



**PROGRAMME AND ABSTRACTS**

# **THIRD INTERNATIONAL PENGUIN CONFERENCE**

**The Breakwater Lodge, The Victoria and Albert Waterfront, Cape  
Town, South Africa**

**2-6 September 1996**

**PROGRAMME AND ABSTRACTS**

Sponsored by:

African Seabird Group  
Avian Demography Unit, University of Cape Town  
Caltex Oil (SA) (Pty) Ltd  
Penguin Fund Japan  
Percy FitzPatrick Institute of African Ornithology, University of Cape Town  
Sea Fisheries Research Institute  
Two Oceans Aquarium

Scientific Committee

John Cooper (Chair), J.-J. Brossy, Rob I, Norbert Klages, Tony Williams

Organizing Committee

Andrea Plös (Chair), Bruce Dyer, Meredith Thornton, Leisha Upfold, Phil Whittington

Edited by John Cooper

African Seabird Group

P.O. Box 34113

Rhodes Gift 7707

South Africa

August 1996

## PROGRAMME

### Sunday 1 September

- 1700 - 1830 Registration, Lecture Theatre 1 Foyer, Breakwater Lodge Conference Centre
- 1830 - 2030 Informal ice-breaker, Lecture Theatre 1 Foyer, Breakwater Lodge Conference Centre

### Monday 2 September

- 0800 - 0915 Registration and poster and trade display erection, Function Room, Breakwater Lodge Conference Centre
- 0915 - 0930 J. Cooper: Welcome and Introductory Remarks, Lecture Theatre 1, Breakwater Lodge Conference Centre

#### REVIEW

Chair: John Cooper

- 0930 - 1030 J.P. Croxall & L.S. Davis: Penguins: paradoxes and patterns
- 1030 - 1100 Morning Tea, Function Room

#### SESSION I: Breeding Biology I

Chair: Rob Crawford

- 1100 - 1125 P. Dann & M. Healy: Supplementary feeding of penguin chicks: its effects on breeding success and parental survival
- 1125 - 1150 M. Fortescue: Temporal and spatial variation in breeding success of the Little Penguin *Eudyptula minor* on the east coast of Australia
- 1150 - 1215 K.R. Kerry & J.R. Clarke: Factors controlling the timing of breeding of the Adélie Penguin in eastern Antarctica
- 1215 - 1240 J.T. Darby & D. Fletcher: Survival and mortality in a group of Yelloweyed Penguins *Megadyptes antipodes*
- 1240 - 1400 Lunch

#### SESSION II: Diseases in Penguins

Chair: J.-J. Brossy

- 1400 - 1425 R.J. de B. Norman: Disease in the Little Penguin *Eudyptula minor*, with emphasis on the pathology of internal helminth parasitism in the Phillip Island population
- 1425 - 1450 H.I. Jones & G.R. Shellam: Ecology of blood-inhabiting parasites in free-living penguins
- 1450 - 1515 G.R. Shellam, H.I. Jones, G.M. Budd, T.V. Riley & J. Iveson: Studies of enteric bacteria of penguins in Antarctic, sub-Antarctic and cool-temperate habitats
- 1515 - 1540 H. Gardner: Adélie Penguin chick deaths at Mawson - implication for monitoring disease
- 1540 - 1610 Afternoon Tea, Function Room

### SESSION III: Breeding Biology II

Chair: Lloyd Davis

- 1610 - 1635 K.A. Edge, J.G. Jamieson & J.T. Darby: Conservation biology meets behavioural ecology: the role of parental investment theory in the management of an endangered species of penguin
- 1635 - 1700 A. Chiaradia: Attendance patterns of Little Penguins during the breeding cycle
- 1700 - 1725 C. Cassidy St. Clair, I.G. McLean, J.O. Murie, S.M. Phillipson & B.J.S. Studholme: Fidelity to nest site and mate in Fiordland Crested Penguins
- 1725 - 1750 M. Cullen: Little Penguin breeding and sea surface temperatures
- 1900 - 2200 Cocktail Party with the fish: Two Oceans Aquarium

### Tuesday 3 September

- 0830 - 0835 Announcements

### SESSION IV: Rehabilitating oiled penguins

Chair: Peter Dann

- 0835 - 0900 C.T. Clumpner: Rehabilitation of oiled penguins: a comparison of spills on three continents
- 0900 - 0925 Little Penguin Oil-spill Monitoring Group: Effects of an oil spill on Little Penguins *Eudyptula minor* in northern Tasmania, Australia. Part II: short-term survivorship and breeding success of oiled birds following rehabilitation
- 0925 - 0950 L.G. Underhill, A.J. Williams, R.J.M. Crawford, P.A. Whittington & D.C. Nel: The 1994 *Apollo Sea* oil spill - its impact on the African Penguin and rehabilitation success
- 0950 - 1015 D.C. Nel & A.J. Williams: Restoration of African Penguins oiled in 1994 into the Dassen Island population
- 1015 - 1040 P.A. Whittington: Rehabilitation - its contribution to population dynamics and role in the conservation of the African Penguin *Spheniscus demersus*
- 1040 - 1110 Morning Tea, Function Room

### SESSION V: Penguins as Swimmers and Divers

Chair: Rory Wilson

- 1100 - 1135 B.M. Culik, K. Pütz, R.P. Wilson, C.A. Bost., Y. le Maho & J.-L. Verselin: Core temperature variability in diving King Penguins *Aptenodytes patagonicus*: a preliminary analysis
- 1135 - 1200 B. Cannell: Light levels and their effects on the foraging behaviour of Little Penguins
- 1200 - 1225 R. Küng: Videoanalysis of locomotion in the King Penguin *Aptenodytes patagonicus*, Gentoo Penguin *Pygoscelis papua* and the Adélie Penguin *P. adeliae*
- 1225 - 1250 R. Bannasch: Advances in biomechanical studies on penguin swimming
- 1250 - 1400 Lunch

### SESSION VI: Population trends

Chair: Tony Williams

- 1400 - 1425 J. Cooper, A.C. Wolfaardt & R.J.M. Crawford: Breeding success of Macaroni and Rockhopper Penguins at Marion Island, 1979-1995
- 1425 - 1450 I. Cordes, R.J.M. Crawford & A.J. Williams: Decrease of African Penguins *Spheniscus demersus* at the Possession Island group, 1956-1995: contrasting trends for colonial and solitary breeders
- 1450 - 1515 R.J.M. Crawford & L.J. Shannon: Population parameters for African Penguins at Robben Island, with observations on their reliability
- 1515 - 1540 L.J. Shannon & R.J.M. Crawford: Management of the African Penguin *Spheniscus demersus* - insights from modelling
- 1540 - 1610 Afternoon Tea, Function Room

### FIRST FORMAL POSTER SESSION

- 1610 - 1730: Function Room
- 2000 - 2200 An evening with the penguins: a show and tell session. Lecture Theatre 1

### Wednesday 4 September

Excursions to the penguin colonies of Robben Island and Boulders. Details will be made available at registration

### Thursday 5 September

- 0855 - 0900 Announcements

### SESSION VII: Foraging Ecology I

Chair: Dee Boersma

- 0900 - 0925 K. Pütz, Y. Roupert-Coudert, J.-B. Charrassin & R.P. Wilson: Foraging areas of King Penguins *Aptenodytes patagonicus* during the breeding season in the southern Indian Ocean
- 0925 - 0950 C.A. Bost, G. Duhamel & M. Koudil: Penguins as indicators of Southern Ocean resources: King Penguin *Aptenodytes patagonicus* at the Kerguelen Islands
- 0950 - 1015 C.L. Hull & M.A. Hindell: The foraging zones of Royal Penguins *Eudyptes schlegeli* during the breeding season: a preliminary satellite-tracking study
- 1015 - 1040 P.J. Moore: Foraging ecology of Yelloweyed Penguins
- 1040 - 1110 Morning Tea, Function Room

### SESSION VIII: Human Disturbance of Penguins

Chair: Mike Cullen

- 1110 - 1135 A.J. Nimon: The significance of nesting Gentoo Penguin *Pygoscelis papua* responses to tourist groups in Antarctica

- 1135 - 1200 K. Crosbie: Skua-penguin interaction in relation to human activities  
1200 - 1225 H. Ratz: Do tourists influence the feeding behaviour of Yelloweyed Penguins?  
1225 - 1250 P.D. Boersma, D.L. Stokes & P. Yorio: Effects of human disturbance on the breeding biology of Magellanic Penguins

1250 - 1400 Lunch

**SESSION IX: A Mixed Bag of Penguins**

Chair: Susan Jackson

- 1400 - 1425 C.J. Scholten: Iris colour of Humboldt Penguins  
1425 - 1450 J. Spletstoesser & F. Todd: Emperor Penguin *Aptenodytes forsteri* stomach stones and geological correlations in coastal Antarctica  
1450 - 1515 B. Stonehouse: [title awaited]  
1515 - 1540 P. Jouventin: How can King Penguins *Aptenodytes patagonicus* chicks identify adult calls in the noisy environment of a colony?

1540 - 1610 Afternoon Tea, Function Room

**SECOND FORMAL POSTER SESSION**

1610 - 1715 Function Room

1800 - 1900 First International Penguin Fun Run (5 Km)

Start and Finish: Two Oceans Aquarium

2100 - 2200 Election of a Penguin Conference Standing Committee, Lecture Theatre 1

**Friday 6 September**

0855 - 0900 Announcements

**SESSION X: Conservation and Captivity**

Chair: Les Underhill

- 0900 - 0925 R. Jessop & M. Healy: Rehabilitation of Little Penguins *Eudyptula minor* at Phillip Island, Victoria, Australia  
0925 - 0950 E.N. Diebold, S. Branch & L. Henry: A summary of the captive management of penguins in North American zoos  
0950 - 1015 J. Govers: Status of the African Penguin in Europe, with special attention to the successful breeding at Amsterdam Zoo  
1015 - 1040 S. Ellis: Penguin Conservation Assessment and Management Plan: a progress report

1040 - 1100 Morning Tea, Function Room

**SESSION XI: A Second Mixed Bag of Penguins**

Chair: Ros Jessop

1110 - 1135 C. Lalas: A maximum density for nesting Yelloweyed Penguins?

- 1135 - 1200 J. Valencia & H. Torres: Pygoscelid penguin mixed colonies, spatial distribution and growth, Ardley Island, South Shetland Islands
- 1200 - 1225 J.B. Charrassin, C.A. Bost, K. Pütz, J. Lage, T. Dahier & Y. le Maho: Changes in depth utilization in relation to the breeding stage: a case study with the King Penguin *Aptenodytes patagonicus*
- 1125 - 1250 A. Simeone, M. Bernal & J. Meza: Incidental mortality of Humboldt Penguins *Spheniscus humboldti* in fishing nets at Valparaiso Region, Chile
- 1250 - 1400 Lunch

**SESSION XII: Foraging Ecology II**  
Chair Norbert Klages

- 1400 - 1425 J.R. Clarke: a comparative study of the foraging strategies of male and female Adélie Penguins
- 1425 - 1450 R.P. Wilson & G. Peters: The foraging behaviour of breeding Chinstrap Penguins at Ardley Island, Antarctica
- 1450 - 1515 P.D. Boersma & D.L. Stokes: Foraging of male Magellanic Penguins during incubation and chick-rearing: new results using satellite telemetry
- 1515 - 1540 B.M. Culik & G. Luna-Jorquera: VHF and satellite telemetry of Humboldt Penguins in northern Chile
- 1540 - 1610 Afternoon Tea, Function Room

**SESSION XIII: Foraging Ecology of Emperor Penguins**  
Chair: Boris Culik

- 1610 - 1635 G. Robertson: Foraging ranges of Emperor Penguin fledglings and potential interaction with fisheries
- 1635 - 1700 G.L. Kooyman: Dispersal of juvenile Emperor Penguins after fledging
- 1700 - 1725 B. Wienecke & G. Robertson: Three-dimensional foraging space of female Emperor Penguins during the Antarctic winter
- 1725 - 1750 R. Kirkwood & G. Robertson: The foraging ecology of female Emperor Penguins in winter
- 1750 - 1800 Conference closure
- 1900 for 1930 Banquet, Function Room





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**AFRICAN PENGUIN *SPHENISCUS DEMERSUS* DIETS AND ANCHOVY DISTRIBUTION OFF DYER ISLAND, WESTERN CAPE, SOUTH AFRICA**

N.J. ADAMS<sup>1,3</sup>, R.J.M. CRAWFORD<sup>2</sup>, B.M. DYER<sup>2</sup> & R.C. LAUGKSCH<sup>1,4</sup>

<sup>1</sup>*Percy FitzPatrick Institute of African Ornithology, University of Cape Town, Rondebosch 7700, South Africa*

<sup>2</sup>*Sea Fisheries Research Institute, Pvt Bag X2, Roggebaai 8012, South Africa*

<sup>3</sup>*Current address: Department of Biology, University of Natal, Private Bag X10, Dalbridge 4014, South Africa (nadams@biology.und.ac.za)*

<sup>4</sup>*Current address: Science Education Unit, School of Education, University of Cape Town, Rondebosch 7700, South Africa*

Although the total population size of the southern African endemic African Penguin *Spheniscus demersus* continues to decrease, there have been significant localized reversals of this trend. The resulting shifts in main concentrations of breeding penguins along the southern African coast are attributed generally to temporal and spatial fluctuations in the biomass and distribution of their main prey species. Over the period 1978-1986, when penguin numbers were highest at colonies along the southwestern and southern coasts, anchovy *Engraulis capensis* was the most important prey species. The traditional view of the distribution of anchovy off the South African coast holds that recruitment of juvenile fish to the commercial fishery is confined to the west coast and that the young anchovy fish migrate to the south coast as they mature into adults. However, the occurrence of considerable numbers of post-larval anchovy in stomach samples recovered from penguins in the early 1980s suggested substantial recruitment may take place along the southwestern and southern coasts sustaining partly the local penguin population. On the basis of a longer time series of data, we re-evaluated this hypothesis, particularly in regard of the more recent decreases in penguin numbers in the area. A

total of 882 stomach samples has been collected from penguins returning to Dyer Island (34° 41'S, 19° 25'E), on the southern Cape coast from diurnal foraging trips. Prey items recovered from stomach samples were identified and counted. Prey length was determined. From 1987 to 1990, anchovy constituted at least 90% of all prey items in the diet. Post-larval but pre-recruit sized anchovy constituted on average only 4.5% of this component. Over the period 1991-1995, the proportion of anchovy decreased to a minimum of 27% in 1995, being replaced partly by sardine *Sardinops sagax*. Concomitant with these changes was a decrease in the numbers of penguin pairs breeding at the island from a maximum of 22 655 in 1979 to a minimum of 2374 in 1993. Penguin diet data for most years are consistent with the traditional model of anchovy recruitment with few pre-recruit anchovy available, and the presence of a large resident population of post-recruit anchovy through most of the 1980s. However, the substantially higher proportions of post-larval anchovy recorded in penguin diets in August 1987 (9.2%) and in 1989 (17%) and 1990 (33%) during a period of declining anchovy spawner biomass suggest some local recruitment of fish. The decrease of the penguin population at Dyer Island is likely to have been related to this decline. However, wide interannual fluctuations in abundance of anchovy during its decrease precludes correlation of abundance with estimates of penguin numbers.

(poster presentation)

**BREEDING SUCCESS AND BREEDING GROUP FEATURES IN ADELIE PENGUINS *PYGOSCELIS ADELIAE***

CLAUDIO A. AGUIRRE

*Instituto Antartico Argentino, Cerrito 1248, (1010) Buenos Aires, Argentina (c/o postmaster@mndian.gov.ar)*

In this paper I attempt to access the relationship between breeding group features and breeding success in Adélie Penguins *Pygoscelis adeliae*. For this purpose I surveyed 52 breeding groups out of a total of 55 at Stranger Point colony, King George Island, and estimated the

following variables for each breeding group: number of occupied nests (NOCUP), nests with eggs (NECH), adults at the laying peak (ADU1) and during creche stage (ADU2), pairs (PAIR), peripheral (NPER) and central (NECN) nests, chicks (CHICK) at creche stage, distance to the nearest breeding group (DNEAR), distance to the coast (DSEA), presence in the breeding group's area of Gentoo *P. papua* or Chinstrap *P. antarctica* Penguin breeding groups (PENG), of predator nests (PRED) and of seal colonies (SEALS). With these variables the following ratios were calculated: nests with eggs (NWE=NECH/NOCUP) and (PCR=NPER/NCEN) adults per nests at laying peak (APN=ADU1/NOCUP) and breeding success (BS=CHICK/NOCUP). BS correlated significantly with PCR and PENG. A multiple regression analysis showed that BS was associated significantly with PCR, PENG and NWE ( $F=7.567$ ,  $p=0.003$ ) in the following way (RPC and NWE were transformed by the neperian logarithm [ln] to increase the significance of the model):  $BS=1.038+1.425 \ln NWE - 0.109 \ln PCR+0.166 \text{ PENG}$ . Association between BS and NWE was foreseeable because the number of chicks produced by a breeding group is dependent on its proportion of nests with eggs. Association between BS and PCR was also expected by reason of the lower breeding success of peripheral nests when compared with central nests. Association of BS with PENG indicates that the presence of Gentoo or Chinstrap Penguin breeding groups would increase breeding success of Adélie Penguins nesting in the area.

(poster presentation)

#### ADVANCES IN BIOMECHANICAL STUDIES ON PENGUIN SWIMMING

RUDOLF BANNASCH

*Fachgebiet Bionik und Evolutionstechnik,  
Technische Universität Berlin, Ackerstrasse 71-  
76 (ACK1), D-13355 Berlin, Germany  
(bannasch@fb10.tu-berlin.de)*

My last Antarctic expedition focused on the collection of data to test current models on penguin swimming, which were developed combining functional morphological, kinematic and energetic analyses. In penguins departing to the open sea, the vertical and horizontal force components generated by the flippers were measured by acceleration sensors incorporated in a streamlined housing attached to the back of

the bird's body. Data could be recorded on-line at a rate of 500 samples per second. The experiment was repeated in a 21-m long swim canal and results confirmed that there were no differences to force generation in free-water tests. In the swim canal the high-resolution acceleration data could be linked exactly to the respective stroke phases (simultaneous video recording). In this way, new insights into the biomechanics of penguin swimming were obtained, and several unexpected effects were observed. In another set of experiments, a novel method for flow visualization of the vortex system generated by the flippers was developed. The most impressive sequences including visualization of the near wall flow along the body will be shown in the video presentation. The latter confirmed that the boundary layer become turbulent in the most frontal part of the bird's body. It will be shown that (and how) the structure of the turbulence can be managed by a number of passive as well as active mechanisms. The effect on drag reduction will be discussed considering also the ejection of air bubbles, which represent an effective measure to temporarily reduce body drag drastically. Thus, the presented material provides a number of new fundamentals for more advanced modelling.

