86	86	60	Disturbance	-0.007	0.063	4382	13.7
0.86	90	60	Disturbance	0.034	0.061	12088	13.5
1.20	86	60	Disturbance	0.032	0.073	11481	16.8
1.20	90	60	Disturbance	0.072	0.071	23753	16.7
0.54	86	60	Oil spill	-0.053	0.070	1406	10.4
0.54	90	60	Oil spill	-0.011	0.065	3978	10.0
0.86	86	60	Oil spill	-0.006	0.078	4556	14.1
0.86	90	60	Oil spill	0.035	0.075	12659	13.6
1.20	86	60	Oil spill	0.031	0.088	11753	17.5
1.20	90	60	Oil spill	0.071	0.087	23070	16.9
0.54	86	60	Oil & Disturb.	-0.057	0.071	1265	9.9
0.54	90	60	Oil & Disturb.	-0.015	0.067	3607	9.3
0.86	86	60	Oil & Disturb.	-0.013	0.080	3825	13.7
0.86	90	60	Oil & Disturb.	0.029	0.076	10817	13.3
1.20	86	60	Oil & Disturb.	0.026	0.089	10110	17.1
1.20	90	60	Oil & Disturb.	0.066	0.088	21910	15.8

C. Juvenile survival = 70%

Chicks/ pair/year	Adult survival	Juvenile survival	Catastrophes	Population growth (r)	SD(r)	N at year 25	%Juveniles
0.54	86	70	None	-0.032	0.052	2316	11.9
0.54	90	70	None	0.009	0.049	6383	11.2
0.86	86	70	None	0.017	0.060	7892	15.7
0.86	90	70	None	0.057	0.058	20531	15.4
1.20	86	70	None	0.059	0.069	21264	18.6
1.20	90	70	None	0.100	0.067	24959	18.5
0.54	86	70	Disturbance	-0.037	0.054	2038	11.4
0.54	90	70	Disturbance	0.003	0.052	5605	11.2
0.86	86	70	Disturbance	0.012	0.064	6905	15.3
0.86	90	70	Disturbance	0.051	0.061	18056	14.7
1.20	86	70	Disturbance	0.054	0.074	19000	18.7
1.20	90	70	Disturbance	0.093	0.074	24892	18.2
0.54	86	70	Oil spill	-0.039	0.072	1987	11.7
0.54	90	70	Oil spill	0.002	0.067	5558	11.2
0.86	86	70	Oil spill	0.010	0.078	6788	15.7
0.86	90	70	Oil spill	0.052	0.076	18514	15.3
1.20	86	70	Oil spill	0.051	0.087	18031	18.5
1.20	90	70	Oil spill	0.092	0.084	24757	18.3
0.54	86	70	Oil & Disturb.	-0.042	0.070	1838	11.1
0.54	90	70	Oil & Disturb.	-0.001	0.067	5130	11.1
0.86	86	70	Oil & Disturb.	0.004	0.082	5883	15.1
0.86	90	70	Oil & Disturb.	0.044	0.082	15663	14.6
1.20	86	70	Oil & Disturb.	0.047	0.093	16680	18.2
1.20	90	70	Oil & Disturb.	0.085	0.089	24316	17.8

In addition to the above combinations of reproductive and survival rates, models were run with intermediate values and more extreme values for reproductive success (from 0.54 to 1.4 chicks per year), and for adult survival (from 86% to 96%). Juvenile survival was kept at 47% and either no or two kinds of catastrophes were modelled. Using the results of the analyses in Table 1A and these additional runs, the effect of reproductive success and adult survival on mean population growth was determined with linear regression. The regressions explained 99.6% of the variation in population growth, indicating that the relationship was almost perfectly linear. Using the regression equations, the line defining the combinations of reproduction and survival which lead to zero population growth was determined for each of the two scenarios for catastrophes (none or two). This line separating the regions of population decline from population growth is shown on Figure 1 for the scenarios with no catastrophes (the lower line) and the scenarios with both oil spills and severe disturbance catastrophes (upper line). The region between the lines indicates the improved reproduction and/or survival that is necessary to allow recovery of the population between years in which catastrophes occur. The reproduction and survival rates estimated for Robben Island are indicated by an 'X' on the figure.

Figure 1.



Effect of age of first breeding -- Although the age of first breeding was estimated to vary from 2 to 5 years as a linear increase, there is uncertainty regarding this potentially important demographic parameter. Therefore, we conducted sensitivity tests in which we examined simulations with the onset of breeding set at 3, 4, or 5 years (for all birds). Table 2 shows the results of these simulations for three of the combinations of reproduction and adult survival (including the two most extreme cases from Table 1), and either no or two kinds of catastrophes.

Table 2. Effect of age of breeding on mean population growth (r), fluctuations in growth [SD(r)], population size (N) at 25 years, and percent juveniles. Juvenile survival = 47%. Other parameters as in Table 1 and as described in the text.

Chicks/ pair/year	Adult survival	Age of breeding	Catastrophes	Population growth (r)	SD(r)	N at year 25	%Juveniles
0.54	86	3	None	-0.062	0.053	1093	9.1
0.86	90	3	None	0.024	0.060	9541	12.8
1.20	90	3	None	0.062	0.068	21833	15.6
0.54	86	3	Oil & Disturb.	-0.073	0.072	840	8.8
0.86	90	3	Oil & Disturb.	0.011	0.079	6972	12.0
1.20	90	3	Oil & Disturb.	0.046	0.089	16129	15.1
0.54	86	4	None	-0.071	0.053	880	8.2
0.86	90	4	None	0.011	0.060	6821	11.4
1.20	90	4	None	0.043	0.069	15351	14.2
0.54	86	4	Oil & Disturb.	-0.081	0.072	708	8.3
0.86	90	4	Oil & Disturb.	0.000	0.079	5335	11.1
1.20	90	4	Oil & Disturb.	0.030	0.090	11317	13.7
0.54	86	5	None	-0.076	0.055	774	7.9
0.86	90	5	None	0.000	0.061	5171	10.6
1.20	90	5	None	0.031	0.069	11222	13.0
0.54	86	5	Oil & Disturb.	-0.086	0.075	621	7.4
0.86	90	5	Oil & Disturb.	-0.009	0.077	4275	10.2
1.20	90	5	Oil & Disturb.	0.017	0.086	8097	12.4

Although the age of first breeding does impact population growth rates and the population size projected at year 25, the general conclusion that a sustainable population requires either reproduction or survival must be improved relative to the rates estimated for Robben Island remains the same regardless of the age at which the penguins begin breeding (within the biologically plausible range). For species with long reproductive life spans, adult survival can be more important than whether the species begin breeding a year earlier or later. The large (more than two-fold) range in reproductive success estimated at various colonies also has a large effect on population growth.

Effect of environmental variation -- The extent of annual variation in demographic rates is not well known, and many more years of data will be required before environmental variation can be accurately assessed. To determine whether our model results are sensitive to the estimates of environmental variation, we examined a subset of scenarios in which environmental variation for each demographic rate was set at either one-half or

1.5 times the values used in the above modelling. The results of these analyses (and the baseline case for comparison) are shown in Table 3.

Although decreased or increased environmental variation had large effects on the annual fluctuations in population growth [SD(r)], there were only slight effects on the mean population growth. With the higher environmental variation, the population size fluctuated 10% or more around the mean expected size each year. In small populations (perhaps less than 500), high variation in population growth can cause a significant probability of extinction. However, the population we modelled, with a starting size of 5 000, is not so small that near term extinction is likely, even if the population does fluctuate considerably across years.

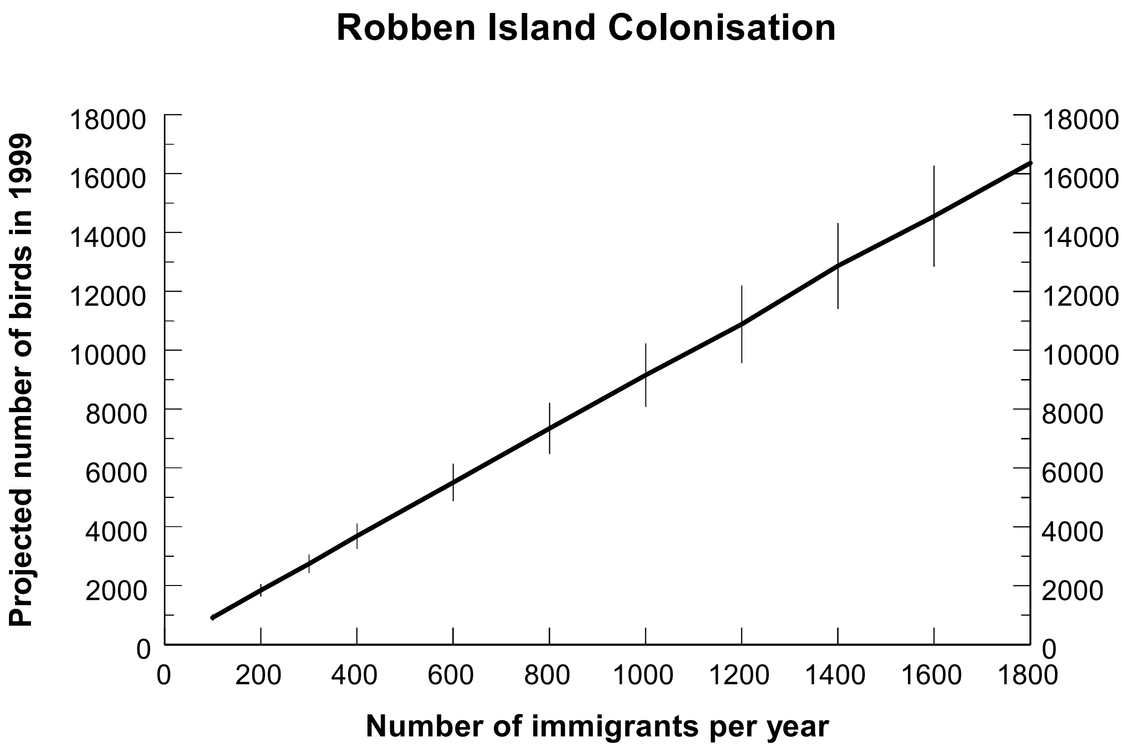
Modelling of the colonisation and growth of the population at Robben Island – Robben Island was recolonised by penguins in 1983, and has grown rapidly since that time, attaining more than 14000 penguins by 1999. As was pointed out by Crawford *et al.* (in press), most of the growth in the colony must have been due to immigration, rather than recruitment of birds born at the island. The analyses presented above suggest that the colony at Robben Island would not be self-sustaining in the absence of immigration from other colonies.

To explore what level of immigration would have been required to produce the observed rate of growth of the population at Robben Island, we examined simulation models in which the population was set at 0 birds prior to 1983, the demographic rates were set to those estimated for the population (see above) and there were varying rates of immigration of subadults. The expected number of penguins in the Robben Island colony in 1999, under the varying rates of immigration, are shown in Figure 2.

Table 3. Effect of varying levels of environmental variation (EV) on mean population growth (r), fluctuations in growth [SD(r)], population size (N) at 25 years, and percent juveniles. Baseline EV is the level estimated for each demographic rate, as specified in the text. Juvenile survival = 47%. Other parameters as in Table 1 and as described in the text.

Chicks/ pair/year	Adult survival	EV relative to baseline	Catastrophes	Population growth (r)	SD(r)	N at year 25	%Juveniles
0.54	86	0.5	None	-0.066	0.030	963	8.6
0.86	90	0.5	None	0.016	0.032	7490	11.8
1.20	90	0.5	None	0.051	0.037	18040	14.8
0.54	86	0.5	Oil & Disturb.	-0.076	0.056	775	8.3
0.86	90	0.5	Oil & Disturb.	0.005	0.058	5935	11.7
1.20	90	0.5	Oil & Disturb.	0.039	0.066	13702	14.1
0.54	86	1	None	-0.068	0.051	950	8.6
0.86	90	1	None	0.016	0.057	7633	11.7
1.20	90	1	None	0.049	0.065	17589	14.4
0.54	86	1	Oil & Disturb.	-0.077	0.070	776	8.6
0.86	90	1	Oil & Disturb.	0.003	0.076	5725	11.6
1.20	90	1	Oil & Disturb.	0.037	0.085	13437	13.8
0.54	86	1.5	None	-0.069	0.076	966	8.6
0.86	90	1.5	None	0.013	0.085	7279	12.3
1.20	90	1.5	None	0.047	0.098	16786	14.5
0.54	86	1.5	Oil & Disturb.	-0.077	0.087	790	8.0
0.86	90	1.5	Oil & Disturb.	0.002	0.098	5734	11.6
1.20	90	1.5	Oil & Disturb.	0.033	0.112	12670	14.0

Figure 2. Projected size of the penguin colony at Robben Island in 1999, as a function of the number of immigrants per year since recolonisation in 1983. Error bars show the variation among iterations of the simulation as $\pm$ 1 SD.



The model results suggest that the growth of the population up to 14000 penguins by 1999 would be achieved only with an average of about 1400 or more immigrants per year.

The low reproductive success observed at Robben Island during the past few years may be in part due to a lower success rate among newly established young pairs, as almost all of the immigrants onto the island would have been. Breeding success may increase (or already have increased) as pairs become more experienced. It is also possible that the lower rate relative to other islands may have been an underestimate or may reflect temporary conditions that would not otherwise be typical of breeding at the island. To explore the effect of higher reproductive success on the colonisation of Robben Island, we examined simulations in which the Robben Island population averaged 0.86 chicks fledged per nest per year. These results are illustrated in Figure 3.

Figure 3. Projected size of the penguin colony at Robben Island in 1999, as a function of the number of immigrants per year since recolonisation in 1983, if breeding success averaged 0.86 chicks fledged / nest / year (the highest breeding success measured at Robben Island).

