



**August 29 – September 3, 2010
Boston, Massachusetts
United States**

Hosted by the



**New England
Aquarium**

Protecting the blue planet

Special thanks to





Welcome to the Seventh International Penguin Conference!

It is my pleasure to welcome everyone to the Seventh International Penguin Conference. Since its inception in 1988, the International Penguin Conference has provided an important opportunity for the world's leading scientists, research managers and policy makers to discuss ongoing research, identify current and emerging conservation issues and create action plans. We are especially proud to bring you all here to Boston for this year's gathering. Not only is this the first time the Conference has been held in the northern hemisphere but the first time an aquarium has hosted the event.

The Steering Committee reviewed more than 90 oral abstracts and has compiled a program of 73 oral presentations that we anticipate will advance a strategic, global effort to protect threatened penguin species. More than 50 posters will introduce you to even more research on significant threats and promising conservation activities. The Organizing Committee has tried to anticipate your needs while you are here, but please don't hesitate to let us know if we missed something.

Finally, a special thanks to the many institutions, companies and individuals who have contributed both financial and in-kind support to bring researchers from around the globe to the Conference.

I look forward to a successful International Penguin Conference and continuing collaboration.

Heather Urquhart
Chair, International Steering and Local Organizing Committees
Penguin Exhibit and Collection Manager
New England Aquarium
Boston, MA USA

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Sunday, August 29 New England Aquarium, Central Wharf, Boston

7:00 p.m. - 10:00 p.m. Registration and Reception

Monday, August 30 Federal Reserve Bank of Boston, 600 Atlantic Avenue

8:00 - 10:00 Registration (Lobby)

8:30 - 9:15 Welcome/Opening (Morris Auditorium, ground floor)

Theme: Breeding Behavior

- 9:15 - 9:45 Keynote: Le Bohec et al., How climate affects juvenile survival and recruitment in the king penguin
- 9:45 - 10:05 Banks to present et al., The influence of colony size on Adélie penguin breeding schedules and endocrinology in 'good' or 'bad' sea ice years – no evidence for the Darling effect
- 10:05 - 10:25 Davis, Breeding behaviour and brood reduction in erect-crested penguins (*Eudyptes sclateri*)
- 10:25 - 11:05 Break**
- 11:05 - 11:25 Saraux et al., Unequal parental investment in breeding little penguins
- 11:25 - 11:45 Nisbet et al., Growth of little penguin (*eudyptula minor*) chicks in relation to hatching date, parental age and parental quality
- 11:45 - 12:05 Salton et al., Links between the non-breeding season and subsequent reproductive performance in an income breeder: the little penguin *Eudyptula minor*
- 12:05 - 12:25 Marker, Location, location, location - it makes all the difference to nesting success of little penguins in Tasmania
- 12:25 - 12:45 Mouterde et al., The impact of triumph displays on "eavesdropping" little blue penguins
- 12:45 - 2:15 Lunch (Bridge, fourth floor)**
- 2:15 - 2:35 Makhado et al., Patterns of attendance of African penguins at colonies
- 2:35 - 2:55 Sherley et al., Spatial and temporal variation in growth and condition of African penguin chicks at five colonies in South Africa
- 2:55 - 3:15 Waller et al., African penguin breeders and adult moulters: colony relationships to surrounding fish stocks
- 3:15 - 3:35 Rebstock and Boersma, Parental behavior determines egg temperature and incubation period in Magellanic penguins
- 3:35 - 3:55 Hiriart-Bertrand and Simeone, Sympatric distribution of Magellanic and Humboldt penguins in southern Chile: ecological implications of coexistence and hybridization
- 4:00 - 5:00 Break**
- 5:00 - 7:00 Posters (AV Lounge and AV Room 3, third floor)**



Tuesday, August 31 Federal Reserve Bank of Boston, 600 Atlantic Avenue

7:30 a.m. - 10:30 a.m. Registration (Lobby)