(oral presentation)

#### THE EFFECT OF COLONY SIZE AND NEST POSITION ON BREEDING SUCCESS IN THE CHINSTRAP PENGUIN *PYGOSCELIS ANTARCTICA*

ANDRES BARBOSA, JUAN MORENO,  
JAIME POTTI & SANTIAGO MERINO

*Dept. Ecología Evolutiva, Museo Nacional de  
Ciencias Naturales, CSIC, C/ Jose Gutierrez  
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We studied the effect of colony size and nest position on breeding success (chick growth and mortality) in the Chinstrap Penguin *Pygoscelis antarctica*. Large colonies sited at Vapour Col, Deception Island, had higher breeding success than did small colonies. The small colonies suffered a higher chick mortality, mainly due to predation by skuas, than did large colonies. The impact of predation was higher on chicks than on eggs. Hatching date was earlier in large colonies. Small colonies had a higher proportion of asynchronous broods than did

large colonies. No relationships were found between both hatching date and hatching asynchrony and chick survival. No differences in chick mortality were found between central and peripheral nests in large colonies. Central nests hatched earlier and contained more asynchronous broods than did peripheral nests. No differences were found in chick size or sibling asymmetry between different-sized colonies or different nest positions. Nests in large colonies, whatever their position, are more successful due to reduced predation by skuas compared with nests in small colonies in the Chinstrap Penguin.

(*in-absentia* poster presentation)

#### HAEMATOLOGY OF AFRICAN PENGUINS IN THE WESTERN CAPE, SOUTH AFRICA

JILL BLACKBEARD<sup>1</sup> & J.-J. BROSSY<sup>2</sup>

<sup>1</sup>Department of Haematology, Groote Schuur Hospital, Observatory 7935, South Africa

<sup>2</sup>Department of Anatomy, University of Cape Town, Rondebosch 7700, South Africa  
([anaaf@anat.uct.ac.za](mailto:anaaf@anat.uct.ac.za))

The range of values obtained in 50 African or Jackass Penguins *Spheniscus demersus* will be illustrated. Differences noted in captive birds tested at SANCCOB (South African National Foundation for the Conservation of Coastal Birds) will be compared to penguins tested in wild colonies (mainly offshore). These results will be compared to values quoted for other species of penguins tested in Australasia. It will be shown that penguins with active avian malaria and babesiosis have significant variations from the normal range.

(poster presentation)

#### FORAGING OF MALE MAGELLANIC PENGUINS DURING INCUBATION AND CHICK-REARING: NEW RESULTS USING SATELLITE TELEMETRY

P. DEE BOERSMA AND DAVID L. STOKES

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([boersma@u.washington.edu](mailto:boersma@u.washington.edu))

We used satellite telemetry to determine foraging locations and behaviours of two male Magellanic Penguins *Spheniscus magellanicus* breeding at Punta Tombo, Argentina, during the egg incubation and chick-rearing periods of the 1995-96 breeding season. Both birds were experienced breeders (both banded as breeders more than 10 years prior to this study) and both had eggs or chicks in their nests during the study. One bird, which we began monitoring prior to its initial foraging trip during incubation of the eggs by the female, swam to a location more than 400 km northeast of the breeding colony during a 26-day foraging trip. On a subsequent trip the bird followed a course similar to that of its first trip. The second male, which we monitored from the time of the first male's second trip, swam over 150 km to the ENE on a nine-day foraging trip. This male also followed its first route on a subsequent shorter trip. In addition to foraging in different locations, the males exhibited different foraging patterns. During the period when the first male took one 18-day foraging trip, the second took six trips averaging 3.7 days in length. Furthermore, although most dives of both birds were very shallow ( $\leq 10$  m), the remaining dives of the first male were spread approximately equally across depths of 10-20, 20-40, and 40-80 m, whereas the dives of the second bird were concentrated at depths greater than 40 m. These results, based on only two individuals, must be considered preliminary; however they suggest that Magellanic Penguins forage farther from breeding colonies than was previously suspected. They also suggest that individuals follow particular foraging strategies and that these strategies differ among individuals within a given sex and age class (i.e. experienced male breeders).

(oral presentation)

#### EFFECTS OF HUMAN DISTURBANCE ON BREEDING BIOLOGY OF MAGELLANIC PENGUINS

P. DEE BOERSMA<sup>1,2</sup>, DAVID L. STOKES<sup>1,2</sup>  
& PABLO YORIO<sup>2</sup>

<sup>1</sup>*Department of Zoology, University of  
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(boersma@u.washington.edu)*

<sup>2</sup>*The Wildlife Conservation Society, Bronx Zoo,  
Bronx, New York 10460, USA*

The effect of human disturbance on wildlife populations is a growing concern. Recent evidence of researcher effects in Antarctic penguin species, along with rapidly increasing exposure of penguins to human activities associated with tourism, make it essential to understand the effects of human disturbance on penguin populations. Furthermore, the validity of scientific studies rests on an understanding of investigator effects and how they may influence results. Magellanic Penguins *Spheniscus magellanicus* at Punta Tombo, Argentina are an ideal population for investigating effects of human disturbance because they have been the subject of a long-term intensive scientific study that employs commonly used seabird research methods, and they are also an increasingly popular tourist attraction. Using data from six breeding seasons at Punta Tombo, we examined the effects of both research- and tourism-related disturbance on various aspects of penguin breeding biology, including egg hatching, chick growth, chick survival, fledging success, site fidelity, and mate fidelity. We found that our research programme appeared to affect negatively several breeding parameters of birds in study areas. Most of these effects were not due to obvious injuries to chicks and eggs caused by researchers, but were related to more subtle effects of nest visitation. Intensity of research activity (e.g. frequency of nest visits by researchers) and type of research activity to which the penguins were subjected (i.e. whether birds were handled or merely observed) also affected disturbance. Effects were more pronounced in years of poor food availability, suggesting that disturbance associated with our nest visits is greater when birds are in poor body condition. Exposure to tourists had little effect on penguin reproduction in areas where penguins had been subject to tourist activity for many years. This probably reflects the ability of penguins to become tolerant of humans.

However, tourism may affect nest settlement by penguins. The results of this study indicate that effects of human disturbance on penguins are subtle but significant. Such effects must be taken into account in planning a research or tourism programme, particularly if the subject of study is an endangered species or population.

(oral presentation)

**PENGUINS AS INDICATORS OF  
SOUTHERN OCEAN RESOURCES: KING  
PENGUIN *APTENODYTES PATAGONICUS*  
AT THE KERGUELEN ISLANDS**

C.A. BOST<sup>1</sup>, G. DUHAMEL<sup>2</sup> & M.  
KODIL<sup>3</sup>

<sup>1</sup>*Centre d'Ecologie et de Physiologie  
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<sup>2</sup>*Museum National d'Histoire Naturelle, 43 rue  
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<sup>3</sup>*COM, Campus de Luminy, Case 901, 163  
avenue Luminy, 13288 Marseille, France*

Since penguins rely on the main food resources of the Southern Ocean, knowledge of their feeding ecology may provide valuable information of prey availability. However, validation of the use of foraging parameters as reliable indicators remains a major challenge. In 1995, a cooperative project was undertaken during summer at Iles Kerguelen in order to compare the foraging activities of King Penguins *Aptenodytes patagonicus* with estimations of potential fish resources provided by a research vessel. Foraging activities were investigated by deploying on the same birds satellite transmitters, time depth-temperature recorders and ingested stomach-temperature loggers. Stomach samples were collected when the fitted birds returned to their colony. Real-time determination of myctophid fish abundance and distribution was performed as close as possible to the penguins' feeding areas during two sessions of five days. King Penguins foraged far from their colony, up to 406-km distance, and concentrated their foraging effort at specific areas close to the Antarctic Polar Front where food availability seems optimal. The depth of foraging as a function of time was closely related to the depth distribution of the main prey. Although myctophid abundance was

found to be the highest at the surface during the night, more than 80% of the prey ingestion events occurred during daylight and twilight hours. Penguin diet composition did not reflect the wide variety of myctophid species caught by net hauls during the night. Catch-per-unit effort of birds was compared with fish stock assessment. In addition to conventional means, monitoring of King Penguin foraging parameters can provide particularly useful indications of the distribution and availability of major mesopelagic fish over fine-to meso-scale areas.

(oral presentation)

#### RELEASE OF PENGUINS INTO THE WILD AFTER REHABILITATION: HOW SERIOUS ARE THE POTENTIAL PROBLEMS?

J.-J. BROSSY<sup>1</sup>, ANDREA L. PLÖS<sup>2</sup> & JILL BLACKBEARD<sup>3</sup>

<sup>1</sup>Department of Anatomy, Medical School, University of Cape Town, Rondebosch 7700, South Africa  
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<sup>2</sup>Department of Zoology, University of Cape Town, Rondebosch 7700, South Africa

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African Penguins *Spheniscus demersus* and other seabirds are regularly brought into rehabilitation centres such as SANCCOB (South African National Foundation for the Conservation of Coastal Birds) after injury and oiling. Recovery times vary from a few days up to several weeks. The birds are then released, either near where they were found or in groups from a chosen point which will give them the best opportunity to resume their life in the wild. During our study of penguins over the past five years we discovered that 25-50% of penguins kept in SANCCOB during the summer months developed peripheral parasitaemia with *Plasmodium relictum*. The mortality of this group was up to 50%. Investigating this further with an ELISA test, we found that 90+% of penguins in the

rehabilitation facility had antibodies to *Plasmodium*. This led us to research the status of the various wild colonies along the southern African coast. Tests showed that all the populations carried a variable incidence of positive ELISA results, ranging from 60-70%. Smears were also taken from all the birds tested, numbering about 800 at present. With two exceptions, no peripheral parasitaemia was found. The first exception was a bird tested on Robben Island, which had been released from SANCCOB the week before, and the second was from Boulders, which is a mainland colony. The latter was a ringed bird found dead on the beach. It is not clear whether this bird had been treated at SANCCOB. During these investigations we discovered that babesiosis is endemic in African Penguins and does not seem to affect their mortality or morbidity unless there is an additional stress factor. After careful investigation it was established that babesiosis had never before been described in penguins and we named the new organism *Babesia peircei*, after Michael Peirce, who has done much of the pioneering work on the piroplasm. Finally, on three successive years, we saw infection of small numbers of penguins with *Leucocytozoon tawaki*, previously only described in the Fiordland Crested Penguin *Eudyptes pachyrhynchus* in New Zealand. Leucocytozoonosis is a serious illness with high mortality. Its origin in African Penguins is not known at present. By contrast, we have found avian malaria in a number of common mainland flying birds, e.g. sparrows, flycatchers, bishop birds, prinias, to name but a few. The vector of *P. relictum* is a culicine mosquito, common in this area. Our conclusion is that over the past 20 years or so SANCCOB activities have effectively disseminated avian malaria throughout the southern African population of Jackass Penguins, whereas the disease was probably rare or even absent previously. Experience has now shown that recovery of population numbers after even severe disasters (e.g. the *Apollo Sea* oil spill) is excellent provided other conditions such as weather and availability of food remain favourable. Given the potential to devastate the population with the introduction of new diseases such as we have described, are our efforts to offer help justified? If so, should such efforts not be strictly under the control of scientific bodies

which may at least have an informed guess at the risks involved?

(poster presentation)

**LIGHT LEVELS AND THEIR EFFECTS  
ON THE FORAGING BEHAVIOUR OF  
LITTLE PENGUINS**

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The role of vision in the prey-catching behaviour of Little Penguins *Eudyptula minor* was tested using four captive penguins in a swimming pool. A live fish was placed in the pool with a penguin at various light intensities before and after dawn and dusk. The penguins' behaviour in the morning was the same as in the evening. As the light decreased, the percentage of fish chased by the penguins decreased, and no fish were caught at a light level less than 0.01  $\mu\text{Einsteins/m}^2/\text{s}$  (which occurs approximately 25 minutes before sunrise and after sunset at 37°S). The time the penguins spent searching for the fish also decreased with decreasing light. The probability of a penguin pursuing a fish was found to be dependent on the amount of light, such that  $\log_e(p/1-p) = 6.323 + 2.08 \times \log_e(\text{average light})$ , where  $p$  = the probability of pursuing a fish.

(oral presentation)

**CHANGES IN DEPTH UTILIZATION IN  
RELATION TO THE BREEDING STAGE:  
A CASE STUDY WITH THE KING  
PENGUIN *APTENODYTES PATAGONICUS***

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Impact of breeding constraints on foraging strategies of penguins have been poorly studied. We examined during two years the foraging behaviour of King Penguins *Aptenodytes patagonicus* during the incubating, brooding and creching periods at Iles Crozet, southern Indian Ocean. In this species, the non-synchronized breeding cycle make possible the simultaneous study of foraging behaviour at two breeding stages, thus allowing a comparison of different foraging activities at constant food availability. Diving behaviour was accessed using time-depth recorders attached to birds. When compared with birds with eggs ( $n=8$ ), birds at the brooding stage ( $n=6$ ) spent twice as much time below 30-m depth at night, dived 80 m deeper and stayed 100 minutes more per day at 141-270-m depth, whereas their foraging trip duration is halved. During the incubating and brooding periods, King Penguins exploit mainly the same frontal oceanic zone, but birds at the brooding stage facing a higher energy demand enhance their feeding efficiency by exploiting deeper waters. These changes in foraging behaviour are strongly related to the dependence of King Penguins on far-off mesopelagic fish patches, which are predictably distributed at the Antarctic Polar Front. Diving behaviour of birds at the brooding stage and of birds with creched chicks is also compared.

(oral presentation)

**THE USE OF IMPLANTED  
TRANSPONDER TAGS TO STUDY  
BURROW-NESTING PENGUINS**

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Most studies of nest attendance in colonies of burrow-nesting penguins necessitate the removal of birds from the burrow to read flipper bands. This method causes undesirable disturbance to the individuals and to the colony as a whole. The advent of transponder tags which may be



implanted in the birds has enabled a new approach to the study of nest attendance by birds. The aim of this study was to test transponder tags and develop protocols for their application in penguin research. Transponders (transmitter + responder) are passive identification devices which receive power from a tag reader and then send data back to the reader. We used implanted transponder tags (TIRIS, Texas Instruments) to record the daily attendance of 225 Little Penguins *Eudyptula minor* at Phillip Island, Australia. These birds were also banded. An automated tag reader was set up to record birds as they entered or left the colony and a portable tag reader was used to check individual nests each day. Transponders were injected subcutaneously between the penguins' scapulas. This injection site is preferred over the nape of the neck which is commonly used in such studies since there is less loose space between the skin and the muscles at this site. Consequently the transponder are unlikely to migrate from the injection site. Three tags were lost from the injection site and two tags malfunctioned. We found the application of surgical glue (Vetbond, 3M) to seal the injection site negates tag loss. The use of transponder tags enabled us to determine attendance patterns and foraging trip duration without further physical or visual contact with the birds and reduced by 75% the time required for nest checking.

(poster presentation)

#### ATTENDANCE PATTERNS OF LITTLE PENGUINS DURING THE BREEDING CYCLE

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Little Penguins *Eudyptula minor* breed asynchronously and visit their breeding grounds

throughout the year. The attendance patterns of individually identified Little Penguins were investigated on Phillip Island, Australia during the pre-breeding (winter), egg-laying, incubation and guard stages of the 1995/96 season. Birds were marked individually with transponder tags which were subcutaneously implanted between the scapulas. Bird presence in the colony was checked daily. Before their laying date, birds made on average 3.9 visits to their nesting site and remained ashore for 3.8 days on each visit. Total periods ashore (not consecutively) ranged from one to 31 days. Males spent a significantly longer time in the colony (15.0 days) than did females (11.4 days) before the laying date. Both males and females remained ashore for 5.0 days over their laying period. Eggs were incubated for 35.5 days (range 31 - 40 days, n = 100). Incubation spells lasted 3.4 days and the number of foraging trips averaged 5.6 trips per bird. After hatching parents guarded their chicks for a total of 14.5 days. Our results showed a significant difference in attendance patterns between successful and failed parents. Successful parents had shorter spells at the colony and more foraging trips than did failed birds during both incubation and chick-guard stages. Conversely, longer incubation shifts and fewer foraging trips during incubation were highly associated with poor breeding performance. Shift patterns changed dramatically at the beginning of November for both successful and failed groups. All birds started to spend longer periods at the colony and therefore longer foraging trips. Finally, the later in the season a Little Penguin started to breed the poorer its breeding performance.

(oral presentation)

#### A COMPARATIVE STUDY OF THE FORAGING STRATEGIES OF MALE AND FEMALE ADELIE PENGUINS

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Gender differences in the foraging behaviour of Adélie Penguins *Pygoscelis adeliae* were

studied at two widely separated Antarctic locations. Foraging trip durations, feeding localities and diet composition of breeding male and female penguins were compared over five chick-rearing periods at Bechervaise Island in eastern Antarctica and two at Edmonson Point in the Ross Sea. Greatest gender differences were found during the guard stage at both locations. Foraging trip durations were extracted from data collected by an automated penguin monitoring system and validated by manual observation. In most seasons at each location females spent significantly more time away from the nest than did males throughout the period when chicks were guarded by alternate parents. Mean guard stage trip durations ranged from 20-26 hours for males and 27-28 hours for females. Foraging locations were determined by satellite tracking at both locations. Birds tracked at Bechervaise Island over five seasons were shown to forage in two distinct zones, either foraging locally within 20 km of the colony or travelling 80-120 km to the edge of the continental shelf to feed. Ninety percent of trips made by males during the guard period were to local feeding grounds whereas the majority (54%) of female trips were to shelf-edge destinations. Once chicks were in creches both sexes made similar proportions of local and distant foraging trips. We could only demonstrate a single foraging zone at Edmonson Point; however, males still showed a tendency to range shorter distances than did females during the guard period. Total mass of stomach contents was generally greater for females than for males during the guard stage and the reverse applied during the creche period. Diet composition varied between seasons at both locations with krill, fish and amphipods being represented in varying proportions between seasons. Within seasons at both locations females Adélie Penguins captured greater proportions of krill, whereas males consumed more fish. These differences were consistent throughout each season although were not always statistically significant. The relationship of these results to gender differences in the energetic requirements of reproduction, the role of sex differences in the intraspecific partitioning of foraging and nest defence behaviours and the implications of gender effects for monitoring programmes such as the CCAMLR Ecosystem Monitoring Program (CEMP) are discussed.

(oral presentation)

#### IMPLANTED IDENTIFICATION TAGS IN PENGUINS

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Subcutaneously implanted passive transponder tags have proved to be a reliable way of identifying individual penguins by both manual and automated means. We have found the survival of tagged Adélie Penguins *Pygoscelis adeliae* over five seasons to be consistently higher than that of birds carrying flipper bands, although not statistically significant on an annual basis. There are, however, some problems associated with the use of implanted devices. The transponder removed from one bird had developed a slimy biofilm harbouring potentially pathogenic organisms incorporated at the time of implantation. If such contamination is common it is possible that the long-term survivorship of tagged groups of birds may actually be lower than that of untagged populations. Migration of tags away from the injection site may also compromise survival in some individuals. These risk factors could limit the use of implanted identification devices in long-lived or endangered species. Introduction of bacteria can be minimized (but perhaps not eliminated) by careful injection techniques and cleansing of instruments and skin with iodine or alcohol. The problem of tag migration is yet to be quantified and may be more difficult to overcome.