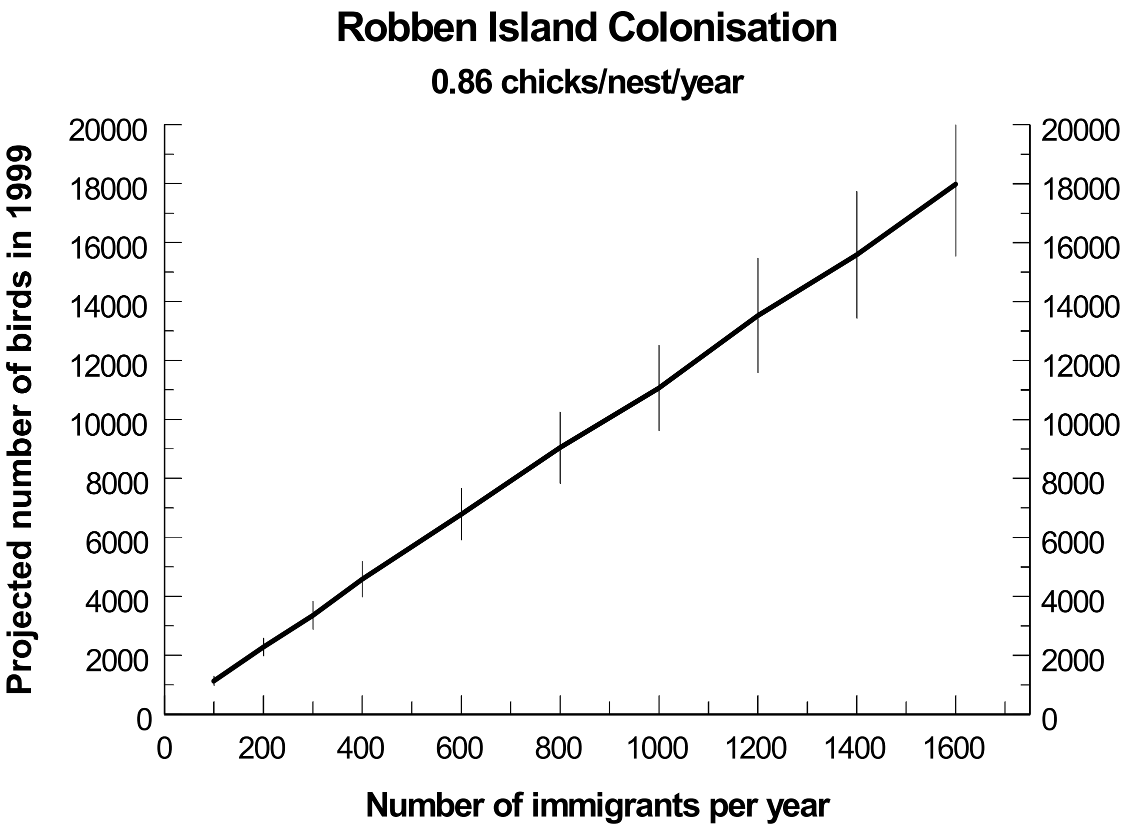


Figure 3 shows that with higher breeding success, somewhat fewer immigrants would have been required to achieve the observed rate of population increase on Robben Island. However, it is still estimated that more than 1,000 immigrants per year would have been needed to achieve the rapid colonisation.

E. DISCUSSION AT THE WORKSHOP ARISING FROM THE INITIAL VORTEX RUNS

1. Point to note: It might be good to allow disturbance (human visitors) at Robben Island at some penguin nests, as long as most of the colony is undisturbed.

2. Tasks that still need to be tackled:

a) Identify management priorities and actions
b) Management should be colony-specific (note differences on islands)
c) Meta-population data needs

d) Catastrophe modelling
e) Practical field issues relating to obtaining parameters for Vortex
3. The simplest and cheapest measure of population stability may to count the juveniles coming ashore at breeding localities annually to moult. However, it could be that a proportion of juveniles moulting at a colony are not chicks from that colony and may not settle there to breed. Therefore, the proportion may not be indicative of the proportion of juveniles in the population of that particular colony.

4. Humans could rear one chick in two egg clutches so that the wild chick is better fed. The reared chick can also be released to boost the population for islands with decreasing populations. The Vortex model can show how much boost is needed to stabilise the population.

5. Meta-population modelling:
The range of parameter values modelled above probably include the range of values for the other sites, so there is no need to model other sites (for which there is insufficient data). However, there is emigration from Dyer to Robben, i.e. the parameters at Dyer must be different.

The parameters we need to investigate (to keep a stable or increasing population):
- the required recruitment rate
- adult and juvenile mortality
- number of moulting juveniles relative to the number of moulting adults

6. Disease:
One of the possibly severe threats to penguins is Newcastle disease. Although diseases have been recorded in penguins, there do not seem to have been catastrophic disease epidemics since the 1930s, but refer to diseases (section 6) discussed under "potential factors threatening penguin survival".

There was discussion about possible strategies to prevent decreases in penguin populations as a result of disease outbreaks.

7. General questions and strategies:
a) Why are some islands/sites more attractive (for breeding) than others?
b) Is there a lower limit to colony size? What effect does this have on social behaviour (penguins feed co-operatively and a breakdown in these "rafts" may increase the effect of predation).
c) The release of hand-reared chicks is feasible but on what scale would it increase penguin populations?
d) Feeding of chicks in their nests may enhance chick survival, although

disturbance could counter the benefits.

e) There is a need for improved knowledge of factors affecting recolonisation of sites where populations have gone extinct, and the formation of new colonies.

F. MONITORING

THERE IS A NEED TO PROVIDE EXPLICIT GOALS FOR MONITORING.

These should be guided by the modelling exercise (for example, indications are that age at first breeding is not as important a parameter as are parameters such as juvenile or adult survival). Once the aims and objectives have been defined we should then progress to re-identifying tasks, ranking them by importance, identifying human and other resources, etc. In the interim, the group discussed the following:

1. Some needs related to monitoring

- Need follow up of resightings (i.e. maintain constant search effort for re-traps)
- Need to provide encouraging feedback to fieldworkers
- Funding is needed from outside SA (even if it is grant money)
- Need to pool all data relating to parameters (we have some idea of all these parameters but not for Namibia, though there may be raw data for Namibia?)
- Need a written protocol for fieldwork to ensure data accuracy and collection of critical data (even in adverse conditions)
- A very important need is to obtain funding for entering all the penguin ringing data (~50 000 records) into the database.. This will facilitate calculation of more accurate survival estimates.

2. Important parameters that may be obtained through monitoring

a) Population size for each colony
b) Movements between colonies
c) Moulting birds - need to recalibrate the ratio of moulting adults/moulting juveniles, as well as the time and duration of moult period
d) Survival of juveniles and adults for each of the three main regions (Namibia, SW Cape, E Cape)

3. Practical methodology

In all cases below, colony specific techniques should be applied because of differences between islands.

a) Visit all the breeding islands, being careful not to cause disturbance
b) Count nesting and moulting birds - there are field difficulties (in seeing all

birds), so do this where feasible, i.e. at selected colonies
- count active and deserted nests

c) Ringing program - only need to ring a proportion of the population
- It would be good to mark cohorts (colony specific) with some colour rings, as they are easier to see in the field than reading individual ring numbers. Alternatively, transponders could be used as this reduces disturbance. For survival analysis, however, individual ringing is still needed.

d) Chick banding would help determine juvenile survival, movement between colonies, and age of first breeding. It is not necessary to ring all chicks - it is possible to estimate how many chicks need to be ringed.

e) Resighting effort is very important. Resightings are needed every year or every 5 years (there is a trade-off between disturbance vs. collecting sufficient data) - this would depend on the specific islands.

f) Monitoring breeding success is labour-intensive. The Mayfield approach (Mayfield, 1975) should be used, rather than trying to track every nest for the duration of the season. One would need a three month period to cover a single breeding attempt, but a nine month period to cover the whole breeding season. Monitoring for even three months is only feasible at some colonies.

g) Monitoring diet is disruptive -- taking diet samples must be kept to a minimum (i.e. according to the current fisheries requirements), but allow for exceptional circumstances.

h) Oiled birds - continuous follow-up monitoring is needed because SANCCOB slightly modifies their techniques (and we want to check for ringed birds anyway).

4. Summary

The minimum monitoring parameter that is required everywhere is an annual count of breeding birds/active nests. Other data as listed in this document may be collected for specific colonies. In some small islands, e.g. Vondeling, we may only need to boat around and not even land to check for catastrophes - one could do relative censuses to track trends.

5. People currently involved in monitoring various parameters

Seals - Jeremy David (Marine Coastal Management - MCM), Jean Paul Roux (Namibia)
Fish stocks - Rob Crawford (MCM), Jose De Oliveira (MCM), Dave Boyer (Namibia)
Oil shipments - Lynn Jackson, Anton Moldan
Kelp Gulls - Rob Crawford (MCM), Graham Avery (SAM), Norbert Klages (Port Elizabeth Museum - PEM), Les Underhill (Avian Demography Unit - ADU)
Colony Managers - Mario Leshoro (Robben Island), Rod Randall (West Coast

islands), Justin Buchman / Paul Britton (Boulders), Anton Woolfardt (Dassen Island)
Population estimation - SW Cape and Namibia: Rob Crawford (MCM), Algoa Bay: Norbert Klages (PEM).

6. Current monitoring effort per island

	counts /yr	Breeding output	Survival (ring) Ad	Juv
Eastern Cape (Algoa Bay Islands)				
Bird	6	y	y	y (some)
St Croix	1		(checked for ringed birds)	
other islands in Algoa Bay	(5 year intervals)			
Southwestern Cape Islands				
Dyer	1			
Stony Point	12	y		
Seal	(5 year intervals)			
Boulders	>3	y	(checked for ringed birds)	
Robben	1	y	y	y (some)
Dassen	1	y	y	y (some)
Saldanha Islanda	1		(checked for ringed birds)	
Bird LB	>6	y	y	y
Namibian Islands				
Ichaboe	?Bartlett			

Clearly the big gap is in Namibia. We can probably get by with the above levels of monitoring effort off South Africa, provided data are pooled and analysed efficiently (i.e., at time scales suitable for management).

7. Research needs

- measure moult duration under different conditions and for different age classes, i.e. adults and juveniles
- develop sexing techniques for adults
- ascertain sex ratio of offspring
- facilitate long distance identification of cohorts – perhaps by using colour bands
- distinguish between moulting adults and juveniles

Straw dog for African Penguin monitoring requirements

1. Monitoring requirements

a) Fortnightly moult counts, separated into moulting adults and juveniles, to determine population size. At accessible colonies (Robben Island, Boulders, Stony Point, Dassen Island) these should take place throughout the year, and at inaccessible colonies at peak moult periods, with extrapolation to annual totals.

b) Banding of chicks and adults at breeding colonies.

c) Sufficient numbers of birds banded and sufficient resighting effort to generate enough resightings and recoveries per year for annual estimates of survival (preferably per main colony). Resighting database should include activity codes.

d) Sufficient annual banding of chicks to estimate percentage of birds that commence breeding at each age, preferably by sex, and to determine trends in these percentages.

e) Detailed study plots of sufficient size to enable (1) percentage of birds that breed per year to be estimated, (2) breeding productivity per pair per colony to be estimated, and (3) number of breeding attempts per pair per year to be estimated. This probably requires fortnightly checks.

f) Diet monitoring, as at present, should continue. [see earlier comments]

g) Monitor impact of tourism on penguin populations.

h) Special additional monitoring might be required to follow each cohort of oiled birds. Give consideration to what additional information could be obtained from each of these birds before release. Regard each year's chronically-oiled birds as a cohort.

2. Potential covariates of breeding productivity and survival should be collected:

a) Numbers of seals at each seal colony should be monitored.

b) Fishery stock estimates for relevant prey species in the foraging zone for each penguin colony should be recorded.

c) Number of shipments of oil and total number of tonnes of oil per year should be recorded.

d) Indices of Kelp Gull abundance and breeding success need to be developed regionally. Similar trend indices should be developed for other predators. Is this necessary for penguins? Note: there are fewer Kelp Gulls than African Penguins, so these indices would be of general interest. Kelp Gulls are not a problem at some islands.

e) Records of predator translocations from Stony Point, Marcus Island need to be kept. Introduced predators should be removed from Dassen (cats) and Robben (cats, rats).

f) Number of tourists visiting each colony and other human activities (is the island manned? how often is it visited?) should be recorded/monitored.

g) Records should be kept of temperature and rainfall extreme events (e.g. daily rainfall >20 mm, temperature > 30 C).

h) The number of rehabilitated birds (SANCCOB and others) should be recorded.

3. Publication of results

a) Write detailed protocols for each of these monitoring requirements.

b) Develop cost estimates.

c) Write results up as a Penguin Monitoring Handbook.

d) Report results annually.