Theme: Captive and Medical

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|----------------------|--|
| 8:30 - 9:00 | Keynote: Henry and DuBois, Creating connections between penguins and the public: the role of zoos and aquaria in facilitating research and communicating results |
| 9:00 - 9:20 | Urban, Penguins - marine ambassadors for conservation |
| 9:20 - 9:40 | Misslin-Dunn et al., Ambassadors for the plight of the African penguin at Mystic Aquarium |
| 9:40 - 10:00 | Jarvis, Successful management in captive penguin colonies |
| 10:00 - 10:40 | Break |
| 10:40 - 11:00 | Schneider, Penguin research and conservation by AZA institutions |
| 11:00 - 11:20 | Mazzaro et al., Dietary salt supplementation for African penguins (<i>Spheniscus demersus</i>) housed in freshwater habitats -- yes or no? |
| 11:20 - 11:40 | Tuttle et al., Eastern Equine Encephalitis infection in a flock of African penguins (<i>Spheniscus demersus</i>) |
| 11:40 - 12:00 | Argilla, An investigation into the prevalence of <i>Leucocytozoon</i> in the endangered yellow-eyed penguin (<i>Megadyptes antipodes</i>) on Enderby Island |
| 12:00 - 12:20 | van Rensburg et al., Ectoparasites of little blue penguins in New Zealand: seasonal trends and host-parasite dynamics |
| 12:20 - 2:00 | Lunch (Bridge, fourth floor) |
| 2:00 - 2:20 | Kane et al., Feather-loss disorder in African and Magellanic penguins |
| 2:20 - 2:40 | Barbosa et al., Variability of plasma carotenoid levels in the Gentoo penguin (<i>Pygoscelis papua</i>): geography, physiology and age |
| 2:40 - 3:00 | Dewar et al., The gastrointestinal microbiota of king penguins (<i>Aptenodytes patagonicus</i>) and the influence of geographical separation |
| 3:00 - 3:20 | Poisbleau et al., Is yolk androgen deposition in rockhopper penguins a maternal favoritism strategy? |
| 3:20 - 3:40 | Banks et al., The effect of stress on the faecal bacteria of Adélie penguins |
| 3:40 - 4:00 | Teulier et al., Passage from shore to marine life increases lipid oxidative capacity in juvenile king penguins |
| 4:00 - 5:00 | Break |
| 5:00 - 7:00 | Posters (AV Lounge and AV Room 3, third floor) |



Wednesday, September 1 Federal Reserve Bank of Boston, 600 Atlantic Avenue

7:30 a.m. - 10:30 a.m. Registration (Lobby)

Theme: Foraging

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|----------------------|--|
| 8:30 - 9:00 | Keynote: Dann et al., Foraging areas of little penguins and the distribution of their main prey in winter: do the penguins know what they are doing? |
| 9:00 - 9:20 | Pütz et al., Post-moult dispersal of sympatrically breeding Humboldt and Magellanic penguins in south-central Chile |
| 9:20 - 9:40 | Rey et al., Foraging behaviour during chick rearing of sympatrically breeding Humboldt and Magellanic penguins in southern Chile |
| 9:40 - 10:00 | Underhill et al., A new approach to track analysis: evaluating the scales of movement of foraging penguins |
| 10:00 - 10:40 | Break |
| 10:40 - 11:00 | Butler et al., Year-round foraging behaviour and energetics of macaroni penguins |
| 11:00 - 11:20 | Le Vaillant et al., king penguins learn air load management with age |
| 11:20 - 11:40 | Wasiak et al., The role of shell grit ingestion in the reproductive biology of little penguins |
| 11:40 - 12:00 | Cannell et al., 2008: The year of the global financial crisis <u>and</u> the Perth penguin crisis? |
| 12:00 - 12:20 | Werner et al., Are penguins in Antarctica in danger from krill fishing? |
| 12:20 - 2:00 | Lunch (Bridge, fourth floor) |
| 2:00 - 2:20 | Polito et al., Stable isotopes reveal regional variation in the pre-breeding diets and foraging habitats of sympatrically breeding <i>Pygoscelis</i> penguins in the Antarctic peninsula |
| 2:20 - 2:40 | Simeone et al., Artificial burrows for Humboldt penguins: first attempt for increasing breeding habitat in Chile |
| 2:40 - 3:00 | Beaulieu, Foraging strategies and oxidative stress: a pair affair in the Adélie penguin |
| 3:00 - 3:20 | Toniolo et al., Foraging success of Adélie penguins as determined by fine-scale oceanographic features of the SW Ross Sea |
| 3:20 - 3:40 | Mori et al., An observation of between-mates feeding behavior in chick-guarding chinstrap penguins |
| 3:40 - 4:00 | Hart et al., From one dive to the next; using time series analysis for penguin dive behavior |
| 4:00 - 5:00 | Break |
| 4:30 - 6:45 | Penguin Status Meeting (New England Aquarium, Harborside Learning Lab) García-Borboroglu et al., Penguin status in troubled oceans |
| 7:00 - 9:00 | Public Event (New England Aquarium, IMAX theatre) |