(poster presentation)

#### POSTFLEDGING MIGRATION OF ADELIE PENGUINS *PYGOSCELIS ADELIAE* IN THE PRYDZ BAY REGION OF EASTERN ANTARCTICA

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Three Adélie Penguin *Pygoscelis adeliae* fledglings were tracked using satellite telemetry following their first departure to sea. One bird fledged from Magnetic Island, Davis (68° 33'S, 77° 54'E) in February 1995 and was tracked for 32 days before transmissions stopped. The other two birds departed from Bechervaise Island, Mawson (67° 35'S, 62° 49'E) in late February 1996 and were tracked for eight(?) and 12(?) weeks, respectively. All three birds travelled westwards parallel to the coast at the level of the continental shelf break. Both fledglings from Mawson made an initial northern detour to 63°S (well north of the shelf break) before returning closer to the continent and moving westward. The birds had travelled up to 1000 km from their natal colonies by the time transmissions ceased. This poster illustrates the journeys of these fledglings in the context of ocean currents, bathymetry and sea ice extent. The tracks are compared and contrasted with those made by postmoult and breeding adult birds from the same region. All postmoult birds tracked to date at Mawson have travelled westwards in the west-wind drift at the fast ice margin, as have many breeding birds on their pre-moult foraging trips. Post-moult adults tracked in the Ross Sea have shown a similar tendency. Although it is possible that the Adélie Penguins of Eastern Antarctica are travelling to common overwinter feeding grounds as has been postulated for those in the Ross Sea, we believe it to be equally likely that the birds allow themselves to drift westwards in the ocean currents, foraging over the shelf as they go, before eventually turning around to return home. This would allow a more even spread of foraging pressure around the coastline in a region where no heavy concentrations of krill are known to exist and also provide the birds an opportunity to prospect potential foraging locations for their prebreeding effort in spring.

(poster presentation)

**REHABILITATION OF OILED  
PENGUINS: A COMPARISON OF SPILLS  
ON THREE CONTINENTS**

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In September 1992 the International Bird Rescue Research Center (IBRRC) was contacted and asked to assist in the cleaning and rehabilitation of oiled Magellanic Penguins *Spheniscus magellanicus* in Patagonia, Argentina, affected by a mystery spill. IBRRC responded by sending five members of IBRRC's Response Team to provide technical assistance and equipment to several local groups working to rehabilitate the penguins. In July 1994 IBRRC sent five team members to Cape Town, South Africa to observe techniques and exchange technical information with local groups caring for oiled African or Jackass Penguins *Spheniscus demersus* following the *Apollo Sea* spill. IBRRC personnel eventually became part of a management team with representatives of The South African National Foundation for the Conservation of Coastal Birds (SANCCOB), the Animal Rehabilitation Center (ARC) and Cape Nature Conservation that oversaw a rehabilitation effort that included nearly 10 000 oiled birds. In July 1995 the ore carrier *Iron Baron* went aground off the northeast coast of Tasmania, Australia resulting in the oiling of thousands of birds. IBRRC was asked by the spiller BHP to send a Response Team member to assist in the wildlife rescue effort. Over 2000 live birds, 95% of which were Little Penguins *Eudyptula minor*, were brought to the rehabilitation centre at Lowhead for care. Over 90% were eventually released. This paper will discuss the wildlife response in each of these spills as they pertain to penguins. It will compare the variables that affected the widely divergent release rates including, identification of a responsible party, agency involvement, physical & human resources, available facilities. Additionally it will discuss post release information and recommendations for future preparedness.

(oral presentation)

**BREEDING SUCCESS OF MACARONI  
AND ROCKHOPPER PENGUINS AT  
MARION ISLAND, 1979-1995**

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At Marion Island breeding success of Macaroni Penguins *Eudyptes chrysotopus* was measured at three colonies between 1979/80 and 1994/95 and Rockhopper Penguins *E. chrysocome* at three colonies between 1985/86 and 1994/95. For Macaroni Penguins, averages of 0.52 and 0.37 chicks were hatched and fledged, respectively, for each clutch laid. Average numbers of chicks hatched per clutch at colonies varied between 0.00 and 0.83, and average numbers of chicks fledged between 0.00 and 0.80. For Rockhopper Penguins, averages of 0.68 and 0.49 chicks were hatched and fledged, respectively, for each clutch laid. Average numbers of chicks hatched per clutch at colonies varied between 0.41 and 0.96, and average numbers of chicks fledged between 0.17 and 0.72. The largest of the three Macaroni Penguin colonies decreased over the study period; the other two remained stable. The only significant relationship between inter-season trends in the number of pairs breeding at the three colonies was a negative relationship between two adjacent colonies, which suggests pairs may have moved between these two colonies. The larger two of the three Rockhopper Penguin colonies both decreased over the study period; the other remained stable. Trends in the number of pairs breeding at the three colonies were all strongly significantly related. This suggests that the proportion of Rockhopper Penguins attempting breeding may vary as a result of some environmental signal, whereas there is little inter-season variation in numbers of Macaroni Penguins that attempt breeding. For Macaroni Penguins over the entire period, inter-season trends in breeding success were significantly correlated at the 5% level in two of the three inter-colony comparisons possible. From 1983/84, when monitoring was more intensive, all three comparisons were significant at the 5% level. Both hatching success and chick survival were significantly related at the 1% level in one inter-colony comparison. One other comparison of chick survival was significantly related at the 5% level. At all three Macaroni Penguin colonies, chick survival was poor in 1989/90. For Rockhopper Penguins, inter-

season trends in both breeding success and chick survival were significantly correlated in only one of the three inter-colony comparisons possible. No trends in hatching success were significantly correlated. Coherence in the performance of colonies was greater for Macaroni Penguins than for Rockhopper Penguins, suggesting that breeding success of Macaroni Penguins may be influenced by a wider-scale phenomenon than is applicable to Rockhopper Penguins. For both species coherence was primarily the result of similar trends in chick survival. Trends in breeding success, hatching success and chick survival of Macaroni Penguins and Rockhopper Penguins were not related to each other, even for nearby colonies. This suggests that factors influencing the reproductive performance of the two species are not the same.

(oral presentation)

#### DECREASE OF AFRICAN PENGUINS AT THE POSSESSION ISLAND GROUP, 1956-1995 - CONTRASTING TRENDS FOR COLONIAL AND SOLITARY BREEDERS

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Between 1956 and 1995, the African Penguin *Spheniscus demersus* population at Possession Island decreased by 96% from an estimated 23 245 breeding pairs to 895 pairs. At adjacent North Reef, African Penguins ceased breeding before December 1988. An estimated 850 pairs bred there in 1956. At Possession Island, an estimated 22 441 pairs of penguins bred colonially in 1956, but there were only 360 pairs in colonies in 1995, a decrease of 98%. By contrast, there were 804 solitary breeding pairs in 1956 and 535 in 1995, a decrease of 33%. All colonies at the southern portion of Possession Island and that at North Reef were abandoned by 1986. In the central and northern portions of Possession Island colonial breeding still persists, but as numbers have decreased colonies have fragmented. Minimal recruitment to the breeding population, probably resulting from food scarcity, is considered the most likely

reason for the long-term decrease in penguin numbers at the Possession Island group. Possible reasons for the contrasting trends of colonial and solitary breeders are considered.

(oral presentation)

**POPULATION DYNAMICS OF THE  
AFRICAN PENGUIN *SPHENISCUS*  
*DEMERSUS* AT ROBBEN ISLAND**

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African Penguins *Spheniscus demersus* recolonized Robben Island in 1983 when about nine pairs bred at the island. By 1996, the colony had grown to about 3100 pairs. Adult survival was probably 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 were assumed to be breeding at age five. The proportion of mature birds that bred in a year varied between about 0.70 and 1.00. During a breeding season, pairs laid their first clutches 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. Both fledging success and immigration of immature birds to the colony were significantly related to the spawner biomass of Cape Anchovy *Engraulis capensis*, the most important prey item of penguins at the island. Growth of the colony has been driven by immigration. Depending on the values assumed for survival of adults and first-year birds, 59-87% of new adults in the colony resulted from immigration. Several birds banded as chicks at Dassen and Dyer Islands were recorded breeding at Robben Island.

(oral presentation)

**SKUA-PENGUIN INTERACTION IN  
RELATION TO HUMAN ACTIVITIES**

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Among the speculated impacts of tourism on the Antarctic ecosystem has been the suggestion that an increase in human activity in the vicinity of a penguin colony would result in an increase in vulnerability of breeding penguins to skua predation. The aim of this study was to assess whether or not there is a change in the predation rates of South Polar *Catharacta maccorni* and hybrid South Polar x Subantarctic *C. antarctica* Skuas on Gentoo Penguins *Pygoscelis papua* during specified human activity in skua feeding territory areas. Having made some preliminary observations during the 1993-1994 season, the following study was carried out during the 1994-1995 austral summer. The study area was located at the northeastern edge of Cuverville Island (64° 42' S, 62° 38' W). Cuverville Island has one of the largest Gentoo Penguin colonies in Antarctica. It also is the breeding ground for an estimated 80-100 breeding pairs of South Polar and hybrid skuas. For several years the island has been a well known tourist destination receiving on average 2500 shipborne tourists a year. The Gentoo Penguin breeding population in the study area comprised approximately 2300 breeding pairs, (about half of the total population), with an estimated 80% of the total skua breeding territories on a steep cliff face overlooking the penguin colony. Despite this juxtaposition, only four to five breeding pairs of skuas held feeding territories in the penguin colony. The feeding territories used in this study were selected on the basis of penguin breeding group size and areas of varying intensity of both researcher and tourist activity. Following Emslie *et al.* (1994) monitoring of skua activity in the penguin colonies took place for two hours alternating sequentially between 0600-2000 each day, starting on 15 December and continuing until 15 February (126 hours in total). This time period enabled data collection covering egg incubation and

through hatching, brooding and creching stages. Monitoring also took place during 28 ship visits and during intrusive research activities within penguin breeding groups (35 hours total). During these times the numbers of visitors and researchers in defined sectors within the study area were also recorded. Behaviour categorization was a modification of that used by Young (1994-1970) and Emslie *et al.* (1994). Weather and other natural variables were also recorded. This provided a baseline from which to measure skua-penguin interaction during both visitor and researcher activities under different environmental conditions and specific situations, as well as during 'undisturbed' conditions.

(oral presentation)

### PENGUINS: PARADOXES AND PATTERNS

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Penguins are often considered to be as ecologically and behaviourally homogeneous as their morphology. However, their structural morphology and associated physiological adaptations are governed by the demands of operating as flightless, subsurface marine predators. Within the very strict constraints of this life-form, penguins in fact show considerable ecological and behavioural heterogeneity, although some of this relates to the range of latitudes and biotopes in which penguins breed. In this paper we: (1) briefly summarize and review some of the main features of the breeding biology, ecology and demography of penguins; (2) identify consistent patterns across species in the grouping of these features - and highlight anomalies; (3) suggest explanations/hypotheses for some of the potential links between ecology, behaviour and demography within this groupings; (4) investigate six topics containing potential paradoxes. These are: 1. **Migration**. At similar latitudes and in broadly equivalent biotopes, why are some penguin species migrants, (e.g. Emperor *Aptenodytes forsteri*, Magellanic *Spheniscus magellanicus*, crested

penguins *Eudyptes* spp.), whereas other species are year-round residents (e.g. African or Jackass *S. demersus*, Gentoo *Pygoscelis papua*, Little *Eudyptula minor* and Yellowed *Megadyptes antipodes*). 2. **Fasting**. Given that all species have very substantial capacities for storing body reserves, why do fasts ashore in the breeding season regularly last 25-40 days in some species (e.g. Adélie *P. adeliae*, Magellanic, King *A. patagonicus* and all crested penguins- not to mention c.100 days in male Emperor Penguins), whereas other species of similar size (e.g. Gentoo, Yellowed) undertake only very short (<3-day) fasts. 3. **Mate fidelity**. If maintenance of a pair-bond with the same individual across years enhances reproductive success, why do annual divorce rates range from <20% (e.g. Galapagos *S. mendiculus*, Gentoo, Magellanic, Yellowed) to >80% (e.g. Emperor, King). 4. **Brood reduction**. All penguins producing more than one egg, lay them about three days apart; a classic basis for subsequent brood reduction. However, in reality penguin species show a wide variety of outcomes, including brood reduction during incubation, invariable loss of one chick, typical, flexible brood reduction, and no evidence of brood reduction at all. 5. **Demography**. Why is there such variation in mean age at first breeding, ranging from three years (Gentoo, Little, Yellowed) through five to six years (Adélie, Emperor, King, Magellanic) to more than seven years (Macaroni *E. chrysolophus*, Royal *E. schlegeli*, Snares *E. robustus*), seems inconsistent with survival rates (longevity) or size. 6. **Breeding Season**. Why do some species take much longer to rear chicks to fledging than other species of similar size breeding at similar latitudes.

(oral presentation)

### VHF AND SATELLITE TELEMETRY OF HUMBOLDT PENGUINS IN NORTHERN CHILE

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Within the last few years, the Humboldt Penguin *Spheniscus humboldti* population has diminished dramatically over the whole range of the species. Humboldt Penguins form

colonies in the vicinity of marine areas of high productivity and high food availability. Unfortunately, the efforts of local fisheries also concentrate on these areas. It has been suggested that large numbers of Humboldt Penguins die at sea, entangled in nets, or starve to death, even during non-"EL Nino" years. We were able to determine for the first time how Humboldt Penguins on the Isla Pan de Azucar (26°S, 72°W) utilize their marine habitat and where their feeding areas lie. For this purpose we employed VHF-and Satellite Telemetry during the breeding seasons of 1994/95 and 1995/96. From VHF-telemetry we were able to determine travelling speed (1.1 m/s, n=173), dive time during travelling (10.6 ± 8 s, n=626) and during foraging (58.1 ± 18 s, n=339) and foraging areas within a 30-km radius of the island. From 1994/95 satellite telemetry (two birds) we obtained a comparison between early (November) and late (December) breeding seasons. Whereas penguins without chicks foraged within 8.8 ± 10.1 km of the island in November (n=18 days), their mean radius increased to 18 ± 17 km in December (n=20 days). Whereas birds foraged on average for 3.8 ± 4 h daily in November, diving activity was increased to 5.5 and 8 h (± 4 h), respectively in December. Simultaneous measurements of sea-surface temperature anomalies (NOAA) indicate that the increase in the foraging effort of Humboldt Penguins in December 1994 was paralleled by a slight El Nino. The data obtained during the 1995/96 breeding season showed no such trends.

(oral presentation)

**CORE TEMPERATURE VARIABILITY IN DIVING KING PENGUINS *APTENODYTES PATAGONICUS*: A PRELIMINARY ANALYSIS**

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Core temperature was determined in two free-living King Penguins *Aptenodytes patagonicus* at Ile la Possession, Crozet Islands, using implantable four-channel temperature loggers. Core temperatures derived from bird No. 1 (sensor placed under the sternum, in the vicinity of the liver and upper stomach) were closely correlated with diving activity (as determined by an external light recorder), and ranged from 38.3°C (on land) to a minimum of 37.2°C during a dive bout. Core temperatures measured in bird No. 2 showed that temperatures near the heart were generally 1°C lower than under the sternum or in the lower abdomen. Core temperatures declined continuously during dives (by 0.8, 1.2 and 2.7°C in the lower abdomen, under the sternum and near the heart, respectively) and showed precipitous drops to 35°C probably associated with food ingestion. Temperatures measured near the heart fluctuated with a period of 288 s, paralleling the duration (from literature) of the surface/dive cycle. The relevance of these findings with respect to diving physiology, blood perfusion of tissues, tissue metabolism and aerobic dive limits is discussed.

(oral presentation)

**LITTLE PENGUIN BREEDING AND SEA SURFACE TEMPERATURES**

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Based on 13 years data, several breeding parameters of Little Penguins *Eudyptula minor* at Phillip Island, Victoria, Australia are correlated with mean monthly sea-surface temperature (SST) in one-degree squares in and around Bass Strait. Highest correlations are in several months prior to breeding, with warm water proving more favorable conditions. A

Principal Components Analysis defines areas showing a similar SST profile, with four components accounting for 98% of the variance. Component 3, waters around Tasmania, provides the best predictor of breeding at Phillip Island. A similar analysis has been attempted with data from breeding parameters of penguin species elsewhere.

(oral presentation)

**SUPPLEMENTARY FEEDING OF  
PENGUIN CHICKS: ITS EFFECTS ON  
BREEDING SUCCESS AND PARENTAL  
SURVIVAL**

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Food availability is generally believed to limit chick growth and fledging success, at least in some years, and adults are thought to incur some cost of reproduction in terms of survival when food is limiting. Previous studies of breeding success and adult survival of Little Penguins *Eudyptula minor* at Phillip Island, Australia found that reproduction did not appear to influence adult survival. Providing food to chicks experimentally allows examination of both the effects of additional food on breeding success and, by reducing reproductive effort, on the cost of reproduction to adults. Chicks of Little Penguins on Phillip Island were provided with supplementary food in 1987/88 and 1992/93 and their masses and survival compared to those of control groups. In 1987/88, when breeding success for the whole colony was below average, and food presumed to be in short supply, the experimental group had a significantly higher fledging success than did the control group. The growth rates of both groups were similar until the young were six weeks old. Beyond this age, the masses of the control group decreased more than the experimental group and a significant number of control chicks died before fledging. In 1992/93, when breeding success overall was well above average, and food presumed to be more available than in 1987/88, fledging success did not vary significantly between the

two groups. Masses at fledging were significantly higher for the experimental group and post-fledging survival was estimated to be greater. The relative cost of reproduction to the parents of both groups in 1992/93 was estimated from their survival over the following two breeding seasons. The survival of the parents of both groups was not different, supporting previous studies suggesting that there was no cost of reproduction in Little Penguins.

(oral presentation)

**SURVIVAL AND MORTALITY IN A  
GROUP OF YELLOWEYED PENGUINS  
*MEGADYPTES ANTIPODES***

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The breeding performance of 244 known-sex Yelloweyed Penguins *Megadyptes antipodes* over 964 breeding attempts was monitored from 1982 to 1995. During this time there were two periods in which significant mortality of adults, chicks and juveniles occurred. In 1986, moderate losses were attributed to a diet switch and in 1990 to an outbreak of avian malaria in which over half of the adult mainland population of this species died. The mortality of females in both events (1986 and 1990) was significantly higher than was that of males. Deferred breeding is more likely to occur in females following a poor food year than in males. Deferment of breeding by males however occurs because of the death of their partners.

(oral presentation)

**INDUCTION OF MOULT IN CHINSTRAP  
PENGUINS *PYGOSCELIS ANTARCTICA* BY  
THE USE OF DEPO-PROVERA**



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In the late 1980s, 56% of the Chinstrap Penguins *Pygoscelis antarctica* on display at Sea World of California's Penguin Encounter were showing aberrant moult patterns. Several explanations were offered including unbalanced sex-ratio, disruption of normal routines due to relocation within the park, thyroid deficiency, overall poor health, and inconsistent light cycles. After restructuring the light cycles and intensities in the exhibit in 1990, many of the moult problems were resolved, confirming that light is an important component in maintaining healthy captive penguins. However, 10 birds remained that had failed to moult after this adjustment. Believing that mass gain also plays an important role in normal moult, we decided to induce mass gain in our non-moulting birds using medroxyprogesterone acetate (Depo-Provera). A series of five weekly injections of Depo-Provera were administered at 30 mg/kg beginning in November, giving the birds sufficient time to gain mass so they could moult in synchrony with the colony. Beginning this therapy in 1991 our results have been positive: nine of 11 birds have completed normal moults without any adverse side effects. Seven of the birds continue to moult seasonally without treatment. Four have shown breeding behavior and three have produced eggs. Whereas some of the birds have responded after only one season of treatment, others have required several years of injections before moulting normally.

(*in-absentia* poster presentation)

**A SUMMARY OF THE CAPTIVE  
MANAGEMENT OF PENGUINS IN  
NORTH AMERICAN ZOOS**

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This paper will review the status of captive management programmes for the 10 species of penguins currently maintained in North American zoos. Husbandry success has been variable from species to species. Successes and failures will be discussed. The American Zoo and Aquarium Association's (AZA) Penguin Taxon Advisory Group (TAG) has recently completed its first Regional Collection Plan (RCP). Objectives of the RCP will be explored.