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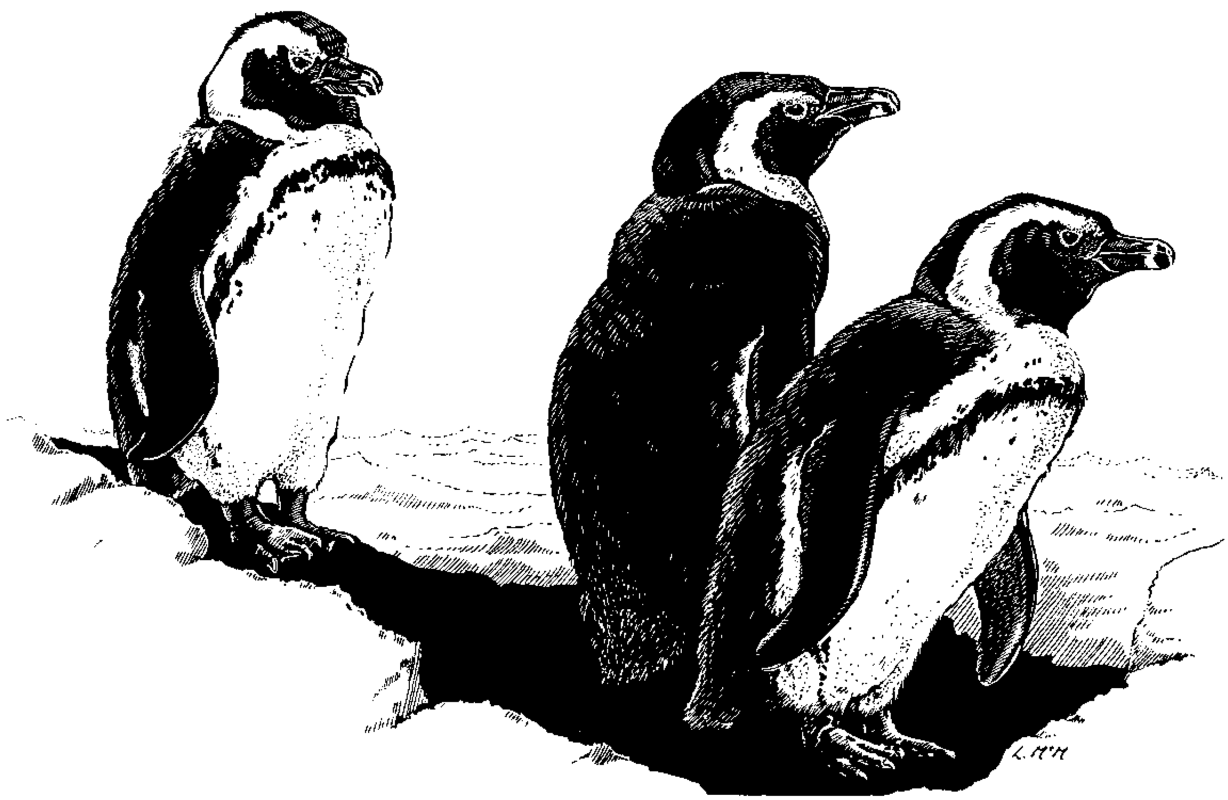
African Penguin

Population and Habitat Viability Assessment

21-24 April 1999
Cape Town, South Africa

Final Report



Section 3

Appendices

Appendix I. List of Participants

African Penguin PHVA Workshop
21-23 April 1999
Cape Town, Republic of South Africa

Johann Augustyn
Marine and Coastal Management
Dept. of Environmental Affairs and Tourism
Private Bag X2
Roggebaai 8012, SOUTH AFRICA
Tel 27-21-402-3107
Fax 27-21-421-7406
augustyn@sfri.wcape.gov.za

Adnan Awad
Conservation Biology Master's Program
PFIAO
University of Cape Town
Rondebosch 7701 SOUTH AFRICA
aawad@botzoo.uct.ac.za

J-J Brossy
Medical School Anatomy Dept.
University of Cape Town
Rondebosch 7701, SOUTH AFRICA
Tel/fax 27-021-551-9280
Fax 27-021-448-7226
brossy@anat.uct.ac.za

Justin Buchmann
South African National Parks
PO Box 62
Simonstown 7995 SOUTH AFRICA
Tel 27-786-2329
Fax 27-780-9525

John Cooper
Avian Demography Unit
University of Cape Town
Rondebosch 7701 SOUTH AFRICA
Tel 27-21-650-3426
Fax 27-21-650-3434
jcooper@botzoo.uct.ac.za

Robert Crawford
Marine and Coastal Management
Dept. of Environmental Affairs and Tourism
Private Bag X2
Roggebaai, 8012 SOUTH AFRICA
Tel 27-21-402-3140
Fax 27-21-421-7406
crawford@sfri.wcape.gov.za

Bruce Dyer
Marine and Coastal Management
Dept. of Environmental Affairs and Tourism
Private Bag X2
Roggebaai, 8012 SOUTH AFRICA
Tel 27-21-402-3137
Fax 27-21-421-7406
bdyer@sfri.wcape.gov.za

Susie Ellis
CBSG/IUCN/SSC
138 Strasburg Reservoir Road
Strasburg, VA 22657 USA
Tel/fax 1-540-465-9589
SusieEllis@compuserve.com

Lyndon Estes
Conservation Biology Master's Program
26 Luisa Way
Hout Bay 7806
Box 1990
Nelspruit 1200 SOUTH AFRICA
lestes@botzoo.uct.ac.za

Kolby Foss
New England Aquarium
Central Wharf
Boston, MA 02110 USA
Tel 617-973-5248
kfoss@neaq.org
Leticia Greyling
Conservation Biology Master's
Program
PFIAO
University of Cape Town
Rondebosch 7701 SOUTH AFRICA
lgreylin@botzoo.uct.ac.za

Onno Huyser
PFIAO
University of Cape Town
Rondebosch 7701 SOUTH AFRICA
ohuyser@botzoo.uct.ac.za

Norbert Klages
Port Elizabeth Museum
PO Box 13147
Humewood 6013 SOUTH AFRICA
pemntk@zoo.upe.ac.za

Bob Lacy
Chicago Zoological Society
Brookfield, IL 60513 USA
Tel/fax 1-315-682-3571
rlacy@ix.netcom.com

Mario Leshoro
P.B. Robben Island Museum
Robben Island 7400 SOUTH AFRICA
Tel 27-021-409-5154 or 5100
Fax 27-021-411-1059

Rob Leslie
Marine and Coastal Management
Dept. of Environmental Affairs and
Tourism
Private Bag X2
Roggebaai, 8012 SOUTH AFRICA
Tel 27-21-402-3141
Fax 27-21-421-7406
rwleslie@sfri.wcape.gov.za

Verna Love
Conservation Biology Master's
Program
PFIAO
University of Cape Town
Rondebosch 7701 SOUTH AFRICA
vlove@botzoo.uct.ac.za

Simiao Mahumana
Conservation Biology Master's
Program
PFIAO
University of Cape Town
Rondebosch 7701 SOUTH AFRICA
smahuman@botzoo.uct.ac.za

José de Oliveira
Marine and Coastal Management
Dept. of Environmental Affairs and
Tourism
Private Bag X2
Roggebaai, 8012 SOUTH AFRICA
Tel 27-21-402-3144
Fax 27-21-421-7406
jdolivei@sfri.wcape.gov.za

Dieter Oschadleus
SAFRING, Avian Demography Unit
University of Cape Town
Rondebosch, 7701 SOUTH AFRICA
Tel 27-21-650-2421
dieter@maths.uct.ac.za

Rod M. Randall
South African National parks
Box 176
Sedgefield 6573, SOUTH AFRICA
Tel 27-44-343-1302
Fax 27-44-343-2331
rodr@parks-sa.co

Helian Ratsirarson
Conservation Biology Master's Program
PFIAO
University of Cape Town
Rondebosch 7701 SOUTH AFRICA
hratsira@botzoo.uct.ac.za

Fidele Ruzigandekwe
Conservation Biology Master's Program
PFIAO
University of Cape Town
Rondebosch 7701 SOUTH AFRICA
fruzigan@botzoo.uct.ac.za

Peter Ryan
PFIAO
University of Cape Town
Rondebosch 7701 SOUTH AFRICA
pryan@botzoo.uct.ac.za

Lynne Shannon
Marine and Coastal Management
Dept. of Environmental Affairs & Tourism
Private Bag X2
Roggebaai, 8012 SOUTH AFRICA
Tel 27-21-402-3138
Fax 27-21-421-7406
lshannon@sfri.wcape.gov.za

Frances Taylor
Conservation Biology Master's Program
PFIAO
University of Cape Town
Rondebosch 7701
ftaylor@botzoo.uct.ac.ua

Meredith Thornton
Bergplaas
Box 579
Robertson 6705 SOUTH AFRICA
tokitae@hotmail.com

Les Underhill
Avian Demography Unit
University of Cape Town
Rondebosch, 7701 SOUTH AFRICA
Tel 27-21-650-3227
Fax 27-21-650-3434
lgu@maths.uct.ac.za

Estelle van der Merwe
SANCCOB
PO Box 11-116
Bloubergrant 7443 SOUTH AFRICA
Tel 27-083-212-9141
Fax 27-021-557-6155
sanccob@netactive.co.za

Claire Volchansky
Conservation Biology Master's Program
PFIAO
University of Cape Town
Rondebosch 7701 SOUTH AFRICA
cvolchan@botzoo.uct.ac.za

Andrew Walker
Conservation Biology Master's Program
PFIAO
University of Cape Town
Rondebosch 7701 SOUTH AFRICA
awalker@botzoo.uct.ac.za

Lauren Waller
Conservation Biology Master's Program
PFIAO
University of Cape Town
Rondebosch 7701 SOUTH AFRICA
lwaller@botzoo.uct.ac.za

Phil Whittington
Avian Demography Unit
Dept. of Statistical Sciences
University of Cape Town
Rondebosch, 7701 SOUTH AFRICA
Tel 27-21-650-3648
Fax 27-21-689-7578
pwhit@maths.uct.ac.za

Tony Williams
Cape Nature Conservation
Private Bag X9086
Cape Town 8000, SOUTH AFRICA
twilliam@pawc.wcape.gov.za

Anton Wolfaardt
Cape Nature Conservation
PO Box 306
Yzerfontein, 7351 SOUTH AFRICA
Tel-27-08-257-32179
dassen@mweb.co.za

APPENDIX II. CAMP TAXON DATA SHEET FOR AFRICAN PENGUINS
(from Ellis *et al.* 1998)

Spheniscus demersus African Penguin

STATUS: New IUCN Category: Vulnerable
Based on**:** A1a, A2b, E
CITES: Appendix II
Other: In South Africa, endangered in terms of the Nature and Environmental Conservation Ordinance, No. 19 of 1974 of the Province of the Cape of Good Hope. This now applies to the Northern Cape, Western Cape and Eastern Cape Provinces. In Namibia, there is no official legal status. Listed as Near Threatened in *Birds to Watch 2* (Collar *et al.* 1994)

Taxonomic status: Species.

Current distribution (breeding and wintering):
Breeding distribution: Between Hollams Bird Island, Namibia and Bird Island, Algoa Bay, South Africa.

Number of locations: 27 extant breeding colonies - eight islands and one mainland site along the coast of southern Namibia; 10 islands and two mainland sites along the coast of Western Cape Province, South Africa; six islands in Algoa Bay, Eastern Cape Province, South Africa (Crawford *et al.* 1995a). There is no breeding along the coast of South Africa's Northern Cape Province, which lies between Namibia and Western Cape Province.

Concentrated Migration Regions: None. Juveniles tend to disperse along the coastline to the west and north (Randall *et al.* 1987).

Historical Distribution: Breeding no longer occurs at nine localities where it formerly occurred or has been suspected to occur (Crawford *et al.* 1995b) - Neglectus, Seal, Penguin, North Long, North Reef and Albatross Islands in Namibia; Jacobs Reef, Quoin and Seal (Mossel Bay) Islands in South Africa. In the 1980s, breeding started at two mainland sites in South Africa (Boulders, Stony Point) for which no earlier records of breeding exist.

Area occupied: Throughout breeding range and farther to the north and east. Rare off Kwazulu/Natal (Cyrus and Robson 1980). Vagrants have occurred north to Sette Cama (2 32 S), Gabon, on Africa's west coast and to Inhaca Island (26 58 S), Mozambique, on the east coast (Shelton *et al.* 1984). In coastal waters, usually within 12 km of the shore. Birds feeding chicks forage within 20-46 km of the colony (Wilson 1985; Randall 1989), mostly within 3 km of the coast (Berruti *et al.*

1989). Adults generally remain within 400 km of their breeding locality, but juveniles regularly move in excess of 1000 km from their natal island (Randall 1989).

Extent of occurrence: About 25,000 km^2, category D (> 20000 km^2).

Population Trends: % Change in Years: There were an estimated 222 000 adults (birds in adult plumage) in the late 1970s 194 000 in the late 1980s and 179 000 in the early 1990s (Crawford *et al.* 1995a). This gives a mean annual rate of decrease between the late 1970s and the early 1990s of 1.3 %, and between the late 1980s and the early 1990s of 1.5 %.

% Change in Generations: Adult survival is estimated to be about 0.90 p.a. (Randall 1983, Crawford *et al.* submitted). Therefore, average life expectancy of breeders is 6.6 years. Mean age at breeding is about four years (Randall 1983, Crawford *et al.* submitted). This gives an average age of breeders of 10-11 years. Birds have been known to live to more than 24 years in the wild (Whittington *et al.* submitted). The overall decrease in breeders between the late 1970s and early 1990s, i.e. about 15 years or 1.5 generations, was 19.4 % (Crawford *et al.* 1995a). Therefore, the mean recent decrease per generation is 12.9 %.

Trend over past 100 years: In 1910, there were probably 1.4 million adult birds at Dassen Island (Shannon and Crawford submitted). In the mid 1950s, the overall African Penguin population was estimated to be about 300 000 adults (Rand 1963a, b). This included 145 000 at Dassen Island, which may have underestimated the population there by as much as 70 000 (Shannon and Crawford submitted). By the early 1990s, the World's wild population had decreased to about 180 000 adults.

World population: In 1991-1994, the World's wild population was estimated to be 56 000 breeding pairs representing 179 000 adults (Crawford *et al.* 1995a). The number of adults was estimated from the ratio between birds in adult plumage and breeding pairs at Robben Island.

Regional populations: There has been regional variation in trends in the abundance of African Penguins (Crawford *et al.* 1990,1995a). In Namibia, there has been a 30 % reduction
since the late 1970s, the most severe declines being south of Lüderitz, where colonies continue to decrease. Populations at Mercury, Ichaboe and Halifax Islands now appear to be stable. In South Africa, numbers fell by 17 % between the late 1970s and early 1990s, with especially severe decreases near Saldanha Bay and at Dassen and Dyer Islands. These decreases have been arrested, except at Dyer Island. Three new colonies were established in the Western Cape Province in the early 1980s, and now support about 10 000 adult birds. At islands in Algoa Bay, the estimated number of adults increased by nearly 30 000 between the late 1970s and the early 1990s, with large increases at St Croix and Bird Islands.