Thursday, September 2 Federal Reserve Bank of Boston, 600 Atlantic Avenue

7:30 a.m. - 10:30 a.m. Registration (Lobby)

Theme: Conservation and Ecology

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| 8:30 - 9:00 | Keynote: Kooyman et al, Mystery and speculation about variability in Ross Sea emperor penguin colonies |
| 9:00 - 9:20 | Garcia-Borboroglu et al., Global Penguin Society: the penguin advocacy for the oceans. |
| 9:20 - 9:40 | Ratcliffe et al., Can tracking data and habitat preference models be used to design marine protected area networks for penguins? |
| 9:40 - 10:00 | Cox et al., The oiled penguin problem in South Africa: recent evidence for sunken ships, natural seeps, and chronic oil dumping |
| 10:00 - 10:40 | Break |
| 10:40 - 11:00 | Kemper et al., Return of the pink brigade: monitoring rehabilitation success and return of African penguins oiled in Namibia and released in South Africa after rehabilitation |
| 11:00 - 11:20 | Boersma et al., Petroleum discharge no longer a major mortality factor for Magellanic penguins along Chubut coast |
| 11:20 - 11:40 | Simeone, Mortality of <i>Spheniscus</i> penguins in gill nets in Chile, a conservation problem that requires an urgent regulation |
| 11:40 - 12:00 | Parsons et al., Hand-rearing and release of African penguin chicks abandoned by moulting parents in the Western Cape, South Africa, 2001-2009 |
| 12:00 - 12:20 | Clark et al., Magellanic penguins pair assortatively by strength of cell-mediated immune response |
| 12:20 - 2:00 | Lunch (Bridge, fourth floor) |
| 2:00 - 2:20 | Ainley et al., The 'ecology of fear' and the natural history patterns of Antarctic penguins |
| 2:20 - 2:40 | Viblanco et al., Social stress in a colonial seabird: heart rate responses of breeding penguins to their aggressive conspecifics |
| 2:40 - 3:00 | Le Maho et al., Approaching penguins for identification: is a robot less stressing than humans? |
| 3:00 - 3:20 | Villanueva et al., Ecotourism effects on Magellanic penguins at San Lorenzo colony, Peninsula Valdés, Argentina |
| 3:20 - 4:00 | Break |
| 4:00 - 4:20 | Walker et al, Behavior and hormonal responses to tourism stress differ with variable history of visitation to Magellanic penguin colonies |
| 4:20 - 4:40 | Dugger et al., Age-related variation in survival and movement rates of the Adélie penguin in response to colony size and breeding status |
| 4:40 - 5:00 | Ballard et al., Modeling of top predators to inform conservation spatial planning in the Ross Sea, Antarctica |
| 6:30 - 10:00 | Dinner Cruise (Spirit of Boston, 200 Seaport Boulevard, Boston) |



Friday, September 3 Federal Reserve Bank of Boston, 600 Atlantic Avenue

7:30 a.m. – 10:30 a.m. Registration (Lobby)

Theme: Global Change

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|----------------------|---|
| 8:30 – 9:00 | Keynote: Crawford et al., South Africa's penguins collapse following intensified competition with fisheries for food, thought attributable to environmental change |
| 9:00 – 9:20 | Pozzi et al., Magellanic penguin (<i>Spheniscus magellanicus</i>) northward distributional changes in Patagonia |
| 9:20 – 9:40 | Steinfurth et al., Breeding behaviour of the Galápagos penguin (<i>Spheniscus mendiculus</i>): implications for conservation |
| 9:40 – 10:00 | Chiaradia et al., The marine life of the smallest penguin (<i>Eudyptula minor</i>) in a changing world |
| 10:00 – 10:40 | Break |
| 10:40 – 11:00 | Crofts et al., Population status, diet and conservation of rockhopper and Gentoo penguins at the Falkland Islands |
| 11:00 – 11:20 | Levy et al., Shifting ice, missing fish – population genetics of the Gentoo penguin |
| 11:20 – 11:40 | Lynch et al., Climate change winners and losers: regional-scale patterns of population change among pygoscelid penguins on the Antarctic Peninsula |
| 11:40 – 12:00 | Lescroël et al., Behavioral plasticity of Adélie penguins in response to varying sea-ice conditions |
| 12:00 – 12:20 | Dugger et al., Plasticity in the natural history patterns of Adélie penguins: results of a millennial-scale natural experiment |
| 12:20 – 2:00 | Lunch (Bridge, fourth floor) |
| 2:00 – 2:20 | Woehler, Breeding population trends of Adélie penguins at Casey over 50 years |
| 2:20 – 2:40 | Emmerson et al., Variability in the breeding phenology of Adélie penguins at a colony: potential causes and consequences for reproductive success |
| 2:40 – 3:00 | Trathan et al., Emperor Island? The demise of the emperors |
| 3:00 – 3:20 | Fretwell et al., Penguins from space: estimating emperor penguin (<i>Aptenodytes forsteri</i>) populations through faecal stains and image recognition analysis of individuals and huddles. |
| 3:20 – 4:00 | Jenouvrier et al., Climate change threatens emperor penguins. |
| 4:00 | Closing Remarks |