(oral presentation)

**CONSERVATION BIOLOGY MEETS  
BEHAVIOURAL ECOLOGY: THE ROLE  
OF PARENTAL INVESTMENT THEORY  
IN THE MANAGEMENT OF AN  
ENDANGERED SPECIES OF PENGUIN**

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Yelloweyed Penguin *Megadyptes antipodes* parents are believed to be unable to adjust their current investment in offspring to match the availability of food. Increased adult mortality under adverse conditions has led to the suggestion that Yelloweyed Penguins incur a cost of reproduction in 'poor food' years and that such a cost could be avoided by relieving them of the burden of raising one of their chicks. We examined the effects of reducing brood size in Yelloweyed Penguins in order to determine (1) how reproductive costs may be expressed, and (2) whether brood reduction has the potential to relieve such costs. Our results

indicate that Yelloweyed Penguins appear to adjust their level of parental effort according to brood size, at least under favourable conditions of food supply. Moreover, parents of single-chick broods were in better condition than those raising twins and guarded their offspring for longer periods. Nevertheless, we found no significant effects of reducing brood size on adult survival or the frequency of juvenile resightings. However, if adult condition is sensitive to the effects of brood size this may have significant implications for their ability to survive postbreeding moult in years of low food availability.

(oral presentation)

**PENGUIN CONSERVATION  
ASSESSMENT AND MANAGEMENT  
PLAN: A PROGRESS REPORT**

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Just prior to the Second International Penguin Conference, a preliminary Penguin Conservation Assessment and Management Plan (CAMP) Workshop was held in Christchurch, New Zealand in 1992, coordinated by the Conservation Breeding Specialist Group (CBSG) of The World Conservation Union's (IUCN) Species Survival Commission. CAMPs are a first-cut assessment process that has been developed to identify those species requiring immediate conservation action. More than 40 CAMPs have been conducted by the CBSG to date on a wide range of taxa and regions. Since the Christchurch workshop, the texts for Antarctic and sub-Antarctic penguin species have been partially revised through the efforts of the Scientific Committee on Antarctic Research Bird Biology Subcommittee (SCAR-BBS). To update the information from the first Penguin CAMP, a recent review of the texts produced at the first meeting for the more northerly penguin species has been undertaken by an international panel of marine ornithologists. To take advantage of the expertise present at the Third International

Penguin Conference, these revised texts, combined with those produced by the SCAR-BBS, will be discussed and further revised at a second Penguin CAMP Workshop, to be held immediately after the conference, with attendance by invitation.

(oral presentation)

**STRANDINGS OF AFRICAN PENGUINS  
ALONG THE KWA-ZULU/NATAL  
COAST, 1981-1995**

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The coast of KwaZulu-Natal falls outside the normal range of distribution of the African Penguin *Spheniscus demersus*. However, every year a number of these birds is found stranded along this coast. These birds are collected by Sea World and rehabilitated either for release or for integration into the captive breeding colony. The data presented show the monthly and annual frequency of strandings as well as the condition of the animals when found.

(poster presentation)

**TEMPORAL AND SPATIAL VARIATION  
IN BREEDING SUCCESS OF THE LITTLE  
PENGUIN *EUDYPTULA MINOR* ON THE  
EAST COAST OF AUSTRALIA**

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A ten-year study of the Little Penguin *Eudyptula minor* on Bowen Island has revealed comparatively high breeding success for this large colony towards the northern limit of the range of the species. Similarly high success has been found at nearby Lion Island. Whereas

prone to episodic wide-scale effects of ocean and climate which influence breeding success of colonies on the east coast of Australia, mean breeding success for first broods of the Bowen colony is 1.23 chicks/pair which is the highest recorded for the species, and 20% of pairs laid second broods in the same season. High-quality nesting habitat contributes to higher breeding success, but reduced foraging ranges during critical stages of the breeding cycle compared with other colonies in the south suggest regional oceanographic characteristics influencing temporal and spatial distribution of major diet items is an important factor. This study is continuing, and early results are presented.

(oral presentation)

**ECOTOURISM, FIELD STUDIES AND STRESS: BEHAVIOURAL AND HORMONAL RESPONSES OF MAGELLANIC PENGUINS TO NEST SITE DISTURBANCES**

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Seabird colonies can be tourist attractions, and often receive many visitors, but human visitation at nest sites poses many potential problems for breeding birds. I studied behavioural and hormonal responses to nest visits at a Magellanic Penguin *Spheniscus magellanicus* colony, in three areas with very different histories and rates of human visitation. One area (TOURIST) received many visits daily and had done so for many years. The other two (STUDY and CONTROL) received a single daily visit for two years, or none at all, respectively, prior to this study. I visited nests for five minutes and collected behavioural data and then collected a blood sample to assess levels of corticosterone as an indicator of stress. STUDY and CONTROL area birds did not differ in either behavioural or hormonal responses, but both differed strongly from TOURIST area birds, which exhibited fewer alarm behaviours and had lower corticosterone titres. Penguins appear to habituate to constant

high levels of visitation, but not to less constant (even though regular) visitations. These results suggest that tourism should be concentrated in as small an area as possible, allowing the visited birds to habituate to humans, while leaving the majority of the colony undisturbed.

(poster presentation)

**LONG-TERM PAIR BONDS, COORDINATION OF INCUBATION TURNS AND PHYSIOLOGICAL SYNCHRONY IN THE MAGELLANIC PENGUIN**

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Long-term pair bonds (LTPBs) have long been associated with enhanced behavioural and physiological synchrony in pairs that remained faithful across breeding seasons yet little evidence exists as to such an association. We studied the ecological and endocrinological correlates of long-term mate fidelity in Magellanic Penguins *Spheniscus magellanicus* breeding at Punta Tombo, Chubut, Argentina. Long-term (OLD) pairs had higher reproductive success than did newly formed pairs of either experienced breeders (NEW pairs) or that included a first time breeder (YOUNG pairs). OLD pairs had better coordination between the sexes of parental duties at hatching than did YOUNG pairs. Too few clutches of NEW pairs survived to hatching for analysis. In OLD pairs, sex steroid hormone levels were elevated after arrival at the colony but declined in both sexes prior to laying the final egg. However, in NEW and YOUNG pairs, both males and females had elevated levels of estradiol (associated with copulation in both sexes and egg formation in females) until later in the laying cycle. These results are some of the first to demonstrate directly an association between LTPBs and physiological synchrony in any avian species.

(poster presentation)

**THE THREE DIMENSIONAL FORAGING PATTERNS OF ADELIE PENGUINS AT EDMONSON POINT, ANTARCTICA**

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The foraging behaviour of Adélie Penguins *Pygoscelis adeliae* rearing chicks was studied at Edmonson Point, Ross Sea region, Antarctica over the 1994/95 and 1995/96 breeding seasons. Time-depth recorders and satellite tracking devices were both employed to obtain a picture of both foraging distribution and foraging depth. Food samples were collected from birds returning to their colony. The principal food item in both seasons was fish. *Euphausia superba* and *E. crystallarophias* were also present as conspicuous food items.

(poster presentation)

**BREEDING ECOLOGY OF THE MAGELLANIC PENGUIN *SPHENISCUS MAGELLANICUS* AT CABO VIRGENES COLONY, ARGENTINA: WHAT REGULATES REPRODUCTIVE SUCCESS?**

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The high variability in the reproductive success of seabirds has important implications for their conservation. Food availability, annual changes in predation rates and changes in weather conditions are the main factors affecting seabird breeding success. We studied the possible factors that determine the annual variation in the reproductive success of Magellanic Penguins *Spheniscus magellanicus* at Cabo Virgenes, Argentina. This study was based on three breeding seasons (1989/90, 1990/91 and 1991/92). Six areas containing approximately 160 active nests were established. Reproductive success, measured by the number of chicks fledged per active nest, was highly variable among years (0.83, 0.19 and 0.58). During the three seasons, the hatching and fledging masses, feeding frequency, number of chicks starved, chicks growth curves, proportion of nest with two fledgling and the length of the nestling period did not change significantly. On the other hand, nest predation rate, nest desertion and the weather conditions (winds, minimum temperatures, storms and snowfalls) showed high variability among breeding seasons. Our results suggest that food availability does not explain variations in breeding success at the Cabo Virgenes colony. Therefore, extremes in weather conditions and fluctuations in egg predation by Kelp Gulls *Larus dominicanus* are important factors influencing annual variation in Magellanic Penguin reproductive success at this colony.

(poster presentation)

**ADELIE PENGUIN CHICK DEATHS AT MAWSON - IMPLICATION FOR MONITORING OF DISEASE**

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Two occurrences of mass mortality of chicks of Adélie Penguins *Pygoscelis adeliae* have been recorded near Mawson and are compared and contrasted in order to raise the options for management if an outbreak of disease is suspected. The first occurred at Low Tongue in February 1972. On this occasion only a single visit was made and no samples were collected for pathological examination. Sixty-five per cent of the total chick population had recently died. Moribund chicks exhibited neurological symptoms. Mortality was confined to this colony. The cause of death remains unknown. The second occurrence was at Bechervaise Island, the site of a CCAMLR ecosystem monitoring programme, and surrounding islands in 1995 where about 15 000 chicks died. Mortality occurred over a six-week period and by mid-February all chicks on Bechervaise Island and in the region were dead. Tissues were collected for virus isolation and histopathology. Swabs of the cloaca were taken from adults and live chicks for isolation of viruses and *Chlamydia* sp. However, morphometric measurements, gross pathology and histopathology results coupled with ecological data indicated that starvation was the principal cause of the deaths. If a single visit had been made to a colony at any time during this period it is likely that the cause of death would have also been assigned to disease. These examples of high mortality of penguins demonstrate the need for systematic and thorough investigation of any suspected disease outbreaks. They also raise the important question of how we should react to disease outbreaks in the Antarctic whether or not they are naturally occurring or are a result of human activity. This is on a background of little knowledge of status and epidemiology of disease in birds in Antarctica

(oral presentation)

**THE EFFECTS OF HUMAN ACTIVITY ON  
THE BEHAVIOUR, HEART RATE AND  
BODY TEMPERATURE OF BREEDING  
ADELIE PENGUINS *PYGOSCELIS  
ADELIAE*: IMPLICATIONS FOR  
MONITORING**

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There is an increasing need for experimental research into the effects of human activity on Antarctic wildlife, since this can be a constructive way of addressing specific, management-oriented questions. A prerequisite for such studies though, is to consider how the methods used to measure responses to disturbance might themselves bias results or harm the animals. As part of a study into the affects of pedestrian, human approaches on the behaviour, physiology and breeding success of Adélie Penguins *Pygoscelis adeliae*, I first quantified the affects of wearing external electrocardiogram (ECG) devices and internal stomach temperature recorders (STRs) on the birds behaviour and heart rates. No significant difference was detected between the behaviour of birds that were handled and subsequently wore ECG devices and those that had never been handled. However, birds that were fitted with both ECG devices and STRs behaved differently to unhandled penguins. The resting heart rates of penguins wearing both ECG devices and STRs was significantly higher than those wearing only STRs. To detect any effects on penguin heart rate of wearing ECG devices, "egg-microphones" were also used to record pulse, since these did not require handling of the penguins. No significant difference was found in the mean, resting heart rates of penguins whose pulse was recorded using ECG devices ( $82 \pm 12$  bpm,  $n = 17$ ) and those whose pulse was recorded using egg-microphones ( $82 \pm 8$  bpm,  $n = 10$ ). Whereas it is essential to minimize investigator disturbance, particularly when conducting research into the effects of other types of human activity, results here suggest that where appropriate care is taken to allow birds to acclimate to wearing devices, and where studies are designed such that birds can act as their own controls, the compounding effects of investigator disturbance can be minimized and/or accounted for during human-impacts research.

(poster presentation)

**MINIMUM APPROACH DISTANCES FOR VISITORS TO BREEDING ADÉLIE PENGUINS *PYGOSCELIS ADELIAE***

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Many Antarctic travellers are informed that minimum approach distances of 5 m are acceptable when observing and photographing breeding penguins, yet the appropriateness of this distance, in terms of minimizing disturbance to breeding animals, has never been scientifically assessed. Accordingly, I employed manipulative experiments, in conjunction with statistical power analysis, to quantify the effects of controlled, human approaches on breeding Adélie Penguins *Pygoscelis adellae* during the incubation and guard phases of the birds' breeding cycle. The aim was to contribute to the development of visitor codes of conduct by determining minimum, safe approach distances for people visiting penguin colonies. Three minimum distances were tested, 5 m, 15 m and 30 m and the responses of penguins were assessed by measuring the behaviour, heart rate and body temperature of individual birds. Approaches to 5 m by a single human interrupted incubation, causing adults to stand and expose eggs. Birds approached to this distance were also more vigilant and displayed agonistic acts more frequently than when approached to other distances or when un-disturbed (control). The heart rates of penguins increased significantly from a resting rate of 82 beats per minute (bpm) to 126 bpm. This was significantly higher than the pulse rate recorded when penguins were exposed to natural disturbances either from interactions with conspecifics (115 bpm) or South Polar Skuas *Catharacta mackormicki* (109 bpm). Approaches to 15 m from incubating penguins caused their heart rates to increase significantly above resting rates, yet there was no observable change in behaviour. This result reinforces the value of taking concurrent measures of behaviour and physiology during human impacts studies. Approaches to 30 m had no measurable effect on either the behaviour or heart rate of

penguins. The body temperatures of penguins were not affected by human approach, irrespective of approach distance. Significant differences were, however, detected between the responses of penguins approached during the incubation phase and those approached during the guard phase.

(poster presentation)

**CAPE FUR SEALS PREYING UPON AFRICAN PENGUINS AT DYER ISLAND, SOUTH AFRICA**

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Dyer Island has been an important African Penguin *Spheniscus demersus* breeding locality in terms of its geographical position within the species range and the number of breeding pairs it supported. Penguin numbers have decreased dramatically over the past 20 years. In the same period numbers of Cape Fur Seals *Arctocephalus pusillus* have risen substantially on immediately adjacent Geyser Island. Witnessing of seals preying upon penguins just off Dyer Island led to regular checking for, and recovery of, penguin carcasses. Almost 300 penguin carcasses were found in three months. Allowing for seasonal change in penguin numbers it is estimated that some 1000 penguins are killed by seals annually around Dyer Island. At this rate Dyer Island would cease to be a penguin breeding colony within 5-10 years. The fur seals also prey on other seabirds at Dyer Island, especially fledging cormorants. As a preliminary response to this situation the local conservation agency plans to shoot seals witnessed killing seabirds.

(poster presentation)

**STATUS OF THE AFRICAN PENGUIN IN EUROPE, WITH SPECIAL ATTENTION TO THE SUCCESSFUL BREEDING AT AMSTERDAM ZOO**

## JAAP GOVERS

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The European Association of Zoological Parks and Aquariums makes proposals of breeding programmes for species who are endangered in captivity as well as in the wild. In 1994 a European Endangered Species Programme was started for the African or Blackfooted Penguin *Spheniscus demersus*. An inventory was made of collections in all European Zoos. One of the goals is to start a successful breeding programme. The Amsterdam Zoo was appointed as studbook keeper and species coordinator, because of it having the most experience and the best breeding results. Since 1975 the Amsterdam Zoo has hatched c. 1200 penguins, who are distributed all over the world.

(oral presentation)

**THE FORAGING ZONES OF ROYAL  
PENGUINS *EUDYPTES SCHLEGELI*  
DURING THE BREEDING SEASON: A  
PRELIMINARY SATELLITE TRACKING  
STUDY**

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Satellite transmitters were deployed on breeding Royal Penguins *Eudyptes schlegeli* during four stages (first male foraging trip during incubation, first female foraging trip during incubation, guard and early creche) of the 1994/5 and 1995/6 breeding seasons. Data were filtered to remove aberrant locations and a maximum expected swimming speed of 10 km/h calculated from the most accurate location classes. Foraging trip length, speed and distance travelled were compared at different times of the breeding season. Foraging trip length and distance travelled were greatest during the incubation and shortest during guard

stages of the breeding season. The location and utilization of foraging zones were described using an Adaptive Kernel analysis. Sea-surface temperature and bathymetry were compared in these zones. The foraging zones of Royal Penguins vary during the breeding season, and on longer foraging trips coincide with a permanent eddy structure to the south-east of Macquarie Island, which is thought to be a region of high productivity. It is suggested that the foraging zones of Royal Penguins are regularly associated with such permanent structures, the locations of which influence the foraging ranges of Royal Penguins.

(oral presentation)

**THE POPULATION STATUS OF  
SOUTHERN ROCKHOPPER PENGUINS  
*EUDYPTES CHRYSOCOME FILHOLI* IN  
THE PACIFIC SECTOR**

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The Southern Rockhopper Penguin *Eudyptes chrysocome filholi* has exhibited a decrease of 94% in population size at its former stronghold, Campbell Island. This decrease is thought to be linked to increases in sea-surface temperature, which may have affected the distribution of prey species. The status of Rockhopper Penguin populations is unknown at Macquarie Island as there have never been systematic surveys undertaken. As sea-surface temperatures have also risen at Macquarie Island, it is possible that the same scenario as Campbell Island may occur, or is occurring. For these reasons a collaborative programme is being established between Macquarie and Campbell Island in order to: (1) determine the population status at Macquarie Island; (2) further monitor the status at Campbell Island; and (3) compare foraging

behaviours and breeding biology between these two sites in order to explore the reasons for the population decrease at Campbell Island. Aspects to be examined in the third part of the programme include: breeding biology (chick growth rates, fledging masses, breeding success, parental attendance times), foraging zones and behaviour (using satellite telemetry and Time Depth Recorders), diet, foraging energetics (using tritiated water) and trophic relationships (using stable isotopes). It is suggested that other sites be included in a circumpolar collaborative project assessing the status of Rockhopper Penguin populations.

(poster presentation)

#### ASSIMILATION EFFICIENCIES OF PENGUINS AND OTHER SEABIRDS IN RELATION TO DIET AND PREY COMPOSITION

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Energy, lipid and calcium assimilation efficiencies (AE), were experimentally determined for three prey types fed to seven seabird species: three penguins, a gannet, and three procellariiforms. Apparent metabolizable energy coefficients (MEC\*) were compared with values predicted on the basis of food composition and endogenous energy and nitrogen losses. MEC\* does not appear to be higher for prey types favoured by naturally foraging birds, and is remarkably similar across all species and all foods despite differences in food composition and in the dietary preferences of the birds. This similarity may reflect "digestive opportunism" in pelagic seabirds feeding on unpredictable prey. Immature albatrosses assimilated calcium more efficiently than did adult conspecifics, presumably to supply growth needs. Penguins that had just

finished moult exhibited higher MEC\*s, and calcium AEs than did prelaying birds under less energetic stress, presumably to make good the energy and nutrient deficit incurred during moult. Surprisingly, energy AE and MEC\* are unrelated to mean retention times of solid digesta in seabird guts. MEC\* of squid is correlated with hindgut surface area, which in turn scales with body mass. Measurements of villus area for seabird guts are needed to investigate the relationship between AE, gut surface area, and body mass. Meal mass may be inversely related to energy AE, and the relationship between meal mass and MEC\* shows that the wet mass of meals fed to experimental birds should not be below 6.5% of bird body mass. Differences in bird body mass and in the duration of experiments may influence commonly used estimates of AE. Interspecific comparisons of MEC\*, a parameter which takes endogenous losses of energy and nitrogen into account, are thus more meaningful than are comparisons of AE calculated simply on the basis of energy intake and excretion. The overall mean value of MEC\* was 75%, close to previously published values for marine predatory birds, suggesting that the assimilation efficiency of 75% hitherto frequently assumed in seabird consumption and energetics models is adequate.