Data Quality: 1

The estimated numbers of breeding pairs and adults at localities in 1991-1994 are listed in the following table (Crawford *et al.* 1995a):

Locality	Pairs	Adults
Hollams Bird Island	1	3
Sylvia Hill	26	83
Mercury Island	3659	11709
Ichaboe Island	2858	9146
Halifax Island	981	3139
Possession Island	751	2403
Pomona Island	8	26
Plumpudding Island	26	83
Sinclair Island	63	202
Namibia	8373	26794
Bird Island, Lambert's Bay	25	80
Malgas Island	99	317
Marcus Island	207	662
Jutten Island	1349	4317
Vondeling Island	229	733
Dassen Island	9389	30045
Robben Island	2799	8957
Boulders	359	1149
Seal Island, False Bay	95	304
Stony Point	77	246
Dyer Island	8349	26717
Geyser Island	328	1050
Western Cape Province, South Africa	23305	74577
Jahleel Island	549	1757
Brenton Island	31	99
St Croix Island	19478	62330
Seal Island, Algoa Bay	375	1200
Stag Island	24	77
Bird Island, Algoa Bay	3784	12019
Eastern Cape Province, South Africa	24241	77572
South Africa	47546	152149
WORLD	**55919**	**178943**

Recent Field Studies:
Breeding cycle: Off southern South Africa the main breeding season is January to September; most birds moult between October and January (Randall 1989; Crawford *et al.* 1995c). The annual cycle farther north lags this by a few months (Crawford *et al.* 1995a).

Population surveys: Namibia's Ministry of Fisheries and Marine Resources (MFMR) counts annually the number of breeding pairs at Mercury, Ichaboe and Possession Islands. South Africa's Sea Fisheries Research Institute (SFRI) monitors the number of breeding pairs at 11 localities (all except Stony Point) in South Africa's Western Cape Province. Breeding pairs at Stony Point are counted by a committee of the local municipality. Port Elizabeth Museum (PEM) counts breeding pairs at Bird Island, Algoa Bay. Other breeding localities are surveyed less frequently by MFMR, SFRI and PEM.

Counts of moulting birds are undertaken at two-weekly intervals by MFMR at Mercury, Ichaboe, Halifax and Possession Islands, Cape Nature Conservation (CNC) at Dassen Island, SFRI at Robben Island, and nature conservation authorities of Eastern Cape Province at Bird Island, Algoa Bay. Counts during the peak moult are also made at Boulders by SFRI and at St Croix Island by PEM.

The relationship between counts of breeding birds and counts of moulting birds, that will enable the adult population to be estimated from counts of breeding birds, is being investigated for Algoa Bay by PEM.

Population parameters: Demographic parameters of African Penguins have been measured at Robben Island (Crawford *et al.* submitted). Adult survival was between 0.82 and 0.90 in 1993/94, but fell to 0.75 in 1994/95 when many birds at the island were oiled following the sinking of the *Apollo Sea* in June 1994. Some penguins initiated breeding when two years old, and all probably bred at age five. The proportion of mature birds that bred in a year varied between about 0.70 and 1.00. During the breeding season, pairs laid their first clutch between January and August, mostly in February and March. The average clutch was 1.86 eggs. Of lost clutches 32 % were replaced, whereas 23 % of pairs losing broods relayed and 21 % of pairs that successfully fledged chicks relayed. On only one occasion was the laying of a third clutch during a breeding season recorded, and this was unsuccessful. The mean number of chicks fledged per breeding pair varied between 0.32 and 0.59 per annum.

Success of rehabilitation efforts: The return to islands and breeding success of penguins rehabilitated after being oiled following sinking of the Apollo Sea has been monitored by ADU and CNC (Underhill *et al.* in press). Of penguins flipper banded after rehabilitation, 65 % had been seen at islands within two years of their release. At Dassen Island, there were some seasonal differences in the breeding success of rehabilitated birds and birds not affected by oil (Nel and Williams submitted). Moulting and breeding cycles were affected.

Diet: The diet of African Penguins is monitored by SFRI at three islands - Dassen, Robben and Dyer (Crawford and Dyer 1995). Anchovy *Engraulis capensis* is the main prey item at Robben Island (Crawford *et al.* 1995c). At Dyer Island there has been a trend to replacement of Anchovy by Sardine, *Sardinops sagax* (Adams *et al.* submitted).

Foraging range: The foraging range of breeding penguins at different localities is being investigated using transmitters to satellites. An adult rearing chicks at Dassen Island moved as far as Boulders and Marcus Island, but normally foraged closer to Dassen Island.

Threats:

CLIMATE:

Heat: African Penguins are subject to heat stress (Randall 1983). In hot, humid, cloudless and windless conditions, parents abandon clutches and broods for the sea to cool and prevent further dehydration. Losses to Kelp Gulls (*Larus dominicanus)* and other predators of eggs and chicks then frequently occur. African Penguins apparently reduce heat stress by breeding in shade, e.g. under bushes and in burrows. However, as a consequence of removal of accumulated deposits of guano, in which burrows can be excavated, penguins have been forced to nest on the surface at many localities, increasing their susceptibility to heat stress.

Rain: Heavy rain may result in flooding of nests, drowning of small chicks and losses of older chicks to hypothermia (Randall *et al.* 1986).

There has been a change in the center of distribution of the breeding population of African Penguins. Much of the breeding population is now in Algoa Bay, where conditions are warmer than elsewhere, both on land and at sea.

Should ambient temperatures increase as a result of global warming, increased desertions of nests and decreased reproductive success can be anticipated. Should rainfall increase, greater flooding of nests will occur.

PARASITES AND DISEASE:

This section deals with parasites and disease in the wild and in captivity. Most of the information arises from studies of captive populations and birds in rehabilitation centers. The possibility exists that diseases contracted by rehabilitated birds can be passed to wild populations.

Endoparasites: Various worms occur in the gastro-intestinal (GI) tract, and some in the kidneys and lungs. Most can be treated with standard anti-worm medication. Cerebral symptoms may be seen with GI worms, whose eggs may be encysted in any part of the body, or endoparasites that lodge in liver, spleen, brain, lungs etc.

Strigeid digenian trematodes *Cardiocephaloides physalis* were responsible for large numbers of chick mortalities at St Croix Island in July 1981 (Randall and Bray 1983).

Ectoparasites: Lice, ticks and fleas are common, but not usually a problem.

Aspergillosis: A fungus that affects the lungs, particularly if penguins are stressed or overcrowded. Treatment is expensive and labor-intensive, involving nebulization (prophylaxis) and injections of Amphotericin-B. Oral itroconazole is favored by many as an effective and simple treatment (R. Norman, pers comm.).

Bumblefoot: May be caused by *Staphylococcus* bacteria, but always associated with damp floors. Treatment difficult, but a dry environment will avoid it.

Haematozoa: The most important is avian malaria *Plasmodium relictum*. Mortality is high, but, if diagnosed, birds can be treated with Chloroquin plus Doxycycline or Proguanil. The latter can be suspended in Keltrod, a mix of Hydroxy-benzoates, which makes it easier to administer. All penguins should be given prophylaxis during their stay in rescue stations, especially in summer, but controlled scientific assessment of the best drug and dose has not been done in South Africa.

Leucocytozoon (commonly present in many flying birds) occasionally affects penguins. Possibly responds to Chloroquine.

Babesiosis is endemic in African Penguins and has been reported elsewhere. Probably causes no symptoms, except under stress conditions.

Newcastle Disease: A virus with very high mortality and very contagious. A vaccine can be prepared, but its efficacy is unknown.

Avian cholera: Avian cholera *Pasturella multocida* has killed penguins at Dassen Island (Crawford *et al.* 1992a).

Infections: Pneumonia (viral or coccal) is common. Usually treated with amoxycillin.

Steps need to be implemented to minimize the risk of rehabilitated penguins returning disease to wild colonies.

FISHING: Commercial purse-seine fisheries off South Africa and Namibia catch large quantities of Sardine and Anchovy, which are important prey items for African Penguins (Frost *et al*. 1976). Sardine stocks off South Africa and Namibia collapsed in the 1960s, respectively contracting to the southeast and north as they did so. A consequent reduced availability of prey was probably the main reason for the large decrease in numbers of penguins between Lüderitz and Dassen Island (Crawford *et al.* 1990). The decrease in number of penguins at Possession Island, southern Namibia, from 23 000 pairs in 1956 to fewer than 500 pairs in 1987 was exponential, with decay equivalent to the natural mortality rate of adults. Recruitment to the colony in this period appears to have been minimal (Cordes *et al.* submitted).

At Robben Island between 1989 and 1995, African Penguins fed mainly on Anchovy. The number of chicks fledged per breeding pair was significantly related to estimates of spawner biomass for the South African Anchovy resource (Crawford and Dyer 1995, Crawford *et al.* submitted). Numbers of immature birds immigrating to the colony were also significantly related to Anchovy biomass. The proportion of adults breeding in any year at Robben Island was related to the biomass of the South African stock of Sardine.

Development of a purse-seine fishery in Algoa Bay may decrease availability of prey fish to the large African Penguin population there.

Limited mortality results from entanglement of penguins in fishing nets (Cooper 1974, R.M. Randall, D.C. Nel unpublished). There is potential for this to increase if gill nets are set in proximity to breeding colonies. In South Africa, gill nets are only used in small fisheries for mullets and sharks.

COMPETITION WITH OTHER PREDATORS FOR FOOD: In addition to fishing, greatly expanded herds of Cape Fur Seals (*Arctocephalus pusillus)* have decreased availability of food to African Penguins (Crawford *et al.* 1992b).
HUNTING FOR FOOD OR OTHER PURPOSES: Collection of penguin eggs was primarily responsible for the very large decrease in numbers of African Penguins at Dassen Island between 1910 and 1956. It is estimated that in the first half of the 20th century 48% of eggs produced at Dassen Island were harvested (Shannon and Crawford submitted). The last sanctioned egg collections were in 1967.

There are unconfirmed reports of penguins being killed as use for bait in rock-lobster traps. Apparently they are attractive as bait because their flesh and skin is relatively tough compared to that of fish and other baits. The extent of this practice is unknown. Most reports emanate from the Namibian islands.

HUMAN INTERFERENCE OR DISTURBANCE: Exploitation and disturbance by humans is the probable reason for penguins stopping breeding at four colonies, one of which has since been recolonized (Crawford *et al.* 1995b). At other localities, egg collecting caused large decreases, especially at Dassen Island and in Algoa Bay. Historically, guano collection has been a major cause of disturbance at many colonies. Disturbance may also arise from tourism, mining, management and research actions, and other activities at breeding localities, such as maintenance, angling and swimming.

Disturbance is most damaging during breeding, at times causing panic and desertions of nest sites with losses of eggs and small chicks to Kelp Gulls. Young birds may also be deterred from breeding (Hockey and Hallinan 1981). Where there are burrows, humans moving about may cause burrows to collapse, thereby destroying breeding habitat and sometimes causing mortality.

Modeling has shown that regular searches for oiled birds have potential to severely depress populations if not properly controlled (Shannon and Crawford submitted). At some localities (e.g. Boulders) African Penguins show remarkable tolerance of humans, whereas at others (e.g. Seal in Algoa Bay) they are readily disturbed. Some of the human residents adjoining the colony at Boulders do not show the same tolerance to penguins. They seek a reduction in the number of penguins at the colony.

LOSS OF HABITAT: Competition for breeding space: Competition with Cape Fur Seals for breeding space is the probable reason for cessation of breeding at five former breeding colonies (Crawford *et al.* 1995b). Expanding seal herds have displaced large numbers of penguins at other breeding localities, including Hollams Bird, Mercury and Sinclair Islands (Rand 1952, Shaughnessy 1980, Crawford *et al.* 1989). Displacement of penguins by seals has recently been countered to some extent by a policy of seal-scaring and placement of artificial shelters at breeding colonies (Crawford *et al.* 1994). African Penguins compete with other seabirds for breeding space. At Bird Island in Algoa Bay, they were displaced from a portion of prime breeding habitat by Cape Gannets *Morus capensis* (R.M. Randall unpublished). The projected rise in sea level may further reduce breeding habitat of African Penguins.

MARINE PERTURBATIONS, INCLUDING ENSO AND OTHER SHIFTS: In addition to fishing, environmental change is thought to have influenced alternating regimes of high and low abundance of Sardine and Anchovy worldwide, including the Benguela system (Lluch-Belda *et al.* 1989, 1992). Long-term trends of African Penguin populations in the Benguela system may to some extent be linked to regimes of Sardine and Anchovy. For example, the decreasing numbers of penguins at Dyer Island since the mid 1980s have matched a decreasing trend in the biomass of the South African Anchovy stock (Adams *et al.* submitted). In the same period, the stabilization or increase of colonies between Stony Point and Lambert's Bay has corresponded with an increasing trend in the South African Sardine stock.

These trends are the opposite of trends that followed the collapse of Sardine and rise of Anchovy off South Africa in the 1960s (Crawford *et al.* 1990).

PREDATION:
Sharks: Detailed examination of injuries sustained by penguins at St Croix Island indicated they were inflicted by Great White Sharks (*Carcharadon carcharias)* (Randall *et al.* 1988). At St Croix Island, these injuries were second only to oil pollution as a cause of mortality of penguins (Randall *et al.* 1988, R.M. Randall unpublished). Cooper (1974) attributed injuries observed at Dassen Island to sharks.

Seals: There are many accounts of Cape Fur Seals killing penguins (Cooper 1974, Broni 1984, Rebello 1984). This phenomenon has been recorded at Ichaboe, Halifax, Possession, Malgas, Dassen and Dyer Islands. The phenomenon is thought to be regional and periodic in occurrence. Mortality may be high - at least 25 penguins were killed on one day at Dassen Island (Cooper 1974).