Oral Presentation Abstracts

How climate affects juvenile survival and recruitment in the king penguin

Le Bohec, Céline [Centre for Ecological and Evolutionary Synthesis, Department of Biology, University of Oslo, PO Box 1066 Blindern, N-0316 Oslo, Norway; Département d'Écologie, Physiologie et Éthologie, Institut Pluridisciplinaire Hubert Curien - CNRS, UMR 7178, 23 rue Becquerel, Strasbourg, France.], **Roger Pradel** [Centre d'Écologie Fonctionnelle et Évolutive - CNRS, UMR 5175, 1919 Route de Mende, Montpellier, France ; Institut Mediterrani d'Estudis Avançats, Esporles, Spain], **Claire Saraux** [Département d'Écologie, Physiologie et Éthologie, Institut Pluridisciplinaire Hubert Curien - CNRS, UMR 7178, 23 rue Becquerel, Strasbourg, France; AgroParisTech ENGREF, 19 avenue du Maine, Paris, France], **Joël M. Durant** [Centre for Ecological and Evolutionary Synthesis, Department of Biology, University of Oslo, PO Box 1066 Blindern, Oslo, Norway], **Michel Gauthier-Clerc** [Centre de Recherche de la Tour du Valat, Le Sambuc, Arles, France.], **Benjamin Friess** and **Yvon Le Maho** [Département d'Écologie, Physiologie et Éthologie, Institut Pluridisciplinaire Hubert Curien - CNRS, UMR 7178, 23 rue Becquerel, Strasbourg Cedex 02, France.] and **Nils Chr. Stenseth** [Centre for Ecological and Evolutionary Synthesis, Department of Biology, University of Oslo, PO Box 1066 Blindern, Oslo, Norway; Institute of Marine Research, His, Norway.]

Seabirds are sensitive indicators of climate-induced changes in marine resources. While juvenile survival and recruitment may be important determinants of population fitness, few studies have directly examined the effect of environmental stochasticity on these life history traits. Here, we investigate the effects of age-specific post-fledging survival and breeding attempts on recruitment related to environmental variability in the King penguin through long-term monitoring of several cohorts (electronically marked at age 1 since 1998). We show that local survival in the year following fledging is lower than subsequent year survival probabilities. We suggest that lower quality individuals may disappear from cohorts during this first stressful event (i.e. the selection hypothesis). This might also result from an increase in foraging performance of individuals as they gain experience (i.e. the constraint hypothesis). Post-fledging survival probability after the first winter at sea differed among cohorts, potentially attributed to the variation in environmental conditions that each cohort experienced early in life (at birth and growth, and/or during their first foraging experience at sea). Recruitment modeling will now allow us to assess the influence of environmental conditions encountered during early life and at breeding on juvenile survival and the probability of breeding at a given age.

The influence of colony size on Adélie penguin breeding schedules and endocrinology in ‘good’ or ‘bad’ sea ice years – no evidence for the Darling effect

Ninnes, C.E., J.R. Waas, , and N. Ling [Department of Biological Sciences, University of Waikato, Private Bag 3105, Hamilton, New Zealand], **S. Nakagawa** [Department of Biological Sciences, University of Waikato, Private Bag 3105, Hamilton, New Zealand; Department of Zoology, University of Otago, PO Box 56, Dunedin, New Zealand], **J.C. Banks, D.G. Bell, and A. Bright** [Department of Biological Sciences, University of Waikato, Private Bag 3105, Hamilton, New Zealand], **P.W. Carey** [SubAntarctic Foundation for Ecosystems Research, 8 Estuary Road, Christchurch, New Zealand], **J. Chandler, Q.J. Hudson, J.R. Ingram, K. Lyall, D.K.J. Morgan, M.I. Stevens, and J. Wallace** [Department of Biological Sciences, University of Waikato, Private Bag 3105, Hamilton, New Zealand], and **E. Möstl** [Institute of Biochemistry, Department of Natural Sciences, University of Veterinary Medicine, A-1210 Vienna, Austria]