(poster presentation)

#### REHABILITATION OF LITTLE PENGUINS *EUDYPTULA MINOR* AT PHILLIP ISLAND, VICTORIA, AUSTRALIA

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Over 760 Little Penguins *Eudyptula minor* have been treated for injury and illness at the Phillip Island Penguin Reserve over the last four years. The major causes of admittance were pre- and post-moult starvation, starvation of juveniles and oiled plumage. Trends in the causes of admittance will be discussed. Analysis of the success of rehabilitating oiled birds from oil



spills dating back to 1990 have been undertaken. Likely outcomes based on degree of oiling, mass and sex have been determined. Implications of rehabilitation of these birds will be discussed.

(oral presentation)

#### ECOLOGY OF BLOOD-INHABITING PARASITES IN FREE-LIVING PENGUINS

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Blood-inhabiting protozoa and helminths are transmitted by arthropod vectors, and are widespread in many orders of birds. They are however infrequent in seabirds, shorebirds and penguins. We have examined thin blood smears (fixed in 100% methanol and stained with Giemsa) from eight species of penguins in the wild: King *Aptenodytes patagonicus* (n=42), Emperor *A. forsteri* (n=50), Adélie *Pygoscelis adeliae* (n=30), Gentoo *P. papua* (n=15), Macaroni *Eudyptes chrysolophus* (n=12), Snares Crested *E. schlegeli* (n=28), Little *Eudyptula minor* (n=197) and Humboldt *Spheniscus humboldti* (n=18). We identified *Trypanosoma eudyptulae* from the Little Penguin in Tasmania. Two other protozoan species have been described previously from penguins in temperate habitats - *Leucozytozoon* sp. from Fiordland Crested Penguin *E. pachyrhynchus* in New Zealand, and *Plasmodium* sp. from African or Jackass *S. demersus* in South Africa. There have been no reports of blood parasites from penguins in sub-Antarctic or Antarctic habitats. The presence of blood protozoa in other sub-Antarctic seabirds (albatrosses *Diomedea* spp.), suggests that potentially suitable vectors may be present in these environments. In this paper we examine the parameters which determine infection of penguins with blood-inhabiting

parasites, and postulate that their absence in Antarctic and sub-Antarctic penguins may be due to a combination of vector availability and density, parasite longevity, and the long periods which these penguins spend at sea, away from sources of infection.

(oral presentation)

#### HOW CAN KING PENGUINS *APTENODYTES PATAGONICUS* CHICKS IDENTIFY ADULT CALLS IN THE NOISY ENVIRONMENT OF A COLONY?

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All marine birds are monogamous. This is due to continuous feeding trips between sea and breeding grounds, both sexes brooding and rearing the chicks. The majority of species are colonial and the partner, coming back among numerous nests, must be identified by its mate or young. In the penguin family, the individual recognition seems particularly difficult because colonies total usually several thousands nests. Moreover, the identification occurs in a particularly noisy environment, not using visual and olfactory but vocal cues. In the genus *Aptenodytes* the difficulty is enhanced because they have no nests, breeders carrying the egg or chick on their feet. So, they have few or any landmarks to find their partner and they constitute good models to study acoustic recognition. The King Penguin *A. patagonicus* breeds in dense colonies (0.5 pairs.m<sup>2</sup>) counting from a few hundreds to 300 000 pairs, on flat and quite greves of subantarctic islands. This large bird, 0.9 m height and 12 kg mass, incubates on its feet its single egg, then its small chick, without a fixed nest site. When big enough, the chick waits alone both parents fishing as far as 500 km and as deep as 300 m. The first detailed study proved by banding that fidelity occurs between mates and between parents and chick during the breeding season. Derenne *et al* (1979) demonstrated that songs have different patterns according to the sex. Jouventin (1982) analysed the song of different

individuals and conducted experiments on individual recognition in natural conditions between adults and between parents and chicks. Robisson (1992) demonstrated that frequency parameters were important for signal recognition in pairs. But parent-offspring recognition was poorly studied in this species although the identification of parents by chick has a survival value. The adult identifies its partner, mate or chick, for a breeding purpose, but the chick identifying its parents allow its feeding i.e. its survival. The adult coming back from fishing grounds calls, trying to locate its chick in the vicinity of the past brooding area. The whole breeding cycle spends more than one year for a pair and his species being poorly synchronized, the previous breeding area is then occupied by a new wave of brooders. During nearly six months, breeders succeed each after others and push outside the brooding area chicks emancipated from the parent has to search for its chick among several ten or hundred foreign chicks in the surrounding area. Consequently the rendezvous site moved. The chick waits near the old breeding zone and calls in reply to the adult signals, running towards its parent to beg for food. So the parent call has to be distinguished among numerous calls of other parents and chicks, but also among numerous displaying calls of mating pairs. In addition to these parasitic noises the recognition process is perturbed by propagation problems due to the screen of bird bodies and thus constitutes a particularly difficult problem of acoustic communication in an extreme colonial environment. To study this problem of parents' recognition by the chick in a high level ambient noise, we have quantified some of the problems which the chick must solve.

(oral presentation)

#### WHERE DO ADELIE PENGUIN CHICKS GO?

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Adélie Penguins *Pygoscelis adellae* are highly philopatric to their natal colony but seldom return before the age of two. Several large colonies of Adélie Penguins breed on the Antarctic Peninsula. Although it is well known that adults winter on the edge of the pack ice, it has not been known where juveniles from the peninsula go during the winter period. We conducted seabird censuses during daylight hours in the Bellingshausen Sea from 26 August to 23 September 1993, on board the rv *Polar Duke*. The transects covered the area between 64-68°S and 64-72°W. We encountered 123 Adélie Penguins and made the first observations on the pelagic distribution of juveniles. Like adults, juveniles were associated predominantly with permanent ice. Although juveniles tended to make up a greater proportion of the Adélie Penguins found in the northern part of the study area, the high proportion of adults in the southern region was possibly a result of the close proximity to Adelaide Island breeding colonies. Juveniles were found for the most part in small groups by themselves and were associated with the northern boundary of permanent pack ice. It is possible that the differences in distributions between the age classes could be related to differences in habitat preference or dispersal tendency.

(in-absentia poster presentation)

#### FACTORS CONTROLLING THE TIMING OF BREEDING OF THE ADELIE PENGUIN IN EASTERN ANTARCTICA

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The Adélie Penguin *Pygoscelis adellae* breeds in geographically discrete colonies that are found around the coastline of Antarctica. Its breeding cycle is highly synchronous with 90% of eggs laid within an eight-day period and laying complete within 18 days. The timing of the breeding season varies little at specific sites but differs between sites. At Bechervaise Island near Mawson the date of the first egg and the

peak of laying varied by only six days over a six-year period. Similar observations have been made at Signy Island at the tip of the Antarctic Peninsula and at Cape Bird in the Ross Sea. The timing of breeding between locations around the continent is related to some extent to latitude with colonies farther south tending to breed later. We have observed, however, that birds at Davis (68° 55'S) breed eight days earlier than do those at Mawson (67° 58'S) and four days earlier than those at Edmonson Point (74° 33'S). Additional factors are thus required to explain these and other variations. We have studied the breeding biology and foraging ecology of the Adélie Penguin for several years at a number of widely spaced locations along the Antarctic coastline between 60°E and 165°E including Mawson, Davis, Casey and Edmonson Point. Breeding chronology, incubation shifts and foraging-trip duration and range have been recorded and food brought into the colony by birds feeding chicks examined. Ice conditions at the coast and over the wider foraging ranges have also been recorded. We use these data to investigate which factors play a role in controlling or modifying the timing of breeding and discuss the possibility that distinct breeding groups, genetically isolated by virtue of differences in timing of the onset of breeding, may occur around the continent.

(oral presentation)

#### HUDDLING AND BASKING BY EMPEROR PENGUINS

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Between May and October 1993, temperature sensors attached to the backs of 64 foraging Emperor Penguins *Aptenodytes forsteri* from the Auster colony on the Mawson coast of Antarctica recorded ambient sea temperatures of -1.5° to 4°C and ambient air temperatures below -2.3°C (the lower limit of the sensors). Ambient air temperatures at the Auster colony over the same time period ranged between -32° to +18°C. However, temperatures recorded by

the sensors on the penguins' backs occasionally rose above zero and at times reached 23°C (the upper limit of the sensors). Light sensors attached to the temperature sensors showed that the higher temperatures coincided with periods of either low light levels or high light levels. We assume the high temperatures and low light levels reflected times when the birds were huddling, while the high temperatures and high light levels occurred when the birds were basking in sunshine. During huddling events at colonies, Emperor Penguins may reduce their metabolic heat production by up to 50% and halve their rate of mass loss. Huddling and basking behaviours may reduce the energetic demands of Emperor Penguins at sea and have not previously been recorded.

(poster presentation)

#### THE FORAGING ECOLOGY OF FEMALE EMPEROR PENGUINS IN WINTER

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The foraging location, diving behaviour, dietary composition and feeding rates of female Emperor Penguins *Aptenodytes forsteri* from the Auster and Taylor Glacier colonies in Antarctica were investigated during the 1993 austral winter. The study was conducted between late May and early August when male Emperor Penguins remain at the colonies to incubate eggs and females forage at sea for self maintenance. During winter, two satellite-tracked penguins from Auster foraged approximately 100 km northeast of the colony in open water over the outer continental shelf in water between 200-500 m deep. Ten Auster and four Taylor Glacier penguins that carried time-depth recorders took about 8 d to reach the ice-edge, spent 60-70 d at sea foraging and took 4 d to return across the fast-ice to the colony. The penguins foraged during an average of 93.2% of their days at sea and rested on the remainder. On each foraging day penguins usually entered the water just after dawn and averaged 4.71 h in

the water before exiting at dusk. Hourly dive rate was constant throughout winter but daily dive rate increased as day length increased, suggesting day length is a primary determinant of hunting effort. Penguins foraged on 47% of dives, the rest being travel, recovery or search dives, and made on average 26 foraging dives per day. Females from Auster targeted prey at water depths of 20-70 m and 100-150 m whereas Taylor Glacier birds targeted prey at depths of 10-70 m, 250-300 m and 330-400 m, suggesting between-colony differences in the prey distribution. The stomach contents of 17 females returning to Auster to brood their chicks were dominated by Antarctic Krill *Euphausia superba* (70% by mass) and Antarctic Silverfish *Pleurogramma antarcticum* (13% by mass). We estimated the relative proportions of prey components in the diet by two techniques: a subjective assessment of prey soft tissue and an quantitative analysis of prey hard parts. The former technique presumably reflected the diet intended for the chick whereas the latter may have reflected the adult's diet over several days or weeks prior to returning to the colony. The soft tissue analysis indicated a diet of 58% fish, 7% squid and 35% krill while the hard part analysis indicated a diet comprising 27% fish, 3% squid and 70% krill. Food consumption rates for five penguins from both colonies were similar and averaged  $67.1 \pm 5.4 \text{ g} \cdot \text{kg}^{-1} \cdot \text{d}^{-1}$  ( $1.9 \pm 0.1 \text{ kg} \cdot \text{d}^{-1}$  for a 28.8-kg female) which equated to a metabolizable energy intake of  $253.7 \pm 20.6 \text{ kJ} \cdot \text{kg}^{-1}$  for each day they foraged; this enabled the birds to gain about 6.1 kg for a trip spanning 70-75 d. Based on mean prey masses and the penguins' dive rates, the penguins consumed about 90 krill or 16 silverfish per foraging dive to depths <150 m. During the winter, each breeding female consumed about 107 kg of prey and the female populations at Auster and Taylor Glacier consumed an estimated 1400 t and 260 t, respectively.

(oral presentation)

#### DISPERSAL OF JUVENILE EMPEROR PENGUINS AFTER PLEDGING

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Emperor Penguins *Aptenodytes forsteri* juveniles weigh about 10-12 kg when they fledge near Christmas Day. Once they leave the colony few are ever seen again. Their whereabouts are unknown until they return to the colony several years later to breed. Our purpose of this study was to determine where juveniles disperse to in the first few months after their departure from the colony. In mid-December of 1994 and 1995 we captured two and four chicks, respectively, while they were waiting at the ice edge to depart from Cape Washington (74° 32'S, 165° 22'E). We purposely selected robust-looking chicks to improve our chances of utilizing successful birds that would at least succeed in the initial part of their journey. A streamlined PTT, weighing 120 g, was glued to the feather of the lower back. Within a few hours the chicks/juveniles left the ice edge. The results of the first two months away from the colony are a surprise. The maximum distance of the latest four juveniles is at this time >2000 km from the departure point. All juveniles have followed a similar path and all have left the Ross Sea. Depending on how one defines the Southern Ocean they have left the Antarctic, but remain south of the Antarctic Polar Front. They are all travelling east with the prevailing current and wind. It is a disappointment that the juveniles leave the Ross Sea. It means that the Ross Sea populations of this species are, at least in one crucial part of their life cycle, exposed to the same vulnerabilities as their more northern conspecifics. Of particular concern is the impact of commercial fishing.

(oral presentation)

#### VIDEOANALYSIS OF LOCOMOTION IN THE KING PENGUIN *APTENODYTES PATAGONICUS*, GENTOO PENGUIN *PYGOŚCELIS PAPUA* AND THE ADELIE PENGUIN *P. ADELIAE*

RUEDI KÜNG

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Because of the long distances between hunting grounds and breeding places, we can expect that penguins reduce their expenditure of energy by optimizing their way of swimming. One way of supporting this can be seen with the behaviour of leaping or porpoising. From physical considerations it is evident that leaving denser waters diminishes body friction. I investigated film of leaping Adélie Penguins *Pygoscelis adeliae* cruising the Antarctic waters and captive King *Aptenodytes patagonicus* and Gentoo *P. papua* Penguins in Basel and Zurich. My findings have confirmed the assumption that wandering animals in the field move at "crossover" speed, where leaping is more efficient. However, the porpoising of penguins in captivity can be understood as a means of communication or just as a performance. A further aspect of my investigations is the propeller-like torsion of the penguin flipper and its functionality under water. Probably the downstroke torsion of the distal part of the flipper corrects the growing buoyancy factor of the proximal part. I suppose that this torsion is actively controlled by the penguin.

(oral presentation)

#### A MAXIMUM DENSITY FOR NESTING YELLOWEYED PENGUINS?

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Green Island Nature Reserve, a 3.5-ha offshore island, is the only mammal-free breeding location of Yelloweyed Penguins *Megadyptes antipodes* along the east coast of South Island, New Zealand. It features the highest breeding density recorded for the species with typically 25-30 nests annually in the 1.0 ha of vegetation through a 13-year study period. These nest numbers did not reflect the large long-term

fluctuations recorded for the species on the mainland. Recruitment appeared to be low and not all breeding pairs nested every year. Most years showed distinct clumping of nests. Nearest-neighbour distances within these clumps averaged between 5-10 m annually in contrast to a random spacing of between 18 and 24 m expected for 25 to 30 nests per ha. Clumping could be detrimental with failure of 10-20% of nests annually attributable to visual contact between pairs either at adjacent nests or on access routes near nests. This prerequisite of a secluded nest site for successful breeding did not apply interspecifically. Nests could about those of Little Penguins *Eudyptula minor* or Kelp Gulls *Larus dominicanus* without detriment to any species. Surprisingly, the locations of clumps of nests have changed through time. The reasons for these changes in nest distribution are as yet unknown but they do show that the availability of nest sites was not limiting. Results indicate that Yelloweyed Penguins should be regarded as loosely colonial rather than as solitary breeders. If Green Island is representative for the species, the potential maximum nest density for a location cannot be deduced simply from availability of suitable nest sites nor from minimum nearest-neighbour distances. Instead the answer probably lies in behavioural studies of breeding territories.

(oral presentation)

#### A DESIGN OF A NEST BOX FOR YELLOWEYED PENGUINS

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Yelloweyed Penguins *Megadyptes antipodes* are surface nesters typically in dense vegetation. Coastal land clearance and its replacement with farmland has virtually eliminated natural breeding habitat at North Otago, South Island, New Zealand. Here vegetation associated with

nests on grazed farmland can be divided into six categories: pasture grass; cliff-edge scrub remnant; open woodland remnant; rush, sedge or tussock; paddock scrub remnant; and invasive shrubs. Only the last two categories provide the optimal lateral and overhead concealment considered necessary for successful nesting. Stock browsing during a drought through 1985 largely destroyed bush remnants. The resulting lack in penguin nest sites was resolved with the deployment of nest boxes designed to replicate optimal nest sites. These nest boxes have a tanalised timber frame 1.2-m long, 0.6-m high and 0.6-m deep with tanalised plywood ends, back and top. Wooden bars across the open front exclude stock. Nest boxes have now been in use for 10 years and appear preferred to natural sites on farmland. They are also used as sites for the annual moult. Nest boxes are also suitable for temporary deployment in revegetation programmes that produce nesting habitat in the long term but do not meet the immediate need for nest sites.

(poster presentation)

**EFFECTS OF AN OIL SPILL ON LITTLE PENGUINS *EUDYPTULA MINOR* IN NORTHERN TASMANIA, AUSTRALIA. PART I: DETERMINING THE IMPACT OF THE IRON BARON OIL SPILL ON LITTLE PENGUINS**

**LITTLE PENGUIN OIL-SPILL MONITORING GROUP**

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The bulk ore carrier *Iron Baron* ran aground on Hebe Reef at the mouth of the Tamar River off the north coast of Tasmania on 10 July 1995. An estimated 325 t of bunker fuel oil was released from the vessel, about half of which came ashore on adjacent coastlines, two estuaries and on one offshore island. Little Penguins *Eudyptula minor* were the most numerous oiled species collected for rehabilitation. A total of 1894 oiled penguins

was recovered from 16 locations in southeastern Bass Strait, however, the effort to recover oiled birds varied greatly between sites. At some sites, extensive beach surveys and trapping meant that many birds were recovered, whereas at others, which were not surveyed until three weeks after the grounding of the vessel, few penguins were recovered. Depending on location, penguins were oiled either by intercepting oil at sea, and/or by walking through oiled runways. The numbers of penguins recovered represents only a portion of the total number affected. As with other oil spills, we faced the problem of estimating the overall impact the oil spill had on seabird populations. Many of the populations of penguins breeding in Bass Strait islands were surveyed in 1986. These were resurveyed using the same techniques in November and December 1995. Islands were categorized as either oil-affected, or two control categories (assumed no risk of oiling, and assumed low risk of oiling). We will present data on population changes at these islands and discuss whether changes in population size, if they have occurred, were a consequence of the oil spill. For one island, where 1076 oiled penguins were captured (Ninth Island), we will also present data on the proportion of oiled birds caught in funnel traps throughout the oil spill, and the use of mark/recapture techniques and previous population surveys to determine losses from that population.