Killer Whales: There are isolated records of Killer Whales (*Orcinus orca)* preying on African Penguins (Rice and Saayman 1987, Williams *et al.* 1990). Their influence is likely to be minor, because they are uncommon in southern African inshore areas (Ross 1989).

Kelp Gulls and Sacred Ibis: Kelp Gulls prey on eggs and chicks (Cooper 1974). Most of their takings constitute scavenging, such as deserted clutches, infertile eggs and dying chicks. They have learnt to capitalize on disturbance, preying on eggs and chicks that are temporarily exposed when parent birds take fright at human activities. The desirability of controlling Kelp Gulls at particular localities needs investigation. Sacred Ibis (*Threskiornis aethiopicus)* also have potential to scavenge eggs and small chicks.

Mole Snakes: At Robben Island, Mole Snakes (*Pseudapsis cana)* eat penguin eggs (Crawford *et al.* 1995c). If this predator attains high levels of abundance, the desirability of control should be researched.

Feral Cats: Feral Cats (*Felis catus)* prey on eggs or chicks of penguins at Dassen and Robben Islands (Berruti 1986, Crawford *et al.* 1995c) and probably also at Bird Island, Lambert's Bay, Boulders and Stony Point. Control programs are underway at Dassen and Robben Islands and are successful in maintaining cat populations at moderately low levels. Ideally cats should be eliminated at these islands.

Other mainland terrestrial predators: Various small predators prey on young stages of penguins at mainland localities and at the two islands (Bird at Lambert's Bay and Marcus) now joined to the mainland. Leopards (*Panthera pardus)* have eaten adult penguins at Stony Point (Crawford *et al.* 1995a). At this locality, predation is thought to have caused a decreasing trend. Some small predators have been trapped and released elsewhere. Black rats (*Rattus rattus)* occur at Marcus Island (R.M. Randall unpublished) and probably other localities linked to the mainland. They are potential predators of eggs.

POLLUTION:

Oil: Oil spills have major impact on African Penguins, especially when the oil washes ashore at breeding localities (Morant *et al.* 1981, Adams 1994, Underhill *et al.* in press). Oil kills penguins by impairing the insulative capacity of their feathers, so that they die of hypothermia in water (Erasmus *et al.* 1981) or of starvation on land because hypothermia makes it impossible for them to feed at sea. Ingested oil may produce a range of physiological abnormalities and is associated with a greater diversity of potentially pathogenic bacteria (Kerley and Erasmus 1987).

Catastrophic oil spills occur irregularly, but there is persistent chronic oiling. Of 689 dead penguins found at St Croix Island over a 10-year period, oil pollution accounted for more deaths (44 %) than any other factor (R.M. Randall unpublished). Cleaning oiled penguins has been undertaken with considerable success, notably by the Southern African National Foundation for the Conservation of Coastal Birds (SANCCOB) - (Underhill *et al.* in press, Nel and Williams submitted). Development of a proposed harbor near to St Croix Island, will place this large colony at increased risk of pollution.

Chemicals: Residues of polychlorinated biphenyls (PCBs) and the organochlorine pesticides DDE and Dieldrin have been found in penguin eggs (Van Dyk *et al.* 1982, De Kock and Randall 1984). In all cases the residue levels were low and unlikely to cause reproductive impairment.

CATASTROPHIC EVENTS:

Fire: At Robben Island and Boulders, the two new colonies where African Penguins breed under wooded vegetation, fire could cause extensive loss of breeding habitat and mortality of birds, eggs and chicks. The risk of fire should be minimized by clearing old wood.

Comments: Classification of the African Penguin as "Vulnerable" according to IUCN Red List Categories (A1a, A2b, E) is straightforward. "Endangered" status is approached, based on a probable decrease of 40 % in the last three generations, and a possible decrease of 40% in the next three generations, extrapolated from the present rate of decrease.

There is little evidence that the annual loss of birds has slowed as the population has decreased (Crawford *et al.* 1995a). If the present loss (40,000 adults in the last 15 years) continues, extinction in the wild will occur within 70 years.

Future trends in the overall population of African Penguins are difficult to predict. The recent decrease has been driven by large losses at Dyer Island and at colonies in the south of Namibia. It could be argued that as these colonies become smaller, further decreases will have less impact on the world population, and may indeed be offset by increases at expanding colonies. Similar reasoning in the early 1980s would have held that increases at then expanding colonies, including Dyer Island, would sooner or later have offset losses elsewhere.

It can be expected that trends at the two large colonies in Algoa Bay (St Croix and Bird Islands), which between them support 42 % of all African Penguins (Crawford *et al.* 1995a), will have a large influence on the future world population. For example, a catastrophic oil spill in Algoa Bay could almost halve the world population. The proposal to create a port and heavy industrial complex near the St Croix group of islands will place the colonies there at high risk.
Trends in Western Cape Province will mainly be influenced by events at Dassen, Dyer and Robben Islands, which support 37% of the World population. The proposal to develop Saldanha as a major port for oil and bulk carriers, with a predicted frequency of major oil spills (equivalent to or larger than the *Apollo Sea* spill) of once in 20 years, threatens the penguin populations within and adjacent to the area.

Mercury and Ichaboe Islands support 78% of the Namibian and 12% of the world populations. Penguins at these localities will be at risk, e.g. from displacement by seals (Crawford *et al.* 1989), if island staff is withdrawn. Additional threats in this region are prospecting for and exploitation of diamonds on or immediately adjacent to breeding localities, oil exploration along the Namib coast, and the present extreme shortage of food for penguins.

The total area available for nesting by African Penguins is less than 1,000 ha (about 16 km^2). There are only 14 colonies with more than 1,000 adults. The establishment of two new breeding localities in the 1980s, and recolonization of a third, must be offset against the loss of one colony off southern Namibia. Breeding may also soon stop at Pomona and Hollams Bird Islands.

RECOMMENDATIONS:

1. Population monitoring
   Trends in populations should continue to be monitored at all extant colonies. At selected localities, demographic parameters should be monitored. Of particular concern is the present paucity of recruitment of young adults to the breeding population at several localities, e.g. Possession Island.

2. Legal protection
   All breeding localities of this vulnerable species should be legislated as nature reserves.

3. Security of food base
   Food is probably the main limiting factor at most colonies west of Cape Agulhas. Means of improving the forage base should be investigated, e.g., ensuring adequate escapement of prey fish from fisheries.

4. Management of oiling
   A reduction in oil contamination should be targeted. Rescue of oiled birds should be supported. A coordinated contingency plan for the rescue of oiled penguins should be devised. A rehabilitation facility in Algoa Bay is necessary given the high proportion of the World population found in that region. The likely impact for the colony at St Croix Island of development of the proposed port nearby needs investigation. The impact on breeding colonies of searches for, and capture of, oiled birds requires research. Procedures to minimize disturbance during rescue operations should be devised. The likelihood of rehabilitated birds returning disease to wild colonies must be minimized. It is necessary to have a data base of hematological values in all captive populations in southern Africa.

5. Management of breeding habitat
   Breeding habitat of African Penguins must be secured, e.g., through continued exclusion of seals, and improved, e.g. through shading and drainage. No guano scraping should be allowed in and around colonies of African Penguins. Risks of fire at Robben Island and Boulders should be minimized.

6. Management of predation
   The impact of seal predation at selected colonies, e.g. Dyer Island, needs fuller investigation through field observations and modeling. There is potential for remedial action through the culling of "problem" seals. Populations of Feral Cats at Bird Island (Lambert's Bay), Dassen Island and Robben Island should be eliminated. The desirability of controlling Kelp Gulls at particular localities needs investigation. Measures must be implemented to preclude introduction of rats to islands.

7. Management of mortality arising from humans
   There should be no exploitation of African Penguins or their eggs. The effect of net fishing in the immediate vicinity of penguin colonies must be investigated,

and no netting that causes mortality of penguins leaving or returning to colonies should be allowed.

8. Management of tourism
   Tourism to selected penguin colonies should be carefully implemented, and its effects monitored. Appropriate national tourism strategies need to be developed. Management of the Boulders colony to minimize conflict with man needs attention.

9. Augmentation and establishment of colonies
   Means of establishing new colonies, or of manipulating colonies to expand in a certain direction (to minimize conflict with man), should be investigated. There is a likelihood that studies of behavior of captive populations can help in this. The possibility of returning birds bred in captivity to the wild should be investigated. The purpose of this would be to augment populations at colonies that are presently depressed of decreasing, and to establish techniques for reintroductions before the overall population has decreased to a critical level. This is a complex procedure and will require the assistance of specialist groups outside southern Africa. The technique, if established, will have value for other *Spheniscus* penguins.

10. Management of captive populations
    African Penguins in captivity (except for rehabilitation) should be kept in such a manner as to be individually recognizable, so that accurate information on ancestry can be maintained in stud books. Export of African Penguins from southern Africa should only be allowed from institutions that keep accurate records of stock, including provenance information, when available, and to institutions that keep similar records.

PHVA: Yes.

Captive Program Recommendation: Level 3.
Level of Difficulty: 1.
Existing Captive Population (ISIS): 873 (121 in Japanese collections may be hybridized and their lineages and genetics need to be examined before inclusion in co-operative programs). In recent years South Africa's East London Aquarium (ELA) has sold captive-born juveniles from excess stock to reputable zoos in other countries. The total number of birds traded by ELA is probably less than 30. In each instance, provincial nature conservation authorities issued the appropriate permits. The Port Elizabeth Oceanarium has sold no birds as yet, but is actively seeking buyers for its excess stock. There seems to be no trade of genuinely wild African Penguins, not even rumors of such activity.
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Species Editor/Coordinator for CAMP: R.J.M. Crawford

Contributors: J.-J. Brossy, I. Cordes, R.J.M. Crawford, N.T.W. Klages, W. Maritz, R.M. Randall

Appendix III.
Paired Ranking Procedure

One simple way to prioritize items on a list is to use paired ranking.
FOR EXAMPLE, Let's say we wish to rank the five fruits we like best.

PART ONE.

1. First list the fruits in a column one below the other. Ask yourself, which is better, apples or oranges? Put a mark next to the one that's better (this is your criterion for the ranking). Then ask which is better, apples or kiwis? Put another mark after the one you prefer.

2. Continue down the list until you have compared apples with each of the other fruits. Then, compare oranges with kiwis, oranges with peaches, and so on. Then, kiwis with peaches and kiwis with apricots, then peaches with apricots.

1st Set		**2nd Set**		**3rd Set**		**4th Set**	
1. Apples	| |	1. Apples	| |	1. Apples	| |	1. Apples	| |
2. Oranges		2. Oranges	|	2. Oranges	|	2. Oranges	|
3. Kiwis	|	3. Kiwis	|	3. Kiwis	| |	3. Kiwis	| |
4. Peaches	|	4. Peaches	| |	4. Peaches	| |	4. Peaches	| |
5. Apricots		5. Apricots	|	5. Apricots	|	5. Apricots	| |

The total number of marks is $\frac{n(n-1)}{2}$. In this case, you should have 10 marks.

3. Develop a table to tally each person's votes in the group. The fruit with the most marks next to it is ranked #1, the second most marks #2, etc.

Fruit	Person 1	Person 2	Person 3	Person 4	Total Votes	Rank
1. Apples	0	0	0	0	0	5
2. Oranges	1	1	1	1	4	4
3. Kiwis	4	2	3	3	12	2
4. Peaches	2	2	2	4	10	3
5. Apricots	3	5	4	2	14	1
TOTAL	**10**	**10**	**10**	**10**	**40**	

4. To rank the fruit against the criteria, develop a table like the one below and pair-rank all fruits by each column's criterion, recording in the appropriate spaces the number of votes each fruit gets. Then multiply the number of votes under each

criterion by that criterion's weight. Add across the rows and enter the total score. Each person in the group should carry out this paired ranking exercise individually.

FRUIT	CRITERIA				
	Ripeness (.40)	Ease of Eating (.30)	In-season (.20)	Tartness (.10)	Total Score
1. Apples	1 x .4 = .4	3 x .3 = .9	5 x .2 = 1.0	3 x .1 = .3	2.6
2. Oranges	3 x .4 = 1.2	1 x .3 = .3	3 x .2 = .6	5 x .1 = .5	2.6
3. Kiwis	2 x .4 = .8	1 x .3 = .3	1 x .2 = .2	2 x .1 = .2	1.5
4. Peaches	2 x .4 = .8	3 x .3 = .9	1 x .2 = .2	0 x .1 = 0	1.9
5. Apricots	2 x .4 = .8	2 x .3 = .6	0 x .2 = .0	0 x .1 = 0	1.4

5. When everyone is finished, flip chart recorders should record each person's total votes for each fruit in a matrix (see below). Then add up the scores and determine the ranking.

FRUIT	GROUP MEMBERS' SCORES					
	Person 1	Person 2	Person 3	Person 4	Total Scores	**Final Ranking**
1. Apples	2.6	1.4	1.5	2.6	8.1	**3**
2. Oranges	2.6	1.5	1.9	2.6	8.6	**1**
3. Kiwis	1.5	1.9	2.6	1.5	7.5	**4**
4. Peaches	1.9	2.6	2.6	1.4	8.5	**2**
5. Apricots	1.4	2.6	1.4	1.9	7.3	**5**

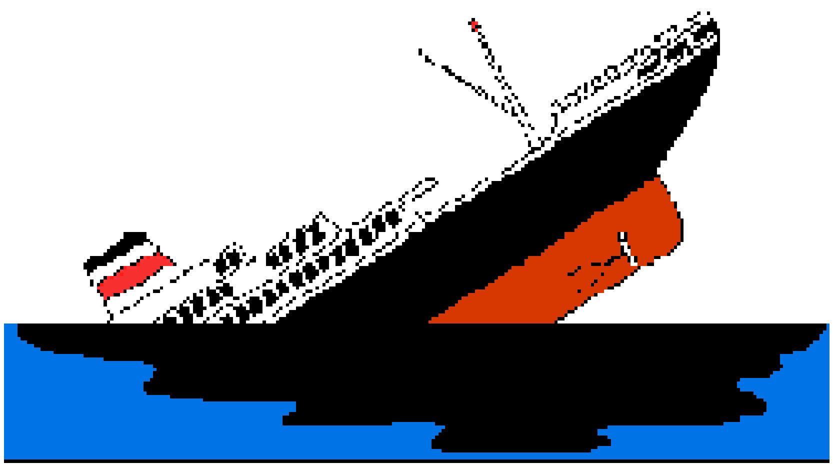
Appendix IV.

SEABIRD RESCUE PLAN IN THE EVENT OF AN OIL SPILL AT DASSEN ISLAND

Anton Wolfaardt:
Dassen Island Nature Reserve
Private Bag X 8
MALMESBURY
7300
Ph: 082 5734039

Zane Erasmus:
South West Region

Deon Rossouw:
Riverlands Nature Reserve



July 1998

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SEABIRD RESCUE PLAN IN THE EVENT OF AN OIL SPILL AT DASSEN ISLAND

1. INTRODUCTION

The southern African coastline is adjacent to one of the world's major shipping routes (Moldan and Dehram 1989), and has experienced more severe oil pollution events than any other country in the southern hemisphere (Williams *et al*. in press). Seabirds, and especially penguins, are susceptible to oil pollution, which is considered to be one of the main mortality factors of adult African Penguins (Randall *et al*. 1980).

Oil Pollution was virtually non-existent prior to the closure of the Suez Canal in 1967. This closure resulted in a dramatic increase in the volume of oil tanker traffic, with its concomitant oil spillages and pollution resulting from the flushing of tanks, around the Cape. Subsequent re-opening of the Suez Canal and the fluctuating price of oil have led to lower volumes of oil being transported around the Cape in recent years (Moldan 1989). However, tankers are not the only sources of oil pollution. The leaking of fuel oil from wrecked cargo vessels, and small-scale releases of bunker oil from ships have been the major cause of seabird oiling in recent years. (Williams *et al*. in press).

Oiled seabirds are a familiar sight at Dassen Island (33°25'S, 18°05'E), which lies 8.5 kilometres west of the coastal town, Yzerfontein (see Appendix 1). Dassen Island is a proclaimed Nature Reserve (Ordinance No. 23/1988, Official Gazette No. 4524), and is managed by Cape Nature Conservation. The vulnerability of the Island's seabird populations - particularly penguins - to oiling was highlighted by the *Apollo Sea* oil spill in June 1994, which released 2400 tons of oil and resulted in the oiling of close to 10 000 African Penguins. Oil pollution will continue to be a threat to seabirds on Dassen Island, especially with the expected increase in tanker traffic to Saldanha Bay.

This seabird rescue plan serves to set out guidelines for the effective management of an oil pollution event on or near Dassen Island. It deals specifically with the capture and stabilisation of oiled birds, penguins in particular, on Dassen Island, and the transportation of birds from the Island to SANCCOB.

2. THE NEED FOR A SEABIRD RESCUE PLAN ON DASSEN ISLAND

Substantial numbers of African Penguins have been oiled in the last three decades (Adams 1994). A penguin that is only lightly contaminated with oil loses the waterproofing and insulative properties of its feathers (Kerley and Erasmus 1987). The rehabilitation of oiled seabirds is a controversial activity.

However, considerable expertise in managing oiled African Penguins has been developed in South Africa, and SANCCOB is regarded as the most successful rehabilitation centre in the world, with a high success rate in rehabilitating oiled seabirds. Indeed, recent research has shown that rehabilitation of oiled African Penguins contributes significantly towards the conservation of this species.

The recent *Apollo Sea* oil spill highlighted the vulnerability of African Penguins to oil pollution. The Apollo Sea released 2400 tons of oil and resulted in the contamination of close to 10 000 penguins. Many tankers carry in excess of 250 000 tons of oil (Moldan 1989). The effects of an oil spill of this magnitude would be devastating.

Erasmus (1995) identified 5 phases of a rescue and rehabilitation operation:

Recognition – where the first signs of an oil spill are noted
Rescue – this phase includes the capture and temporary stabilisation of oiled birds at the site of pollution, and the transportation of the effected birds to a rehabilitation centre
Rehabilitation – where birds are given the appropriate medical attention, fed and cleaned by trained personnel at a rehabilitation centre
Release – where birds are released only after being tested, at selected sites which will ensure the safe introduction of the birds to their natural habitat
Review and Monitoring – where the post release survival and success of the operation is monitored so that the efficacy of actions can be ascertained and reviewed

This seabird rescue plan deals with the first two phases, i.e. the **Recognition** and the **Rescue** phases.

One of the major downfalls of the *Apollo Sea* rescue and rehabilitation operation was the lack of preparedness in the initial rescue phase, which included the capture of birds on the Island and the transport of birds from the Island to SANCCOB. The rescue phase of a rescue and rehabilitation operation is possibly the most important, since birds which are handled incorrectly, or excessively, experience higher levels of stress, and thus have a lower chance of survival. The effective implementation and management of this phase will therefore contribute significantly to the overall success of any rescue and rehabilitation operation.

This document has been compiled as a guideline for the effective management of any oil spill event that may occur at or in the vicinity of Dassen Island. It is meant to serve as a practical guide to management staff having to undertake a seabird rescue operation in response to an oil spill.

This plan, although drawn up for Dassen Island, can be adapted for use on other islands where similar circumstances may exist.

3. ORGANISATION

3.1 Management Structure of Cape Nature Conservation

Cape Nature Conservation's (CNC) management responsibilities in the Western Cape Province are distributed among four Management Regions, which are determined by geographical boundaries. Each Region is responsible for the various conservation components within its confines. Dassen Island Nature Reserve falls within the South West Region. A conservator, who is based on the Island, is responsible for the management of the reserve.

Staff required to assist in the event of a major crisis are drawn from the South West Region and neighbouring regions. The organogram in Appendix 2 illustrates the current local management structures.

The Manager - Dassen Island will be the front line manager, who will be responsible for co-ordinating rescue operations from the Island. There are currently no other Cape Nature Conservation employees present on the Island. The Manager - Dassen Island will therefore have to recruit assistance from other reserves in almost all kinds of oil spill incidents. For more serious oil spills outside assistance will also be necessary, particularly trained personnel who can assist with the supervision of different aspects of the rescue operation.

3.2 Equipment necessary on the Island:

It is essential that an adequate supply of the necessary equipment is stored permanently on the Island so that it is immediately available when the need arises. Appendix 3 provides a complete checklist of the equipment, which is to be acquired by the Manager - Dassen Island. The Manager is responsible for maintaining supplies and ensuring that the equipment is in working order.

4. SOURCES OF OIL POLLUTION

Oil tankers are obviously a major source of oil pollution. Oil spills from these vessels are both accidental and intentional - the deliberate flushing of tanks at sea. The wrecking of cargo vessels and the release of their fuel oil is another major source of oil pollution. It is important to appreciate that vessels carry various types of oil, both as cargo and as fuel, and that the effects of these oils on seabirds may vary. A bird contaminated with diesel oil, for example, will be more difficult to identify than a bird contaminated with crude oil. However, diesel may be more detrimental to seabirds due to its sever effect on the bird's respiratory system.

5. CATEGORIES OF OIL SPILL

The type of response necessary will depend on the severity of the oil spill. For the purpose of providing guidelines for the response to an oil spill, three levels of oil spill have been identified. The classification is based on the number of birds affected. This plan provides broad guidelines about how to respond to the different levels of oil spill. It must be emphasised that in any kind of emergency situation a certain amount of flexibility and initiative will be necessary.

The three classifications of oil spill are termed **Light, Moderate** and **Major.**

5.1 Light Spills may occur when ships clean their tanks, or bilge's, at sea. This can result in relatively small amounts of oil entering the foraging range of penguins. These spills are often not even found, and the sources are seldom traced. This kind of spill normally results in a relatively small number of penguins being affected. Oiling of this nature (i.e. only affecting a small number of penguins) can also occur as a result of an oil spill that occurs out of the general foraging range of the penguins at Dassen Island. Up to 30 birds may be affected.

5.2 Moderate Spills may be expected when carbon fuels or crude oil is accidentally spilt at sea. Slicks from stricken ships may also progress to within the general foraging range of the penguins, even though the location of the wreck may be distant. The number of birds affected by this kind of spill is between 30 and 2000.

5.3 Major Spills are experienced when a significant portion of the penguin population on the Island is threatened by the spill. A tanker, or bulk carrier, will have been wrecked or sunk in close proximity to the Island, or a major slick will have approached under the influences of the weather and sea. More than 2000 penguins are affected.

6. RESPONSE TO OIL SPILL INCIDENTS

The steps indicating the response to be taken by each role player are indicated in this section. Details of the actions expected of each are found in Appendices 4, 5 and 6. These appendices contain relevant lists and procedures, and are therefore critical reference records and role players will need to be familiar with the contents of the appendices. The mode of communication between the relevant parties will be by means of telephone or radio. The Island is equipped with a cell-phone, a radio-phone and a VHF radio linked to other Cape Nature Conservation reserves and offices.

6.1 Assessment of the extent of an oil spill:

The first indication of an oil spill will be the observation of oiled birds during regular routine patrols, or of the actual oil itself, in the water adjacent to the Island or washed up on the beach. The **Manager - Dassen Island** may also be informed of a known oil spill, or the presence of oiled birds, elsewhere, and thus the potential for penguins from Dassen Island being affected.

Dassen Island falls within the ***Coastal Oil Spill Contingency Plan No. 2 Swartland Zone***, which is published and managed by the Sea Fisheries Research Institute (SFRI), a Directorate of the Department of Environment Affairs and Tourism (DEAT). The first action of the **Manager** of the Island would be to assess the severity of the oil spill in terms of the numbers of birds affected, and other possible signs such as the presence of oil on beaches or offshore. After an initial assessment has been made the **Manager - Dassen Island** will inform the Oil Pollution section of the SFRI of the level of pollution. The Manager will provide as much information as possible about the oil spill. Depending on the nature of the oil spill, the information to be provided includes:

- Date and time of observation and by whom,
- Location of the oil or pending pollution e.g. . NW or SE coast
- The extent and nature of the oil i.e. the position, length, breadth of the oil, the colour of the oil etc.
- Where applicable, a description of the affected coast (Appendix 8)

The oil pollution officers will immediately investigate the spill with the resources at their disposal (all telephone numbers are maintained and kept up to date in Appendix 7). Liaison between the SFRI and the Manager - Dassen Island should indicate what level of pollution could be expected to affect the Island, and therefore what category the oil spill falls within. If there is any doubt about the classification of the oil spill, it will be classified as a moderate oil spill, to be upgraded or downgraded at a later stage. The **Manager - Dassen Island** will inform the Area Manager and SANCCOB of the incident. He will provide an estimate of the number of birds that are affected, and inform SANCCOB of the pending arrival of the birds. Appendix 5 discusses the transport of penguins.

6.2 Response to light, moderate and major oil spills

6.2.1 Light spills

A light oil spill has been defined as one in which less than 30 birds are affected. The rescue of this number of penguins will be handled by the **Manager - Dassen Island,** with the assistance of the field – ranger or labourer. (There is currently no field-ranger or labourer on the Island, and until there is the Manager - Dassen Island will need assistance. The **Area Manager** will be asked to organise assistance, if it is required).
1} The **Manager - Dassen Island** and his assistant will recover penguins (Appendix 4 details the procedures to follow when capturing and handling oiled penguins). If the birds cannot be transported to SANCCOB immediately, the affected birds will be placed in temporary pens and the birds will be stabilised as prescribed in appendix 5.

2} The **Manager - Dassen Island** will organise transport to ferry the penguins from Dassen Island to Yzerfontein. The form of transport he uses will depend on the weather conditions prevailing at the time. He will also organise transport from Yzerfontein or the landing zone to SANCCOB.

3} The **Manager - Dassen Island** will place the birds in the SANCCOB boxes and dispatch them in the defined transport. He will immediately notify **SANCCOB** of their departure and their expected time of arrival.

4} The **Manager - Dassen Island** will continue to inspect the Island for oiled birds.

6.2.2 Moderate spills

A moderate oil spill has been defined as one in which anything between 30 and 2000 birds are affected. This large range means that the kind of response necessary for this category of oil spill will vary according to the severity of the spill within this category. The actions necessary to rescue the affected penguins will be similar, but the number of people necessary to assist in the rescue operation will vary. For the more severe oil spills within this category, there will also be a need for additional assistance from experienced personnel. These personnel would assist with the supervision of the operation.

1} Having established that a moderate spill is pending, **The Manager - Dassen Island** will recruit assistance from neighbouring reserves as the need arises. This will be done through the **Area Manager**. The **Manager - Dassen Island** will co-ordinate operations from the Island, but depending on the severity of the spill will need assistance in the supervision of the operation. Experienced supervision will be needed in the following phases of the operation:

- the capture of birds
- the stabilisation of birds
- the transport of birds, especially from the landing place to SANCCOB

SANCCOB should be approached by the **Area Manager** to provide experienced personnel as the need arises.
2} Designated supervisors will be in charge of the labour teams while The **Manager – Dassen Island** will be in charge of the operation.

3} Birds are again held in temporary pens until the **Manager - Dassen Island** has arranged recovery transport.

4} The birds will be placed in transport crates and loaded into the designated transport. Again operations are supervised by the **Manager - Dassen Island.** However, when large numbers of birds are affected, an extra supervisor/co-ordinator will be needed to assist.

5} All communication ensues between the **Manager - Dassen Island** and the **Area Manager**. The **Area Manager** communicates with **SANCCOB**. Specialist advice regarding the biology and health of the penguins should be obtained from the **Chief Scientist in charge of birds** at Cape Nature Conservation, and the **SANCCOB Manager**.