(poster presentation)

**EFFECTS OF AN OIL SPILL ON LITTLE PENGUINS *EUDYPTULA MINOR* IN NORTHERN TASMANIA, AUSTRALIA. PART II: SHORT-TERM SURVIVORSHIP AND BREEDING SUCCESS OF OILED BIRDS FOLLOWING REHABILITATION**

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A total of 2060 Little Penguins *Eudyptula minor* from 16 locations in Southern Bass Strait, Tasmania, was rehabilitated following an oil spill. This process involved washing to remove oil, followed by containment for an average of 19 days ( $\pm 14$  d) while the birds' regained satisfactory muscle condition, the integrity of their plumage was restored following washing and the original capture sites of the birds were cleaned. Just over half (53%) of the rehabilitated penguins were eventually released at or near their capture site, the remainder had to be translocated for release up to 500 km away (because of delays in cleaning the birds' original capture locations of oil). A long-term monitoring programme is currently underway to determine the short-term survivorship of penguins following rehabilitation, containment and, in some cases, translocation prior to release. To date, approximately half (51%) of the rehabilitated birds have been recaptured during regular trapping. Between the time of release and their first recapture, most rehabilitated birds lost mass, although subsequent trapping of the same individuals indicates that they have steadily gained mass, reflecting the mass gains that occur naturally with the progression of the birds' breeding season. The short-term survivorship of birds with different oiling, rehabilitation and release histories was estimated by their retrappability. The major factors affecting short-term survivorship were degree of oiling, number of days spent being rehabilitated and release mass. Release location was not a major factor affecting short-term survivorship. Preliminary results will also be presented on the breeding success of oiled and unoled penguins.

(oral presentation)

#### DIVING BEHAVIOUR OF HUMBOLDT PENGUIN *SPHENISCUS HUMBOLDTI* IN NORTHERN CHILE

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The Humboldt Penguin *Spheniscus humboldti* is an endangered species with declining populations over its whole distributional range. In support of conservation efforts, systematic studies are being conducted of the ecology and behaviour of birds at sea. With the use of time-depth-recorders we investigated the foraging behaviour of breeding Humboldt Penguins on Isla Pan de Azúcar (26°S, 72°W), northern Chile, during the breeding seasons of 1994 and 1995. We employed a four-channel logger (MK6, Wildlife Telemetry) equipped with speed, depth, temperature and light-intensity sensors. We recorded 20 foraging trips, from 12 penguins. This amounts to a total of 301 hours of swimming and diving behaviour summarizing 11 011 dive events. Concurrent with the 2-4 day attachment of the loggers to the adult birds, in the 1995 season, we recorded the change in body mass of six first-hatched chicks. Time of departure from the colony was between 06h00 and 09h00, whereas time of return was mainly between 15h00 and 23h00. Distance travelled was strongly correlated with total time spent at sea, and both parameters were positively correlated with gain in body mass of the chicks. Maximal dive depth was 53 m around mid-day when light intensity was maximal. At night some diving activity was detected with a maximal dive depth of 12 m. Maximum dive depth correlates well with dive duration ( $r = 0.80$ ), as well as with descent and ascent angle ( $r = 0.78$ ), and descent and ascent rate ( $r = 0.86$ ). Dives between 0.5 and 3 m were interpreted as travelling dives with a mean depth of 1.6 m (SD = 0.77;  $n = 3688$ ). All dives deeper than 3 m were interpreted as foraging dives, having a mean depth of 11.5 m (SD = 7.32;  $n = 6849$ ). Mean dive duration during travelling and foraging were 18.4 s (SD = 12.5;  $n = 3688$ ), and 47.9 s (SD = 21.85;  $n = 6848$ ), respectively. Mean swim speed during travelling was 1.7 m/s (SD = 0.87;  $n = 3878$ ), with a preferred travelling speed of 1.8 m/s. Maximal speed recorded during travelling was 6.5 m/s. Overall foraging speed during the three phases of the dive (descent, bottom and ascent) was 1.9 m/s (SD = 0.75;  $n = 17691$ ). The main prey of the Humboldt

Penguin, the anchovy *Engraulis ringens*, occurs in dense schools in the top 50 m of the water column, where nutrients and light intensity are maximal. Consequently, we believe that the Humboldt Penguin adjusts its dive parameters to the ecology of the prey.

(poster presentation)

#### NEST-SITE SELECTION BY YELLOWEYED PENGUINS ON GRAZED FARMLAND

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The viability of Yelloweyed Penguins *Megadyptes antipodes* on South Island, New Zealand, is regarded as threatened by the loss of breeding habitat by land clearance for farming and the loss of chicks to introduced mammalian predators. Penguin habitat ashore at Papanui Beach, Otago Peninsula, is spread through about 10 ha of grazed farmland that varies from paddocks of pasture grass to gullies of shrubs and tress. Grazing is restricted to sheep in order to minimize impact on shrubs and trees. Predation is minimized by trapping. Penguin nest sites vary from optimal sites with total lateral and overhead concealment to fully exposed sites. Deaths attributed to avian malaria decimated the breeding population of 21 pairs in January 1990. Nest numbers have recovered to 21 nests in the 1995/96 season but their distribution has changed. Nests lacking overhead concealment in grass paddocks increased from two (10%) in 1989/90 to 12 (57%) in 1995/96. Unexpectedly, the new generations of breeders appear to have selected open surroundings instead of the supposed preferable nesting habitat of dense vegetation. Breeding success has not been affected. A relatively large number of juveniles congregated on foreshore pastures in the 1995/96 season:

minimum 21, including at least 13 from other locations. The presence of such areas of bare ground could be important for the recruitment of new breeders. Results show that with management Yelloweyed Penguins can flourish on grazed farmland.

(poster presentation)

#### GENETIC VARIATION IN THE ADELIE PENGUIN: A WORLD VIEW

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We present this poster as a proposal and request for assistance from all scientists studying Adélie Penguins *Pygoscelis adeliae* in Antarctica. We hope to collaborate with scientists in as many locations as possible in order to get blood (and/or tissue) samples from Adélie Penguins throughout their circumpolar distribution. Using a combination of Cytochrome b and major histocompatibility complex (MHC) genes we intend to investigate the genetic variation in Adélie Penguins on a variety of scales. On a continental scale we will determine the relationships among widely scattered populations and determine if there were few or many centres of dispersal around the continent. On a meso-scale we will describe the population genetics of extant Adélie Penguin populations that expanded into the Ross Sea over the past 11-13 thousand years. Finally, we will address the relationships and origins on different sides of the Adélie Penguin gap in the Antarctic Peninsula region. With the help of a variety of scientists we can develop a world view of the genetics of the Adélie Penguin.

(poster presentation)

#### ADELIE PENGUIN COLONY AT CAPE BIRD, ROSS ISLAND

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Adélie Penguin *Pygoscelis adellae* colonies consist of distinct subcolonies which change in size relatively independent from the colony as a whole. Penguin colonies that have been studied intensely (or visited frequently by tourists) dwindle and even disappear. We must understand the natural dynamics of subcolony formation and disappearance to understand the significance of such observations. Furthermore, if the size of subcolonies mirrors the changes in the entire colony, it may be possible to obtain accurate census information without counting the entire population of a given breeding colony. Using a large collection of aerial photos spanning 12 seasons, we describe the dynamics of subcolonies within the Adélie Penguin colony at Cape Bird, Ross Island. Subcolony disappearance is related to disturbance, but small subcolonies are also vulnerable to persistent predation from South Polar Skuas *Catharacta maccormicki*, early season snow cover, and changing patterns of melt-water streams. Furthermore, new colonies appear more frequently in recovery years following years with reduced breeding

(poster presentation)

#### FORAGING RANGE OF THE YELLOWEYED PENGUIN

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Foraging ranges of Yelloweyed Penguins *Megadyptes antipodes* were estimated off the southeast coast of South Island, New Zealand during three breeding seasons, 1991-1993. Triangulation of radio bearings from two land-

based receiving stations was used. At the main study area, Boulder Beach on the Otago Peninsula, 14 individual penguins were radio-tracked for two-three weeks during three stages of two consecutive breeding seasons. Birds at Otago Peninsula foraged over the continental shelf, which is mostly 40-80-m deep and 30-km wide. The median foraging trip was 14 hours (two hours to seven days) and birds travelled a median of 13 km (up to 57 km) from the breeding area. The longer, more distant trips occurred during the incubation period, except during 1992-93, when trips were relatively of shorter duration and distance. Individuals showed different, although usually overlapping, foraging ranges and retained these patterns at different times of the breeding season and in different years. Some birds were markedly inshore feeders, with centres of activity <5km from the coast. The majority of birds were mid-shelf foragers (5-16 km from the coast), whereas some centred their activity >16 km from the coast. Breeding success, foraging time and range was affected, at least for some birds, by disturbance.

(oral presentation)

#### THE EFFECTS OF HATCHING DATE AND PARENTAL QUALITY ON CHICK GROWTH AND MORTALITY AND CRECHING AGE IN THE CHINSTRAP PENGUIN *PYGOSCELIS ANTARCTICA*

JUAN MORENO

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I studied the effect of hatching date on breeding performance and creching and fledging ages of Chinstrap Penguins *Pygoscelis antarctica* at Deception Island, South Shetland Islands over three years. Hatching date was consistent for pairs between years. The mean hatching date and all breeding performance variables differed between years. Hatching date had only a slight effect on mortality and early growth, but was negatively correlated with creching age, that in turn was positively related to final chick size. The decision to leave the chicks unguarded was

not based on chick condition, but presumably on adult condition. Fledging age was also negatively correlated with hatching date, and this effect was more marked in the year with poor growth performance. In the fourth season, we experimentally tested two hypotheses to explain the effects of hatching date on creching age and final chick size: 1) Late-breeding pairs experience a conflict between properly caring for their chicks and commencing the period of premoult reserve storage; and 2) Late-breeding pairs are formed by low-quality breeders which are not able to feed their chicks efficiently and are forced to leave them unguarded at younger ages. By exchanging chicks with hatching days six days apart between nests soon after hatching, we separated the quality of the adults as expressed by their breeding dates from the hatching dates of the chicks in their nests. The results of the experiment clearly showed that parental quality does not explain the seasonal trends in creching ages and growth performances of chicks, which are linked to the hatching date itself.

(*in-absentia* poster presentation)

**PEREX (PENGUIN RESEARCH  
EXPEDITION) ORGANIZED BY THE  
PENGUIN CONFERENCE JAPAN**

YUKO MUTOH & MIHOKO NUMATA

*Penguin Conference Japan, 5-16-15  
Nishiotsunui, Nerima-ku, Tokyo 178, Japan*

PEREX (Penguin Research Expedition) is organized by the Penguin Conference Japan (PCJ). The PCJ intends that expeditions to wild penguin habitats will raise consciousness towards improving captive penguin conditions in Japanese aquaria. Members of PEREX are aquarium curators, keepers, volunteers for aquaria and zoos, school teachers, artists, scientists and friends or amateur researchers of penguins. PEREX has been to Chile three times to observe Humboldt *Spheniscus humboldti* and Magellanic *S. magellanicus* Penguins. Ornithologists and students in Chile guide us to the habitats. Coordinators in Chile help us collect ecological information on penguins. PEREX also plays a role in carrying

donations for penguin conservation from PCJ and other Japanese people. Such expeditions are a form of ecotourism. PEREX members remind themselves that observations in nature should not disturb the wilderness of penguins, and our behaviour should not be misunderstood. We believe, especially, that the experiences on PEREX affect the way of raising penguins. PEREX members have observed how the "habitats" are, and some of the members have come to consider improving circumstances of captive penguins. Whoever is interested in penguin conservation can join PEREX.

(poster presentation)

**HEMATOLOGICAL PARAMETERS IN  
DIFFERENT SPECIES OF ANTARCTIC  
PENGUINS: POTENTIAL USE AS  
BIOLOGICAL MARKERS OF  
CONTAMINATION**

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The Antarctic Continent constitutes an environment in which communities are exposed to anthropogenic disturbances. Among them penguins stand out due to their migratory and alimentary habits. The impact of a contaminating agent on an organism is reflected through disturbances in its physiological, cellular and biochemical balances. The effect of the toxin can be measured as a disturbance of the state of balance at different levels of functional complexity. The aim of this study was to determine normal limits of some hematological parameters and its potential use as a biological marker of environmental contamination. The study was carried out on

adult Adélie Penguins *Pygoscelis adeliae*, adult Chinstrap Penguins *P. antarctica* and adult and chick Gentoo Penguins *P. papua* in the South Shetland Islands, Antarctica. Furthermore, experimental intoxication in adult Adélie and Chinstrap Penguins was performed. For this purpose oil byproducts such as fuel for air and land transport in the area (JPI and GOA), as well as organometallic compounds e.g. trimethyltin (TMT) were used. Glucose, total lipids, total proteins, hemoglobin, haematocrit, serum activity of the intracitoplasmatic enzymes aspartate transaminase (AST) and alanine transaminase (ALT) and the electrophoretic pattern for serum proteins were determined. Glucose values showed differences not only according to the species but also according to age e.g. from chicks to adults. Total proteins and lipids were similar among species. Haematocrit values were lower in Adélie Penguins and significantly lower in Gentoo Penguin chicks. Similar levels were observed for haemoglobin. Electrophoretic pattern, total proteins, AST and ALT, in experimental intoxicated animals were measured. The animals intoxicated with TMT showed higher values of AST and ALT. An increase in total protein was recorded. Increase of the beta globulin fraction as well as the fusion of alpha 1 and alpha 2 globulin recorded may account for this. The total protein serum levels of animals exposed to JPI and GOA showed similar trends.

(*in-absentia* poster presentation)

#### RESTORATION OF AFRICAN PENGUINS OILED IN 1994 INTO THE DASSEN ISLAND POPULATION

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Despite substantial funds spent on cleaning oiled seabirds little information is available on the degree to which cleaned seabirds are restored into the wild breeding populations. An estimated 7000 oiled adult African Penguins *Spheniscus demersus* were removed from Dassen Island after the *Apollo Sea* oil spill in

June 1994. Subsequently some 2700 were released (with flipper bands) from the mainland after cleaning. By January 1996 68% of the adult rehabilitees had been seen at Dassen Island. In contrast, of 800 juveniles released after cleaning or which had been hand raised after being orphaned, less than 5% had returned. Of the adult rehabilitees 46% had attempted to breed (seen on eggs or chicks). These are not final figures as return of birds, and recording of "first" post-cleaning breeding attempts, continues. In 1995 most rehabilitees moulted out of phase with the larger control population. Some birds started to breed within a few months of release but most were not recorded breeding for 6-12 months after release. Comparison of pairs in which one bird was a rehabilitee with controls in which neither bird had been oiled reveal that chick growth was essentially the same, as was fledgling production during the austral spring and summer months but in 1995 pairs including a rehabilitee had lower breeding success than control pairs during the autumn and winter. In a sample of 35 rehabilitees which were recorded twice or more at the nest 11 (33%) changed partners. Break-up of pre-oiling pairs, and delay in establishing durable new pair bonds, is considered an important factor contributing to the lower breeding success of rehabilitee pairs in time of seasonal food limitation. The study demonstrates substantial restoration of cleaned oiled birds into the breeding population; stresses the high cost-benefit rate of cleaning adult birds, versus the low benefit of cleaning juveniles; and indicates that it will take some 50+ years for the restored birds to generate sufficient offspring to replace the number of adult penguins which died during the spill.

(oral presentation)

#### THE SIGNIFICANCE OF NESTING GENTOO PENGUIN *PYGOSCELIS PAPUA* RESPONSES TO TOURIST GROUPS IN ANTARCTICA

AMANDA NIMON

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Antarctic penguins breed ashore in large colonies where they are susceptible to human disturbance. Concern over increasing tourism and recent attempts to make legal provision for the protection of wildlife have highlighted the need for reliable information on how visitors can affect penguins. A series of experiments measured the behavioural and heart rate responses of nesting Gentoos *Pygoscelis papua* to large tourist groups and to naturally-occurring disturbance stimuli. Heart rate changes are useful indicators of nesting penguins' reactions to events in their environment because often their behaviour does not appear to vary until the point at which they flee, exposing eggs and chicks to predators. The use of unobtrusive techniques, including an artificial egg which detects heart rate via an infra-red sensor, permitted these responses to be measured in penguins which had not been handled or disturbed prior to experiments. The results indicate that Gentoos do not always react to the presence of visitors in accordance with intuitive predictions. Human-induced stimuli which would appear to be highly disturbing may fail to draw a response, although penguin reactions can vary with the behaviour of humans involved in an interaction and penguins which have previously experienced interference may abandon nests when approached. The responses of nesting penguins to humans in these experiments have inherent significance, and can also be compared to responses during conspecific agonistic encounters so that their relative or contextual significance may be assessed.

(oral presentation)

**DISEASE IN THE LITTLE PENGUIN  
EUDYPTULA MINOR, WITH EMPHASIS  
ON THE PATHOLOGY OF INTERNAL  
HELMINTH PARASITISM IN THE  
PHILLIP ISLAND POPULATION**

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Systematic studies of disease in wild bird populations are infrequently made. Reports of disease in penguins are often limited to small numbers or to limited pathogen groups. The present study examined more than 300 free-living Little Penguins *Eudyptula minor*, principally from the Phillip Island population on the southeast coast of Australia, which died between 1992 and 1995. Cadavers were subjected to detailed post mortem dissections, and histopathological examination of tissues where appropriate. A range of causes of death was determined, and additional factors contributory to mortalities were identified. Intercurrent diseases, including parasitism in a large proportion of birds, were examined. Indices of maturity and nutritional status of birds were measured and associations between these and the pathological processes discovered were examined. Photographic documentation of lesions and pathogens identified was comprehensive, and a selection of this material will be demonstrated.

(oral presentation)

**CHANGES IN CIRCULATING  
THYROXINE AND STEROID HORMONES  
IN MOULTING HUMBOLDT PENGUINS  
IN CAPTIVITY IN JAPAN**

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Penguins have a far shorter moulting duration (2-4 weeks) than do passerines (1-2 months).

Since all body feathers drop at the same time during moulting, penguins are forced to stay ashore and fast due to the lack of heat insulation of feathers for foraging behaviour in cold sea water. To clarify the endocrine mechanisms controlling this phenomenon, we collected blood samples from eight pairs of Humboldt Penguins *Spheniscus humboldti* which had been successfully breeding in an open outdoor display pen at Tokyo Sea Life Park in Kasai, Tokyo from May to September 1994 and estimated circulating levels of luteinizing hormone (LH), thyroxine (T4) and sex steroid hormones (testosterone (T) and estradiol (E2)). However, due to constraints of zoo-keeping, we could not sample frequently: every three weeks for each pair. Breeding activity and stage of moulting were estimated by frequent observations. We designated the day feathers began to drop as the commencement of moulting. The results show that the plasma T4 levels were low until early July, but increased significantly in late July and reached maximum T4 levels (40.08 ng/ml in males, 45.54 ng/ml in females) by the time of moulting. The plasma concentration LH was high at the beginning of the study in May and declined to minimum levels (0.53 ng/ml in males, 0.72 ng/ml in females) by late July. The circulating T concentrations were high during May and declined to minimum levels (0.16 ng/ml in males, 0.18 ng/ml in females) by late July. Plasma E2 concentrations did not change during the premoulting period and increased after moult. Steroid hormone levels were low during moulting in both sexes. These results suggest that a decline of circulating steroid hormones and a steep increase of circulating T4 may play an important role in the short duration of penguin moult.

(poster presentation)

#### DESIGN AND IMPLEMENTATION OF A NEW AUTOMATED PENGUIN MONITORING SYSTEM

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The determination of baseline data on penguin populations is invaluable for use in conservation and monitoring programmes but in the past has been a difficult and labour-intensive task. The need for some form of automated electronic data-gathering system that would provide a less intrusive and more complete data set than that obtained through manual methods became apparent and it was with this in mind that research was instigated into the possibilities of such a system. Development began in 1990 and a prototype system was installed during the 91/92 austral summer. Experience gained from the ongoing development and refinement of this original system has culminated in the design of a new Automated Penguin Monitoring System (APMS). Complimentary microprocessor-controlled power and communications systems have also been specifically developed to aid operation and control in isolated locations. Together with the APMS these systems form a rugged and reliable installation intended for remote operation in the Antarctic environment. Four complete systems have already been deployed. Two of these are located at Bechervaise and Verner Islands (near Mawson) in the Australian Antarctic Territory while a third is located at Edmonson Point in Terra Nova Bay as part of a collaborative project with the Italian Antarctic Programme. All three of these systems will be used in studies of the Adélie Penguin *Pygoscelis adeliae*. The fourth system has been installed at Phillip Island in Victoria, Australia, for the study of the Little penguin *Eudyptula minor*. A fifth system has been constructed and it is intended that this system will be deployed at Macquarie Island during the coming 1996/97 austral summer for studies of the Royal Penguin *Eudyptes schlegeli*. Features of the new system include an implanted tag reader with a range of greater than 600 mm, a stand alone weighing platform with 500 Hz output sample rate from an inbuilt microprocessor-controlled signal conditioner unit, a dual infrared proximity direction detector and modular design to permit easy servicing by field personnel. The software incorporates a multi-tasking operating system for maximum reliability and offers various levels of users access to simplify operation. Also included in the design is the ability to access remotely the system via a satellite or radio communications link, thus allowing the user to retrieve data, change system settings or carry out diagnostic tests at unattended sites. This poster presents some of the design philosophy and engineering techniques that have evolved with the development of these systems and discusses the relative advantages and disadvantages of the approaches taken.

(poster presentation)

**FORAGING AREAS OF KING PENGUINS  
APTENODYTES PATAGONICUS DURING  
THE BREEDING SEASON IN THE  
SOUTHERN INDIAN OCEAN**

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The breeding strategy of King Penguins *Aptenodytes patagonicus* is unique among penguins because chick-rearing takes more than one year. Such slow chick development appears caused mainly by an increase in parental foraging trip duration in winter. Between January and March 1994 and between January and June 1995 we used Global Location Sensors (GLS) to determine the feeding areas and travelling speeds of King Penguins breeding at Possession Island (46° 25'S, 51° 40'E). The results indicate that between January and March summer birds (n=15) typically travelled rapidly away from the colony (c. 8 km/h) to a preferred feeding area at 50°S 52°E, about 350 km south of the island. Here, travelling speeds were much slower (<5 km/h), before the birds moved again rapidly back to the colony (c. 8 km/h). Travelling speeds at night were always higher than those during the day. Mean foraging trip duration at this time was 7.6 ± 3.4 days. Between late April and mid-June two King Penguins equipped with GLSs executed foraging trips with durations of 53 and 59 days, respectively. Both birds travelled south beyond 60°S with maximum distances to the colony of 1600 and 1800 km, respectively, and total distances travelled of about 5000 km. The trips performed were characterized by alternating periods of higher and lower travelling speeds,

indicating a highly variable feeding success at different localities.

(oral presentation)

**WHO IS WATCHING WHOM? CHECKS  
FOR IMPACTS OF TOURISTS ON  
YELLOWEYED PENGUINS  
MEGADYPTES ANTIPODES**

H. RATZ

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The Yellow-eyed Penguin Conservation Reserve at Penguin Place, Dunedin, New Zealand is an ecotourism venture where visitors view breeding Yelloweyed Penguins *Megadyptes antipodes* at close range from hides and covered trenches. Yelloweyed Penguins are a timid and secretive species that could be regarded as unsuitable for observation at close range. Similar trends in the number of Yelloweyed Penguin nests were recorded in the colony visited continually by tourists and in the adjacent control colony with no public access. Breeding success differed between years and between the two colonies but no trends were apparent. The impact of the presence of tour groups on the feeding behaviour of chicks was investigated at two-chick nests at the guard-stage during the summers of 1994/95 and 1995/96. The number of food-transfers was counted in five-minute intervals for 30 minutes. Eleven and eight feeding sequences were observed in the colony with tourists and without tourists, respectively. No difference was found in the patterns of feeding sequences. The feeding pattern was therefore not significantly altered by the proximity of tourists. A previously unrecorded behaviour of adult penguins was observed. Although going through the normal feeding motions, no food was transferred. This behaviour was termed "pseudo-feeding" and appeared to be an appeasement that temporarily stopped begging by chicks.

(oral presentation)

**WHO'S DONE IT? PREDATOR  
IDENTIFICATION FROM BITE MARKS  
ON PENGUIN AND ALBATROSS CHICKS**

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Ferrets *Mustela furo*, stoats *M. erminea* and feral house cats *Felis catus* are introduced predators in New Zealand that threaten many nesting seabirds and other native species. Fiftyone Yelloweyed Penguin *Megadyptes antipodes* chicks, four Royal Albatross *Diomedea epomophora* chicks and one Little Penguin *Eudyptula minor* adult were necropsied. Four Yelloweyed Penguin chicks, three Royal Albatross chicks and the Little Penguin had puncture holes in their skin from predator bites. Three Royal Albatross chicks also had markings on their bills that were analysed separately. Only outlying puncture holes could be matched unequivocally with the species-specific inter-canine distance of each predator species. Most bites were clustered and separate bites could not be discerned. One Yelloweyed Penguin chick and two Royal Albatross chicks were preyed upon by stoats, but the culprit of none of the other 21 bitten birds could be definitely determined. There are many logistic problems and unquantified assumptions in other methods of identifying predators. Development of better diagnostics to identify the culprits would help conservation management by allowing better targeting of predator trapping and poisoning efforts.

(poster presentation)

**LOCATIONS OF PENGUINS AT SEA**

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Locations of penguins at sea were recorded during systematic bird observations carried out on sea voyages between Hobart Australia and Antarctica during 1991 to 1995. Two types of voyages were undertaken: five World Ocean Circulation Experiment (WOCE) cruises between Hobart and Durmount D'Urville on the longitude 140°E; and two Antarctic and Heard Island fishing exploratory/supply voyages between Hobart, Heard Island and the Australian Antarctic Territory. Nine species of penguins were observed. Locations of penguins were related to the variables latitude, longitude, depth of water, salinity, sea-surface temperature, ice cover and icebergs. A Principal Co-ordinate Analysis revealed that the relationship to these factors varied between groups of species. There were four latitudinal groupings, with Emperor Penguins *Aptenodytes forsteri* the most southerly, and Rockhopper *Eudyptes chrysocome* and Royal Penguins *E. schlegeli* the most northerly. The longitudinal distribution could be related to the proximity of Heard and Macquarie Islands and the species that breed at these sites. There were three temperature groups, with Emperor and Adélie Penguins *Pygoscelis adeliae* in the coldest water, King *A. patagonicus*, Royal and Fiordland Penguins *E. pachyrhynchus* in the warmest. Emperor Penguins were found in the most saline waters, and there were two depth categories, with Emperor, Adélie and Gentoos *P. papua* Penguins in the shallowest waters. The distribution of the penguins was also assessed in terms of ocean frontal structures, revealing which species were associated with these structures. Distances to assumed breeding grounds was also calculated to give an indication of minimum foraging ranges for each of the species.

(poster presentation)

**SURVIVAL ANALYSIS OF LITTLE  
PENGUIN *EUDYPTULA MINOR* CHICKS**

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Survival analysis was used to investigate chick mortality pattern and breeding success of Little Penguins *Eudyptula minor* on predator-free Motuara Island, Cook Strait, New Zealand. Chick mortality was high (64%) with starvation accounting for 59% of all deaths. The risk of dying was greatest between age 5 and 10 days, but decreased significantly afterwards. Dying of exposure to rainfall was restricted to the guard stage whereas starvation occurred during the entire nestling period. Chicks from early broods had a greater chance of surviving to the age of fledging than did chicks from late broods. Brood reduction due to sibling competition occurred in an estimated 65% of nests that hatched two chicks ( $n=22$ ). Peak mortality in the early breeding season also coincided with a Pilchard *Sardinops neopilchardus* die-off in surrounding coastal waters. The risk of chicks dying on a particular day was dependent of the amount of rainfall on the previous day ( $r^2 = 52\%$ ,  $p = 0.017$ ). About twice than average rainfall and poor food supply were likely causes for the low breeding success.

(poster presentation)

**FORAGING RANGES OF EMPEROR  
PENGUIN FLEDGLINGS AND  
POTENTIAL INTERACTION WITH  
FISHERIES**

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Unlike other species of high Antarctic penguins Emperor Penguins *Aptenodytes forsteri* fledge their chicks in the peak season for commercial

fishing activity in Antarctic waters. Competition for prey (and potential resource depletion) has the potential to affect feeding rate and survival in the formative stages of a fledgling's life at sea. It is important, therefore, to understand the foraging whereabouts of fledglings in the early months of independence to gauge the extent of overlap with fisheries. To examine foraging ranges of fledglings satellite transmitters were attached to seven birds from Taylor Glacier colony in mid December 1995 as they marched out of the colony for the ice edge. Birds with a minimum 2-kg lipid store were selected to maximize their chances of reaching the ice edge and surviving the first few days at sea. Transmitters were programmed to estimate the fledglings' positions until May 1996. Unlike adult Emperor Penguins from a nearby colony, which foraged in winter and spring within 150 km of the colony, fledglings dispersed up to 12 degrees of latitude north of their natal site in open water well beyond the northern reaches of the pack-ice zone (the greatest distance travelled was 6800 km in five months). As the winter approached and the pack-ice reformed the fledglings moved southward. The study provides the first insight into the migration patterns of Emperor Penguin fledglings and suggests competition with commercial fisheries operating in high Antarctic waters in summer would be minimal for fledglings in the early stages of the exodus and maximal in the late stages.

(oral presentation)

**MAXIMUM BREATH-HOLDING BY  
EMPEROR PENGUINS**

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We recorded the maximum dive durations of Emperor Penguins *Aptenodytes forsteri* from Auster colony on the Mawson Coast of Antarctica in the winters of 1988 and 1994. Dive durations were recorded by



microprocessors attached to penguins leaving the colony on foraging trips. Dives of 22.0 minutes and 21.27 minutes were recorded in 1988 and 1994, respectively. Both dives were made by male Emperor Penguins in August of each year on their first foraging trip following the four-month pre-nuptial and incubation fast. The 22-minute dive was preceded by 2.8 minutes surface time (following a 7.8-minute dive) and was followed by 3.0 minutes surface time. The penguin then dived for another 3.16 minutes. Apart from the descent and ascent the entire dive was spent below 35 m. The 21.27-minute dive was spent at a depth of 66 m except for the ascent and descent. This dive occurred at the end of a diving bout in which the penguin attained a depth of 345 m. Both dives exceed the theoretical aerobic dive limit of Emperor Penguins by a factor of four. The 22-minute dive is the longest dive duration recorded for a seabird.

(poster presentation)

#### FORAGING PERFORMANCE AND POPULATION BIOLOGY OF CHINSTRAP PENGUINS AT SEAL ISLAND, ANTARCTICA

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We studied the ecology of Chinstrap Penguins *Pygoscelis antarctica* at Seal Island, Antarctica, during eight consecutive austral summers (1988-1995). Shipboard sampling provided contemporaneous information on the regional abundance of the penguins' principal prey, Antarctic Krill *Euphausia superba*. The total breeding population varied among years from 31 000 to 46 000 birds and was positively related to krill abundance, which varied over an order of magnitude. Breeding adults were in comparatively poor condition in years of late ice breakout but this did not appear to influence decisions about whether to breed, nor did it affect subsequent reproductive success. During the chick-provisioning period, krill capture rates at sea increased with krill density, which is inconsistent with recent arguments that penguins

may be most efficient at harvesting krill at intermediate densities. High krill intake rates translated into faster growth and enhanced survival of chicks, as well as greater overall productivity on Seal Island. Several measures of provisioning behaviour suggested that penguins at Seal Island increased reproductive effort in years when krill were more abundant, which is contrary to widespread indications from other studies of marine predators. Our findings suggest that Chinstrap Penguins are better characterized as "income breeders" rather than as "capital breeders", and also that these birds may trade off current reproduction versus survival in complex ways. These insights have important implications for selecting and interpreting reproductive parameters in predator-prey monitoring studies.

(poster presentation)

#### IRIS COLOUR OF HUMBOLDT PENGUINS

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Data have been collected on the eye colour of Humboldt Penguins *Spheniscus humboldti* monthly for more than 13 years in a captive colony of about 50 animals. Iris colour was grey in juveniles. In adults it ranged with age from whitish yellow to red. Very old birds have black irises. Males acquire red eyes at an earlier age than do females. The manner in which iris colour correlates with season, iris colour of mates, breeding performance and aggressive behaviour will also be discussed.

(oral presentation)

#### MANAGEMENT OF THE AFRICAN PENGUIN *SPHENISCUS DEMERSUS* - INSIGHTS FROM MODELLING

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The African Penguin *Spheniscus demersus*, which has decreased markedly through the 20th century, is endemic to southern Africa. In the first half of the century its eggs were harvested commercially. More recently it has been subject to both chronic and catastrophic oiling. Monte Carlo modelling is used to explore influences of exploitation of eggs and oiling on longterm trends of African Penguin populations. Recommendations are made for future management of the species.

(oral presentation)

#### STUDIES OF ENTERIC BACTERIA OF PENGUINS IN ANTARCTIC, SUB-ANTARCTIC AND COOL-TEMPERATE HABITATS

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Although infectious diseases of penguins have been well studied in captive populations in which suscept

ibility to a number of infectious agents has been reported, relatively little is known about the normal microbial flora of penguins in their natural habitats. In order to obtain basic information on enteric bacteria in free-living penguins, we cultured cloacal swabs taken from seven different penguin species at the following locations: Antarctica, Cape Denison (*Adelie Pygoscelis adeliae*), Macquarie Island (Royal *Eudyptes schlegeli*, King *Aptenodytes patagonicus*, Gentoo *Pygoscelis papua*); Heard

Island (Macaroui *E. chrysolophus*, Rockhopper *E. chrysome*, Gentoo); Iles de Kerguelen Macaroni, Rockhopper, King, Gentoo); Iles Crozet (King); Penguin Island, Western Australia (Little Penguin *Eudyptula minor*); and Franklin Island, South Australia (Little). Swabs were taken aseptically and placed in transport medium (Stuart's Strontium B chloride broth, Carey Blair medium or Robertson's cooked meat medium) for carriage back to our laboratory at ambient temperature, followed by inoculation onto a variety of selective and non-selective bacteriological media and incubation at 37°C. The opportunistic Gram negative pathogen *Edwardstiella tarda* was the most frequently isolated microorganism (100/809 birds swabbed) being recovered from from all species except for Little Penguins, and from all Antarctic and sub-Antarctic habitats. *Salmonella enteritidis* (9/294 Adélie Penguin, Cape Denison), *Pleisiomonas shigelloides* (8/294 Adélie penguin, Cape Denison) and *Citrobacter* species (8/17 Gentoo Penguin, 1/28 Royal Penguin, Macquarie Island), were commonly isolated whereas isolations of *Salmonella oranienburg*, *S. antarctica*, *Pseudomonas alcaligenes*, *Acinetobacter calcoaceticus* bio. Lwoffii, *Moraxella phenylpyruvica* and *Enterobacter* spp. were made less frequently. No isolations of *Campylobacter* species were made. In a smaller study of cloacal swabs from 100 Adélie Penguins from Cape Denison (in which a range of growth media and conditions were employed), *Escherichia coli* (15/100), *Enterococcus faecalis* (66/100), *Klebsiella* spp. (2/100), *Pleisiomonas shigelloides* (8/100), *Pseudomonas cepacia* (1/100), *E. tarda* (1/100), and *Enterobacter agglomerans* (1/100) were isolated from aerobic cultures. Anaerobic culture yielded clostridial species in all of 10 swabs which were tested from this collection. These studies, which have revealed the presence of a number of common aerobic enteric bacteria and anaerobic clostridia as well as several less frequently isolated microorganisms, raise questions about the ecology of these microorganisms. The presence of several potentially pathogenic species suggests that the widely reported susceptibility to infectious disease of wild penguins brought into captivity may not always reflect super-infection, but may also result from the effect of endogenous pathogens coupled with stress. Because these

studies, of necessity, depended on the use of several different transport media, carriage at variable ambient temperatures over varying periods of time (1-4 weeks), and culture in media usually employed for bacteria of human origin, a comprehensive analysis of faecal bacteria in penguins awaits the development of standardized protocols for carriage and culture of faecal specimens and the use of media for culturing a wide range of bacteria including those of marine origin. The rapidly increasing exposure of penguins colonies to human activity highlights the importance of collecting baseline data on the presence of microbial agents, both for monitoring human impacts and for developing conservation strategies for penguins in the wild.

(oral presentation)

**INCIDENTAL MORTALITY ON  
HUMBOLDT PENGUIN *SPHENISCUS  
HUMBOLDTI* IN FISHING NETS IN THE  
VALPARAISO REGION, CHILE**

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Some of the main causes of decrease in the population abundances of the Humboldt Penguin *Spheniscus humboldti* are the loss of nesting habitat resulting from guano harvests and food shortage due to extensive overfishing. Other causes of probable mortality, such as drowning in fishing nets, have been poorly reported. Since 1991 we have been surveying the shoreline between the cities of Viña del Mar and Concón in the Valparaíso Region, assessing penguin mortality. This area is heavily exploited by local fishermen. We have detected three massive drownings of spheniscid

penguins, mainly Humboldts. Other diving birds (e.g. Guanay Cormorant *Phalacrocorax bougainvillii*, Redlegged Cormorant *P. gainardi*) have been also affected. The first drowning event occurred in 1991 resulting in 132 dead birds. A second occurred in 1992 with 156 dead birds. The last massive mortality (and the largest), occurred in 1994 with 193 dead birds. During 1993 and 1995 no large mortalities were detected but small and localized ones were reported. These mortalities are probably affecting the density of the local breeding colonies, which are located at Cachagua (an islet about 50 km north of the drowning area) and Pájaros Niños (an islet about 90 km south of the drowning area). Nevertheless, no birds from the latter colony have been identified (many of which are marked) among the dead birds. Thus, it is highly probable that Cachagua is presently the most affected nesting site on the Central coast of Chile.