6} It is the **Area Managers** responsibility to direct all operations. He will organise the deployment of transport, labour and supplies. .

7} The recovery teams are only withdrawn when the **Area Manager** has inspected the Island, and has satisfied himself that no further contaminated birds are on the Island.

8} The **Area Manager** arranges for the withdrawal of the teams. The **Dassen Island Manager** arranges to re-stock the Island with all the necessary equipment and provisions.

The **Dassen Island Manager** will be responsible for continually assessing the situation. He should conduct regular patrols to ascertain the number and location of birds still to be collected, and the number of newly oiled birds.

6.2.3 Major spills

1} The **Regional Manager** will co-ordinate the overall operation from a centre on the mainland.

2} The **Regional Manager** will recruit assistance from neighbouring Regions, as the need arises. He will also liase and co-ordinate all operations with other organisations such as: The South African Air Force, The South African Navy, South African Transport Services, SANCCOB, other NGO's and Local Authorities

3} The **SANCCOB** recovery team will be deployed to the Island, subsequent to liaison with the **Regional Manager**. The **SANCCOB** recovery team should include a vet, and personnel experienced in the stabilisation of oiled birds.

4} All teams on the Island fall under the control of the **Area Manager** who will be deployed to the Island**.** He will co-ordinate capture operations, designating teams (under the control the **Manager Dassen Island**) to sectors of the Island.

5} Somebody with the necessary experience (one of the **SANCCOB** recovery team) may supervise the temporary holding of penguins in pens, the stabilisation of birds before they are transported off the Island, placement of penguins in transport crates, and the dispatch of penguins at the designated transport.

6} A supervised team should be present at the landing place to ensure that the birds are packed correctly, before being transported to **SANCCOB.**

7} All transport operations will be co-ordinated by the **Regional . Manager**.

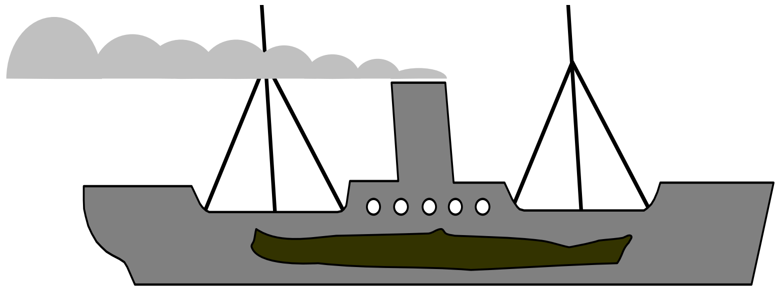
8} Communication between the Island and the mainland will ensue between the **Area Manager** and the **Regional Manager.** If the crises extends for longer than 7 days, Officers mutually briefed and appointed by either, will take over. Specialist advice regarding the biology and health of the penguins should be obtained from the **ornithologists** at Cape Nature Conservation (Jonkershoek), and the **SANCCOB Manager.**

9} The **Regional Manager** may decide to commence with a Chick Rescue Operation on the Island if the following criteria can be met: -

a) It can be determined that more than 300 chicks have been abandoned by both parents.
b) Adequate stocks of fish can be acquired to feed the chicks.
c) Permanent staff can be appointed to care for and feed the chicks.

A Chick Rescue Operation should only be considered after the oiled adults and immature birds have been rescued from the Island. The success rate of rehabilitating adults is far greater than the success rate for rehabilitating juveniles, or hand-rearing chicks (Nel 1996). It is therefore important that oiled adults be given top priority in a rescue operation.

6.3 Summary on what to do in the event of an oil spill.



OBSERVATION

↓

ASSESSMENT OF SEVERITY AND CLASSIFY

< 30 birds	***30 – 2000 birds***	> 2000 birds
MINOR SPILL	**MODERATE SPILL**	**MAJOR SPILL**

Manager Dassen Is. and staff organise rescue operation and transport from Island.	**Manager Dassen** Is. and staff Organise rescue operation on Island.	**Area Manager** assists **Manager Dassen Is.** and staff to organise rescue operation on Island
Operation controlled 0n Island by **Manager Dassen Is.**	Additional assistance and transport organised by **Area Manager.**	Additional assistance, transport and co-ordination with other organisations organised by **Regional Manager**
	Operation controlled from Mainland by **Area Manager.**	Operation controlled from Mainland by **Regional Manager**

7. MEDIA MANAGEMENT

An oil spill incident is invariably a disaster attracting the attention of journalists from the various forms of media. The attention of the public is attracted by the sensationalism of the crises, concern for the environment, and sympathy for the birds that are contaminated.
Reporters and journalists prefer to get their information from those that are involved in the operations. This practice can be disruptive and can lead to frustration on the part of the Managers, who may already be stressed. It is however, critically important that the public receive regular and accurate information. This will invariably have a number of advantages:

1} Public response and behaviour can be influenced. Legal issues can be addressed, voluntary assistance can be directed and general inaccurate perceptions can be eliminated.
2} Accurate and positive information will positively reinforce the image an organisation may have. It may also establish an understanding of the problems the organisation experiences in pursuit of its objectives.

It is imperative therefore that Managers prepare for liaison with the media. The most important rule applicable when providing information to the media, **is that only one person should be assigned the task of providing information.** This eliminates the possibility that contradictory information is supplied.
Media liaison will take place as follows:

7.1 Minor and Moderate Oil Spills:

All media inquiries are directed to the **Regional Manager**. He will receive 3 hourly reports from the **Manager - Dassen Island**, and relay that information. He is the only person authorised to do interviews or release information about the rescue of penguins on the Island to the media. It is advised that he prepare a press release/statement twice a day, and fax this information to both the electronic and press media representatives. This ensures that regular and updated information is received. It often makes it necessary for the reporters to search for information, and it entrenches the source of information. It is important that the media statements are co-ordinated with those released from other organisations involved in the rescue, rehabilitation and clean up operations elsewhere.

7.2 Major Oil Spills

Each Region of CNC is assigned a Media Relations Officer (MRO), who is based in Head Office. The Regional Manager is far to busy with the management of a major oil spill, to be able to manage media reports as well.

Past experience has indicated that the most practical procedure is to assign the MRO to continuously “shadow” the Regional Manager (i.e. this entails accompanying the Regional Manager throughout his involvement, and monitoring his management of the operation). In this way the MRO will be aware of any developments, and can relay this information to the media when it becomes available. The MRO will issue press releases in the morning and evenings, and will hold any interviews if the Regional Manager is not available

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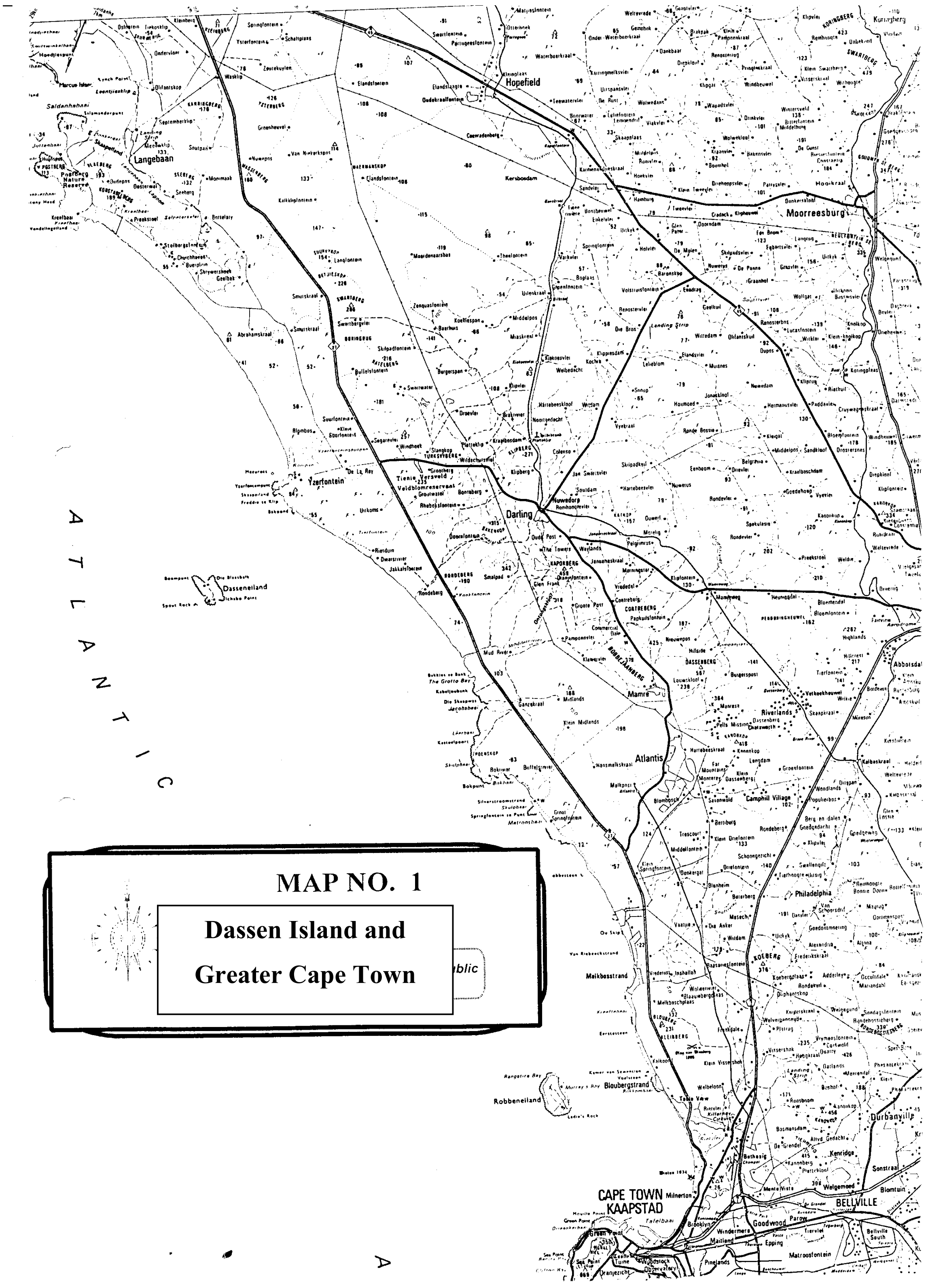
APPENDIX I


MAP NO. 1
Dassen Island and
Greater Cape Town
ATLANTIC
Hopefield
Langebaan
Moorreesburg
Yzerfontein
Darling
Dasseneiland
Mamre
Atlantis
Philadelphia
Robbeneiland
Durbanville
CAPE TOWN
KAAPSTAD
BELLVILLE

APPENDIX 2

South West Region Management Structure

Regional Manager:

Zane Erasmus

↓

Area Manager 1:
Mark Gentle (actg.)

↓

Reserve Managers:

Dassen Island Nature Reserve

Anton Wolfaardt

Riverlands Nature Reserve

Deon Rossouw

Jonkershoek Nature Reserve

Patrick Shone

Hottentots Holland Nature Reserve

Leon Lourens (actg.)

Limietberg Nature Reserve

Arnold Swart (actg.)

Kogelberg Nature Reserve

Mark Johns

Environmental Education

Yvonne Korver

Fanus van der Walt

Area Manager 2
Paul Gildenhuys (actg.)

↓

District Services Officers

Robin Jangle

Carl Brown

Anita de Kok

Tienie van der Westhuizen

Dian Dreyer

APPENDIX 3

List of equipment and provisions to be stored on the Island

DESCRIPTION	QUANTITY
Corral units for herding birds	4
Long-handled nets for catching birds	3
SANCCOB penguin boxes	50
Gloves (Long-sleeved leather)	10 Small 25 Medium 10 Large
Gum Boots	10 Small 25 Medium 10 Large
Oil Skin sets	10 Small 25 Medium 10 Large
Human first-aid kits	2

DESCRIPTION	QUANTITY
Provisions for stabilisation of penguins	
Boxes of pilchard	6
Darrows	5 bottles
PPR (charcoal)	5 bottles
Ringer Lactate	5 drip bags
Iron Dextrin	2 bottles
Betadine mouthwash	1 bottle
Amphajel	1 bottle
Terramycin	10 tubes
Ensure	4 tins
Syringes	10 Small
	10 Medium
	10 Large
19 gauge needles	50
23 gauge needles	50
Duodenal tubes	6
Sponges	5
Milton	3 bottles
Cotton Wool	2 packets
Buckets	6
Newspaper	3 crates
Hospital tags	2 boxes
Bird record cards	100

The above is a list of provisions which should be maintained on the Island at all times. The quantities would be sufficient to cope with up to 100 birds. When more than 100 birds are affected, additional provisions would need to be obtained from SANCCOB.

APPENDIX 4
Capture and handling of penguins

Penguins that have been contaminated by oil are invariably showing signs of shock. They will have lost their insulatory ability, and may also be suffering form the toxic effects of the oil. This may have been ingested while preening, may have been inhaled, and quite probably have adversely affected the bird's eyes.

Birds in this state will be extremely vulnerable to further trauma, and could quite easily succumb if not treated correctly.

The following handling procedures are provided as a guideline for managers that will supervise capture operations, and if adhered to, should contribute largely to the successful rehabilitation of the penguins.

1. Safety of the capture teams is paramount and each person is to be equipped with gloves, oil-skins, and gum-boots.
   Any injury should be treated immediately as the risk of infection is high. Certain avian viruses can be passed on to humans.
2. Do not chase birds haphazardly, because they will only become exhausted. Try to cause the least disturbance possible, by moving slowly and carefully. Do not shout and scream. Catchers should work together in teams, walking carefully to "corner"/ herd birds using corrals before capture.
3. Strict supervision should ensure that capture teams do not unnecessarily disturb nest sites. This applies particularly during light and moderate spills when most birds are not affected, and teams may only be searching for oiled birds. Losses of eggs and chicks to marauding gulls may far exceed the alternative loss of an oiled bird.
4. Birds that have escaped to rocks should be recovered by using the long handled nets.
5. Birds that are captured by hand should be held away from the body. Particular care should also be taken that the bird also faces away from the body, avoiding the eyes and face of the holder. People holding penguins should ensure that they keep the bird out of the way of other persons.
6. Penguins should be caught by placing a hand under each flipper, and exerting just enough pressure to immobilise the bird. Two factors are important when handling penguins
   a) Don't injure the bird.
   b) Don't injure yourself.
   The best way to carry and hold a penguin is to grip it firmly behind the head, so that the beak is facing away from the holder. Use the other

hand to support the body weight of the bird, by supporting it firmly between the legs.