(oral presentation)

**EMPEROR PENGUIN *APTENODYTES  
FORSTERI* STOMACH STONES AND  
GEOLOGICAL CORRELATIONS IN  
COASTAL ANTARCTICA**

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This paper reports on an analysis of field collection of stomach stones from Emperor Penguin *Aptenodytes forsteri* colonies in the eastern Weddell Sea (Aika Bay, Riiser-Larsen, and Dawson-Lambton colonies). It has been known for some time that Emperor Penguins ingest stones, perhaps while feeding, but why this is done is uncertain. It may be accidental, but may also be related to the need for ballast for deep diving, or as a grinding agent for food (e.g. squid beaks). The stones are presumably collected from the sea bottom, but could possibly be ingested while they sink through the water column after release from the melting ice, thereby resembling food. Whatever the reason, these stones are often revealed when the

stomach of penguins are flushed to determine the makeup of their food resource. Stones are also seemingly found in guano in the colonies, but more commonly regurgitated on the ice. The latter implies that some of these stomach stones are passed from adults to chicks during feeding, and the chicks presumably eliminate them by vomiting. This paper is primarily about the analysis of hundred of stomach stones ingested by Emperor Penguins as a means of correlation with coastal geology adjacent to the penguin colonies. These coastal areas are mostly glacier-covered, and no visible geology is evident for hundreds of kilometres inland to assist in geological interpretation. Offshore sedimentation is a function of glacier erosion on land, and deposition of sediments in a near-shore environment. Many stomach stones reach pebble-size, i.e. 2-64 mm-Modified Wentworth Scale. The availability of stomach stones from penguins can assist in broad correlations between stones representing bottom sedimentation samples and nearby geological sources of the pebbles, and perhaps information on glacier flow and iceberg production. This combination of multidisciplinary study incorporates both biological and geological information to determine glacial-sedimentation processes and source areas where little, if any, information is known about the coastal geology. In one documented case in the Weddell Sea, a stone found by flushing an Emperor Penguin stomach yielded an industrial-grade diamond, a mineral previously unknown in any land-based discovery on the Antarctic Continent. A reassembly of Gondwanaland segments would suggest a geological connection between Antarctica and South Africa, an area of known diamond deposits.

(oral presentation)

#### EXCEPTIONAL MECHANISMS OF BROOD REDUCTION IN CRESTED PENGUINS

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Brood reduction, the death of one or more dependent offspring, occurs routinely in

hundreds of avian species but crested penguins (genus *Eudyptes*) are unique among all birds for the manner in which it occurs. Here, the first-laid egg is 15 to 40% smaller than the second, either disappears from the nest soon after laying (three species) or, if retained throughout incubation (as occurs with a variable frequency in the other three species), hatches after the second-laid egg. To understand better the evolutionary implications of this pattern, I attempted to identify the proximate mechanisms responsible for two outstanding features: (a) extreme first-egg mortality and (b) reversed hatch order. Observed first-egg losses in Royal Penguins *E. schlegeli* mainly resulted from apparently deliberate ejection by female parents: 15 of 22 eggs were scraped or lifted from the nest. Most first eggs were lost within the 24-h period before second eggs were laid. Rates of extra-pair parentage among cross-fostered, first-egg chicks were low, making it unlikely that this phenomenon has led to the evolution of ejection behavior. Parents manipulated to raise first eggs had only half the hatching success of parents that raised only second eggs, suggesting that first eggs provided little insurance value in Royal Penguins. In Rockhopper Penguins *E. chrysocome*, by contrast, observed first-egg losses stemmed from Subantarctic Skua *Catharacta antarctica* predation, aggressive behaviour among conspecifics, and sibling movements. Rates of first-egg retention varied little between two geographic locations, but differed significantly among three microhabitat types within a single site. First eggs provided slight, but detectable, insurance against second-egg failure at laying and during incubation. Three factors, laying order, intra-clutch dimorphism, and laying date, contributed significantly and additively to incubation length in Rockhopper Penguins and presumably cause the unique reversal in hatching asynchrony characteristic of crested penguins. Differences in incubation onset and absolute egg size had no effect on incubation length, despite the disproportionate amount of albumen in larger eggs.

(poster presentation)

#### FIDELITY TO NEST SITE AND MATE IN FIORDLAND CRESTED PENGUINS

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Fiordland Crested Penguins *Eudyptes pachyrhynchus* are the least gregarious of the eudyptid penguins, nesting in caves, burrows, and under dense vegetation along the southwest coast of New Zealand. A population on Open Bay Island (43° 50'S, 168° 53'E), New Zealand was monitored, with varying degrees of intensity, from 1988 to 1995. During this period, 175 adults were banded in three semicontiguous areas and their returns to 46 mapped nest sites were recorded. In 1989, reproductive success to the creche stage was also known. Mean nest fidelity averaged 73% for males and 68% for females with slightly lower values for mate fidelity (66% for males, 61% for females). Cases of mate infidelity stemming from separation (i.e. both members of the previous pair were present) averaged 11% for males and 20% for females. None of these parameters differed significantly between the sexes. Fidelity in 1989 to a 1988 nest site resulted in higher reproductive success for both sexes in 1989 with a trend in the same direction for mate fidelity. By contrast, reproductive success in 1989 did not influence 1990 patterns of nest or mate fidelity. Separation in 1990 (i.e. mate switches that occurred when the previous mate was present) was significantly more likely in both sexes following reproductive failure in 1989. Eight cases of mate switching occurred within years in addition to those that occurred between them. We compare these patterns to similar published data for other species of penguins and seabirds.

(oral presentation)

#### DO HUMAN VISITS HARM COLONIAL PENGUIN COLONIES?

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Antarctica's colony-breeding penguins, until recently visited only occasionally by scientists, are now popular targets for tourist visits. At current levels of tourist numbers, colonies at some popular sites may receive parties of 40 to 100 visitors every second or third day throughout the breeding season. During the past seven to eight years passenger numbers have doubled and redoubled. Further substantial increases may be expected by the end of the century, with corresponding increases in tourist visits. Evidence on the effects of frequent visits to breeding colonies is conflicting. Some colonies have declined during periods of frequent human visitation; others have remained steady, or increased due to other causes despite visitation. Though tour operators generally seek to minimize interference in visited colonies, there is no clear understanding of what constitutes damaging levels of visitation, and little information on such key issues as habituation, size, and vulnerability of colonies at different stages of the breeding cycle. Research is inhibited by the need for methods that impose less impact than the visits themselves. This paper reviews evidence from recent field studies of tourist visits to Antarctic Peninsula penguin colonies, and suggests achievable strategies that will (a) critically monitor impacts of visits, and (b) minimize the overall effects of visits on Antarctic populations.

(oral presentation)

#### FOOTPRINTS OF THE PENGUIN FUND

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The Penguin Fund is a nonprofit and voluntary organization having a network of people who like penguins. With the slogan of "sharing our future with penguins", it was set up on 23 December 1986 by Aoyanagi and a few others who take particular interest in penguins. Our major activities are: 1. Financial support for the groups and individuals who are working under penguin protect plans, and also for penguin researchers; 2. Sponsor of the cultural and research exchange programmes between penguin researchers all over the world; 3. Encouraging the current penguin research; 4. Collecting materials and literature on penguins; and 5. Publishing books on penguins. There are no regulations and membership fees are not obligatory. All the staff and members are volunteers. The penguin goods such as penguin stationery, t-shirts and dolls are sold by auction for our fund raising. However, any contributions are gratefully accepted from companies and individuals who kindly offer to the Penguin Fund. Regular meetings and auctions are held every other month. A lecture series on penguin biology by Aoyanagi is held usually five times a year and members are requested to register for the course. Our last 10-year contributions have amounted to 3.7 million Yen, being distributed to the First (1988), Second (1992) and the Third (1996) International Penguin Conferences, and also to some groups such as the Yellow-eyed Penguin Trust (New Zealand), the Phillip Island Penguin Reserve (Australia), the Charles Darwin Foundation (Ecuador) and the South African National Foundation for the Conservation of Coastal Birds (South Africa). In addition, we have supported two other groups in England and Australia, totalling 10 penguin researchers with 50 000 Yen each. This year is the 10th anniversary of the founding of the Penguin Fund, and our undertaking, past and present, will provide a basis for a brilliant future of activity and contribute to penguin protection and to penguin research.

*(in-absentia presentation)*

**THE 1994 APOLLO SEA OIL SPILL - ITS  
IMPACT ON THE AFRICAN PENGUIN  
AND REHABILITATION SUCCESS**

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The *Apollo Sea* sank between Dassen and Robben Islands, South Africa, on 20 June 1994. Heavy fuel oil subsequently washed ashore at these two islands, oiling many African or Jackass Penguins *Spheniscus demersus*. An estimated 9758 oiled African Penguins were rescued following the spill, including 86 from islands in Saldanha Bay, about 50 from Vondeling Island, about 7200 from Dassen Island and about 2400 from Robben Island. Most of the oiled penguins were in adult plumage. At both Dassen and Robben Islands, about 25% of the adult populations were oiled. About 5% of the overall population of adult African Penguins was affected. Reports of flipper-banded birds indicate that few penguins died at sea. About 1000 orphaned chicks were fed to fledging, many at Dassen Island, but an estimated 1650 chicks died at Robben Island as a result of the loss of their parents. An estimated 4669 penguins died during rehabilitation, whereas 5089 were returned to the wild. Approximately two thirds of the deaths occurred either during transport (1735 birds) or immediately after arrival at the rehabilitation centre (1240 birds). By 31 March 1994, only four of the 4076 penguins that were released with flipper bands had been reported dead. More than 2000 rehabilitated adults had been resighted at Dassen Island and about 500 at Robben Island. Rehabilitated birds continue to be sighted for the first time since release, indicating that proportion of released birds successfully rehabilitated will be substantially larger than 50%. At Dassen Island [x]% of rehabilitated adults had been observed breeding

by 31 March 1996, and at Robben Island [y]%. At Dassen Island, there were 9389 breeding pairs in April 1989 immediately prior to the spill. Post-spill counts have been 9792 in April 1995 and 9502 in March 1996. Thus there has been little overall impact of the spill on the breeding population. However, in the two areas at Dassen Island subject to heaviest oiling, there were substantial decreases in numbers of breeding birds in 1995 and 1996. At Robben Island, there were 2799 breeding pairs in May 1994 prior to the spill. This fell to 2279 in May 1995. Numbers of adult penguins at Robben Island decreased from over 7000 in 1993/94 and 1994/95 to less than 6000 in 1995/96, indicative of poor recruitment to the adult population following the oil spill.

(oral presentation)

**AQUARIUMS AS TOOLS IN PROMOTING  
CONSERVATION AND EDUCATION  
WITH SPECIAL FOCUS ON PENGUINS  
AT THE NEW ENGLAND AQUARIUM**

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The role of aquaria in conservation and education is ever increasing. The New England Aquarium's mission is to Present, Promote and Protect the World of Water and through our penguin outreach programmes, this goal is accomplished. The penguin has become a flagship species to increase awareness of and involvement in conservation efforts, not only at the New England Aquarium but around the world.

(poster presentation)

**PYGOSCELID PENGUIN MIXED  
COLONIES, SPATIAL DISTRIBUTION  
AND GROWTH, ARDLEY PENINSULA,  
SOUTH SHETLAND ISLANDS**

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Ardley Peninsula (62° 13'S, 58° 54'W) in the vicinity of King George Island, South Shetland Islands, has a mixed nesting colony of 4260 penguin nests, made up of Gentoo Penguins *Pygoscelis papua* (2985), Adélie Penguins *P. adeliae* (1226) and Chinstrap Penguins *P. antarctica* (49). The peninsula is 3.5 km long and 1.7 km at its wider sectors, highest elevations are 70 m. All nests are on the eastern zone. Our aims were to explain the uneven distribution of the nesting groups, determine how the colony grows and the precise locations of nests for each species and find some of the factors that influence nest-site selection. The spatial distribution of all the nests was determined using a laser theodolite Wild TC-500 with record card GR-4 and a 486 laptop computer. Since the topography of the peninsula was not available we obtained a preliminary version using a series of aerial photos from a survey by the Chilean Air Force in 1983. Then we created a data base for a GIS. To facilitate the obtaining of unequivocal data of the number and position of each group of nests, we divided the nesting area in seven zones. Only one zone (3) contains nest groups of the three species. Chinstrap Penguins never nest alone in this locality, only two groups have nests of the three species. Groups containing two species are more frequent and tend to increase with time. We compared the spatially explicit census data of seasons 1993-94, 1994-95 and 1995-96. Our data shows fluctuations for each species and seasons. One of the factors that affects nest site selection and position is the availability of nest construction material. Nests may contain as many as 1200 pebbles, to collect that amount of material is a time-consuming task, our observations show that nests are recycled. Successful pairs will tend to nest at the same site. We discuss the possible factors that influence nests site selection for these species.

(oral presentation)

**TOTAL MERCURY IN ADELIE  
PENGUINS FROM SOUTH SHETLAND  
ISLANDS, ANTARCTICA**

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Concentrations of total mercury in several tissues and organs of adult specimens of the Adélie Penguin *Pygoscelis adeliae* have been determined. The specimens were collected during the 1992/1993, 1993/94 and 1994/95 austral summer seasons around Jubany Station, King George Island, South Shetland Islands, Antarctica. The sampling was carried out taking only animals found recently dead, without evident damage or deterioration signs. The animals were immediately frozen at -20°C until autopsy and analysis. The concentration of total mercury was performed utilizing classical "cold vapour" methodology. The observed trend in mercury concentration was in order feathers > liver > kidney > heart > muscle > egg. Results were similar with those reported for Adélie Penguins from Eastern Antarctica, but the mercury concentrations were higher.

(poster presentation)

**BODY MASS CHANGE OF ADELIE  
PENGUIN PARENTS DURING FORAGING  
TRIPS AND CHICK REARING IN AREAS  
WITH AND WITHOUT SEA-ICE**

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Parents of long-lived seabirds (petrel species, etc.) adjust food provisioning for the chicks to maintain their own mass by alternating long and short foraging trips. Adélie Penguins *Pygoscelis adeliae* show great variability in their foraging trip duration depending on season, year and region. Relationships between their trip duration, parental mass change and food provisioning were compared between two areas of contrasting sea-ice condition at the time units of trip duration (1-7 days) and chick rearing (three weeks; guard to early creche stage). Parents made longer trips with greater meals and larger mass increase at Magnetic Island, Prydz Bay in 1992/1993 where sea-ice disappeared than they did at Hukuro Cove, Lüzow-Holm Bay in 1995/1996 where fast sea-ice remained. Throughout chick rearing, parents lost mass at a similar rate at both colonies. At both colonies the mass increase rates of broods were greater for parents delivering meals with higher rates, though were not dependent on the rates of parental mass loss. These indicate large individual and regional variations in the foraging efficiency or food allocation pattern.

(poster presentation)

**REHABILITATION - ITS CONTRIBUTION  
TO POPULATION DYNAMICS AND ROLE  
IN THE CONSERVATION OF THE  
AFRICAN PENGUIN *SPHENISCUS  
DEMERSUS***

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Pollution of the marine environment by oil is an ever present threat to coastal and marine flora and fauna. Of the bird species affected by such pollution in southern Africa, the African or Jackass Penguin *Spheniscus demersus* is particularly vulnerable, being flightless and foraging within a relatively short distance of its inshore and coastal breeding localities. Since 1968, the South African Foundation for the Conservation of Coastal Birds (SANCCOB) based in Cape Town, has cleaned and rehabilitated an average of 2000 African Penguins per year. However, fuel oil spilt from



a sinking bulk ore carrier, the *Apollo Sea*, in June 1994, resulted in over 9700 penguins arriving at SANCCOB from this one incident alone. In contrast to many other attempts to rescue oiled seabirds around the world, SANCCOB has attained a high degree of success in releasing rehabilitated penguins. This paper shows that flipper banding of rehabilitated birds has provided an insight into the survival of these birds after release, allowing us to assess the contribution made by rehabilitation to the population dynamics and conservation of this near-threatened species.

(oral presentation)

### THREE-DIMENSIONAL FORAGING SPACE OF FEMALE EMPEROR PENGUINS DURING THE ANTARCTIC WINTER

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We determined the three-dimensional foraging space of female Emperor Penguins *Aptenodytes forsteri* from Auster colony during the Antarctica winter of 1994. Information was gathered by deploying satellite transmitters and time-depth recorders on 12 females leaving the colony after laying (May) to spend the winter at sea. Foraging space was also determined for three males on their first feeding trip after their extended winter fast at the colony. Over 40 000 dives and 1308 days of tracking were recorded for the female Emperor Penguins. Trip durations for the females were 2-5 months during which time they travelled up to 5000 km. In contrast, males went to sea for 20-30 days during which they travelled up to 500 km. Ten females spent the winter within 150 km of Auster to the north and west of the colony over the outer edge of the continental shelf. Their foraging grounds were roughly coincident with a polynya of open water that formed between the edge of the fast ice and dense pack ice. Whereas most dives were in the upper reaches of the water column the females occasionally foraged on the sea bed at a depth of

more than 380 m. The remaining two females spent the winter in dense pack ice; one ventured up to 300 km north of the colony. In contrast to the females the males foraged east of Auster within 70 km of the colony over the continental shelf and in waters over a 1000-m deep canyon. The males tended to forage mainly at similar depths to the females but their maximal diving depths were deeper (478 m). Preliminary analysis showed that they consumed similar types of benthic prey species as did the females. The extent and thickness of the fast ice over the continental shelf changes during the sampling period and appeared to have had a major influence on foraging space available to both females and males.

(oral presentation)

### THE FORAGING BEHAVIOUR OF BREEDING CHINSTRAP PENGUINS AT ARDLEY ISLAND, ANTARCTICA

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The foraging behaviour of breeding Chinstrap Penguins *Pygoscelis antarctica* was studied at Ardley Island (62° 13'S, 58° 55'W), Antarctica during the austral summer of 1990/91 and 1995/96. Multiple channel loggers (MCLs) recording swim speed, heading and dive depth were fitted to birds which had also been given stomach temperature loggers (STLs) to determine when prey were ingested. All dives were either V or U shaped and appeared to be pelagic. Birds rarely dived in excess of 100 m. The following parameters were positively correlated with maximum depth reached during the dive: descent duration, ascent duration, dive angle, return to surface angle and rate of change of depth. There were differences in the characteristics of the dives according to whether the birds fed or not. The sequence of maximum depths reached by birds during a dive bout was not random and is considered in detail.

(oral presentation)

title. Penguin banding: time for a reappraisal?

B. STONEHOUSE

tract. Penguins have been marked individually in research for over 90  
rs. Early banding experiments date from January 1909, when coloured  
sus bands of unknown material were applied to Adelle penguins, and  
covered in the same and the following year. Tarsus banding, with the  
ortant adjunct of web-punching, formed the basis of Richdale's major  
dy of yellow-eyed penguins 1932-58. Sladen (1947 onward) appears to  
e been the first to use metal flipper bands, and to have experimented  
h different materials and methods of fastening. His lead has since  
n followed by almost every subsequent penguin researcher, though with  
appointing lack of innovation or consideration of alternative methods  
marking for different purposes. Most workers for most purposes still  
uire markers that are cheap, readily applied, immediately identifiable,  
provide at least cohort and at best individual recognition, of the  
d that flipper bands provide. While standard bands of durable metal  
still be best for some purposes, mass-banding with all-purpose bands  
uld no longer be regarded as sound practice. In any study involving  
ding, care needs to be given to determining the precise nature of  
ormation required, and optimizing the nature, design and materials of  
bands to be used, and the numbers required to achieve particular  
activities.

(oral presentation, replacing that in booklet)

**PENGUIN PUMPING PROBLEMS?**Y.M. VAN HEEZIK<sup>1</sup>, J.T. DARBY<sup>2</sup> & P.J. SEDDON<sup>1</sup><sup>1</sup>National Wildlife Research Center, P.O. Box 1086, Taif,  
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Since the development of the stomach-flushing technique for obtaining stomach contents from penguins, many penguins have lost their dinners in the pursuit of systematic data collection, and much valuable information has been collected and published. In the case of the Yelloweyed Penguin *Megadyptes antipodes*, a comparatively rare species, efforts have been made to reduce the immediate impact of removing a meal by feeding something back after the birds had been flushed out. Medium- and long-term effects are more difficult to assess. We present information on effects of stomach flushing on the future survival, breeding and breeding success of Yelloweyed Penguins.

(poster presentation)