7. The condition under which birds are confined for transport have proven to be the
most critical of all handling procedures. High mortalities can be expected if birds are not carefully loaded into crates. The primary concern is that there should be enough ventilation. Oil fumes tend to build up if the air around the birds is not allowed to dissipate. No more than three penguins should be placed in the SANCCOB boxes. Juveniles must be kept separate from adults.

   Mortalities can also occur as a result of excessive handling. Therefore, the number of times a penguin has to be handled should be kept to a minimum. If transport is immediately available, penguins captured in the field should be placed directly in the SANCCOB boxes, and prepared for transport. If transport is not immediately available, the penguins will be placed into boxes in the field and then transferred to a temporary holding pen at the base.

8. The temporary pens will be erected where birds can be kept while transport is arranged. This will allow the managers to sort the birds prior to dispatch. Managers must ensure that age groups are not mixed in crates, i.e. juveniles should not be packed into crates with adults. It may be difficult to distinguish age classes when all the penguins are covered in oil. If time permits, and the operation is closely supervised however, then careful use of the temporary holding pens should make this task less complicated.

The capture and rescue operation on the Island is provisionally based on the following elementary steps:

Capture in the field

⇓

Place penguins in boxes

⇓

Transport to base / temporary holding pens

⇓

Sort into age and condition classes

⇓

Reload into boxes (a maximum of 3 per box, of the same age class)

⇓

Transport off Island to Rehabilitation Centre.

It is most likely that the operation will not be as straightforward as this. The basic procedure should however be adhered to as far as possible.

APPENDIX 5

Stabilization of oiled penguins

Birds succumb to the effects of contamination in a number of ways:

- Oil on the feathers will impair water repellence, and other insulating properties. Hypo or hypothermia sets in as the bird is exposed to external water and air temperatures.
- The penguins will instinctively bathe or preen, and in doing so will ingest oil and toxic pollutants. Poisoning can have long or short term effects.
- Penguins lose their buoyancy, and can drown if they don't reach dry land.
- Contaminated penguins are unable to hunt for food. No fluids are taken in and dehydration as well as starvation can set in.

By the time penguins are captured, they are dehydrated, exhausted and either extremely hot or cold. The climatic conditions that may exist during a rescue and recovery operation may make it difficult to organise transport from the Island. It may then become necessary to stabilise the birds so as to neutralise the initial affects that the oil may have on them, while they await transport. Quite simply, stabilization should be seen as only "First Aid" for the penguins. It does not include washing the birds. This practice is not encouraged at all. Penguins that have been stabilised will have a better chance of survival once rehabilitation treatment is commenced.

Stabilization consists of four basic components.

1. Clearing of mouth, nostrils and eyes: Heavily oiled penguins sometimes have debris and oil built up in their mouths and nostrils, which can impair their breathing. Prior to anything else, debris should be removed from these areas using cotton swabs, rags and tweezers. Eyes can be flushed out with clear non-medicated saline solution or water, if nothing else is available.
2. Temperature Regulation: Normal bird temperatures range between 102 and 106 degrees F. Birds with temperatures below 101 should be considered hypothermic. The holding pens should be partially erected in the sheds on the Island. This will permit the birds that are hypothermic to move indoors to keep warm, or to move outside if they are hypothermic and need to keep cool. Temporary shade facilities should be provided. Temperature taking is not advised as this may lead to further stress of the bird.
3. Treatment for Dehydration: It should always be assumed that oiled birds are dehydrated. Fluids should be tube-fed to birds on a regular schedule beginning at stabilization. This procedure should only be followed if transport of the penguins to SANCCOB is delayed, <u>and,</u> if a trained and experienced person on the Island can perform the technique.

A schedule of dosages and directions follows:

a) Clean out mouth with **Betadine mouthwash**, including area under tongue; syringe in 2-5 ml. of **Amphajel** into mouth being careful not to squirt any liquid into the penguin's breathing hole.
b) Wash out eyes with **tears eyedrops**, and administer **Terramycin** cream in and around eyes – use liberally.
c) Administer 20ml. **activated charcoal (PPR)** (once off dose), followed by 60-120ml. diluted **Darrows** solution (50 ml. Darrows to 1 litre of water). These fluids are given using a syringe and tube. If bird is severely dehydrated (this can be ascertained by grabbing the penguin at the back of the neck – if it feels very "tight" , i.e. like there is very little flesh, then the bird is badly dehydrated), inject 20ml. ringer lactate into each side of the neck (40 ml. in all), using a 19 guage needle.
d) Inject 0.2ml. **iron dextrin** into the breast muscle, using a 23 guage needle (once-off injection).

The above tasks must only be conducted by experienced personnel. Feeding of birds should take place three times a day for relatively strong birds and every three hours for weak birds. Once birds have been re-hydrated they can receive fish.

4. **Rest:** By the time oiled penguins are captured they are often in an exhausted state. They will use all of their energy to fight and may look livelier that they actually are. Even so, it is important to assume that they are suffering from exhaustion. Temperature taking, fluid administration and any other handling should always be done quickly so that the bird can rest. Oiled birds should be kept in the holding pens with good ventilation when not being handled. They should not be disturbed during this time except when being monitored. They need to rest as much as possible.

Stabilization Facilities

Stabilization facilities are actually oiled wildlife first aid stations. Their purpose and design is only to provide a place where initial care for oiled birds, immediately following capture and prior to transport, is done.

APPENDIX 6
Transport of penguins

Successful capture, or rehabilitation operations, could be negated if penguins were to succumb to detrimental handling techniques during transport. The following guidelines are included to ensure that operations run smoothly with the least possible mortality.

Form of Transport

The prevailing weather conditions and the resources available will determine the form of transport utilised at the time. The important consideration is that penguins be treated as soon as possible after capture, as birds which are still in good condition have a better chance of survival (Kerley and Erasmus, 1986). Helicopters, while expensive, may enable the birds to be treated soonest. In past operations, no visible effect has been observed in response to the excessive vibrations and noise experienced on board a helicopter. Managers should however, still ensure that adequate ventilation and air movement is possible between the crates, as temperatures, even for a short flights, can be quite high. Logic should also indicate that ventilation on the other hand should not be too extreme, and penguins should not be exposed to open cargo doors, or transported outside the helicopter! Penguins may ultimately only be able to be transported by boat. Excessive jostling and bumping can take place if the seas are rough and managers should consider postponing transport operations until calmer conditions prevail. There appear to be no limitations on the period for which birds can be transported by road, provided adequate ventilation, and favourable temperatures are maintained.

APPENDIX 7

This is a list of the relevant telephone numbers in the departments of Nature Conservation and Sea Fisheries.

	OFFICE	HOME	
Nature Conservation:			
Regional Manager: **South West Region**			
Zane Erasmus	021 8891560	082 4146344	021 585230
Area Manager I: **South West Region**			
Mark Gentle	021 8891560	0827841752	0225 4826
Chief Scientist in charge of birds			
Dr. Tony Williams	021 4833020		021 5561284
Reserve Manager: **Dassen Island**			
Anton Wolfaardt	0825732179		
Reserve Manager: **Riverlands**.			
Deon Rossouw	0224 77360	0825734039	0224 77028
Reserve Manager: Jonkershoek.			
Patrick Shone	021 8891560		0224 3801
Reserve manager:**Limietberg**			
Arnold Swart (Actg.)	021 8711536	0824949707	0218681619
Reserve Manager: **Hottentots Holland**			
Leon Lourens	0225 4826		0225 4790
Reserve Manager: **Kogelberg**			
Mark Johns	028 2729425		02823 29335
Area Manager II: **South West Region**			
Paul Gildenhuys	021-8891560	082 5518312	
District Service Officers:			
Robin Jangle	021- 521070	082 5749259	
Carl Brown	021- 521070	082 7848718	
Anita de Kok	021- 521070		
Dian Dreyer	021-8891560		
Tienie van der Westhuizen	021-8891560	082 7847173	
SANCCOB	021 5576155	Pager 233333 page:8006	021 5575203 021 5575557
Sea fisheries			
Patrol Boats	022 7143703		
Saldanha Patrol:			
Andries Visser	022 7141710 / 7142226	0825799137	022 7143446
Portswood Control:			
Gellie Geldenhuis	021 217618		021 5578444
Yzerfontein Control:			
Wade Theron	02245 267	0827718910	

DEA pollution officers

Dr Lyn Jackson	021 402 3344	0214615591
Mr R Harding	021 4023338	021 7902288
Ms A Dehrmann	021 4023342	021 5519464
Mr Piet Van As	021 4023342	021 5105403
All Hours Cellular Phone	0825576612	

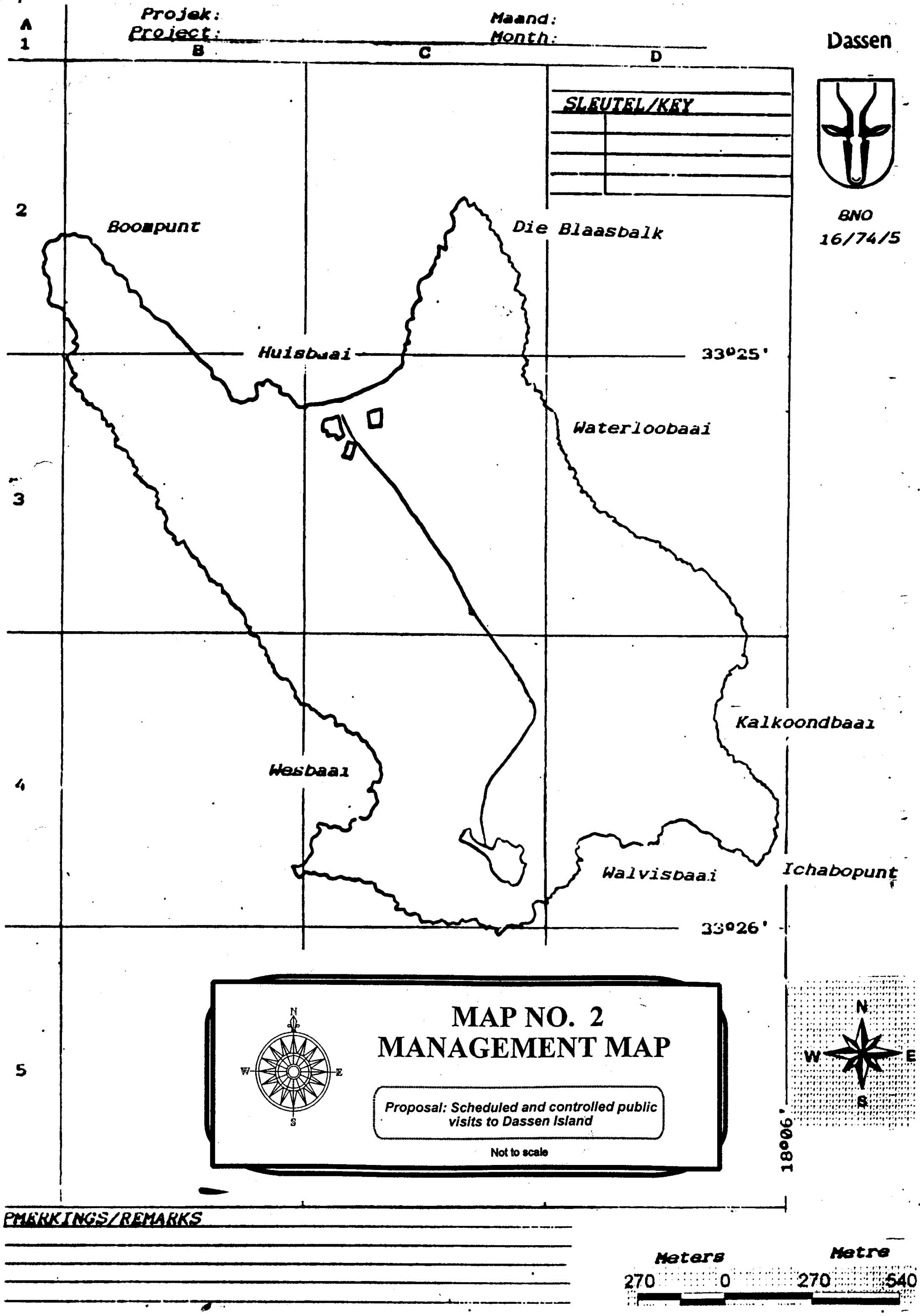
Portnet

Cape Town:		
Barney Germishuis	0214495738	0832847091
Lighthouse Dassen:		
Pierre van Zyl	021 4494143	

S.A.N.D.F

Air Force:	
Silvermine:	021 7972911/2247
Ysterplaat	021 5086269/6222
Navy:	
Simons Town	021 7873911
Cape Town	021 212123
Army:	
Wynberg	021 4691111

Appendix 8



Projek:
Project:
Maand:
Month:
A
B
C
D
1
2
3
4
5
Dassen
SLEUTEL/KEY
BNO
16/74/5
Boompunt
Die Blaasbalk
Huisbaai
33°25'
Waterloobaai
Kalkoondbaai
Wesbaai
Walvisbaai
Ichabopunt
33°26'
MAP NO. 2
MANAGEMENT MAP
Proposal: Scheduled and controlled public visits to Dassen Island
Not to scale
N
W
E
S
18°06'
OPMERKINGS/REMARKS
Meters
Metre
270
0
270
540