The Darling hypothesis predicts that in colonial birds, breeding is hastened and synchronized in larger colonies due to increased social stimulation (via endocrine changes). We examined, at two sites over two seasons, whether the timing of breeding varied with colony, or sub-colony size; baseline hormone levels, and survival, were measured to investigate mediating mechanisms. The influence of environmental variability was also examined, by relating the above parameters to sea ice conditions. The smaller colony showed later, but more synchronous breeding than the larger colony; perhaps because of the persistence of extensive sea ice at the smaller breeding site during the first season. Sub-colony size did not influence the onset or synchrony of breeding, survival, or hormone levels within either of the two breeding sites. Therefore, little support was found for the Darling hypothesis at the colony or sub-colony level. Higher corticosterone metabolite and lower sex hormone levels at the smaller colony correlated to later breeding and lower survival compared to the larger colony. This is also likely due to the persistence of extensive sea ice conditions late into the first season. Combining physiological, behavioural, and ecological information shows that many interacting variables may mediate the impact of the Darling effect.

Breeding behaviour and brood reduction in erect-crested penguins (*Eudyptes sclateri*)

Davis, Lloyd S. [Centre for Science Communication, University of Otago. P.O. Box 56, Dunedin, New Zealand]

Erect-crested penguins (*Eudyptes sclateri*) are obligate brood reducers and exhibit the most extreme egg-size dimorphism of any bird. It remains unclear why these birds should lay two eggs but only ever rear one chick. Davis, Renner and Houston have previously shown that the two most seriously considered hypotheses put forward to explain the phenomenon of obligate brood reduction in crested penguins are not consistent with the data derived from erect-crested penguins (namely, one egg does not function as insurance in case the other is lost, nor are egg losses due to fighting sufficient to explain reduced investment in the first-laid egg). Here I analyse data on behaviour collected from 139 nests of erect-crested penguins during a study from 29 September – 22 October 1998 and compare them with data obtained from the literature in order to assess likely evolutionary advantages and origins of brood reduction in these penguins.

Unequal parental investment in breeding little penguins

Saraux, Claire [Institut Pluridisciplinaire Hubert Curien UMR7178 CNRS, 23 rue Becquerel, Strasbourg, France; AgroParisTech ENGREF, 19 avenue du Maine, Paris, France], **André Chiaradia** [Research Department, Phillip Island Nature Park, P.O. Box 97 Cowes, VIC, Australia], and **Yvon Le Maho** and **Yan Ropert-Coudert** [Institut Pluridisciplinaire Hubert Curien UMR7178 CNRS, 23 rue Becquerel, Strasbourg, France]

One of the crucial points of life history theory in long-lived animals is to determine the characteristics of individuals that contribute disproportionately to the next generations, as they are a major force driving demographic trends. Using little penguins (*Eudyptula minor*) as a model, we investigated whether individuals of a pair provided equal parental investment when raising offspring and whether their behaviour was consistent over 8 years of contrasting resource availability (as inferred by breeding success). Using an automated identification system, we found that 72% of little penguin pairs exhibited unforced (i.e. that did not result from desertions of one parent) unequal partnership along the post-guard stage. This proportion decreased in years of high breeding success. If being an equal pair appeared to be a better strategy, it was nonetheless the least observed, probably because of unsustainable costs for one of the two partners. Individuals displaying a lower investment (negative parents) in raising chicks than their partner (positive parents) were not less experienced and neither did gender explain differences between partners. Further, positive or negative parents tended to remain so in subsequent years. We suggest that the reason for an unequal investment during breeding may result from individual's intrinsic quality.

Growth of little penguin *Eudyptula minor* chicks in relation to hatching date, parental age and parental quality

Nisbet, Ian C. T. [I. C. T. Nisbet & Company, 150 Alder Lane, North Falmouth MA, USA], **Andre Chiaradia** [Research Department, Phillip Island Nature Park, P.O. Box 97, Cowes, Victoria, Australia], and **Stephen P. Oswald** and **Jennifer M. Arnold** [Department of Biology, Pennsylvania State University, Berks Campus, P.O. Box 7009, Reading PA, USA]

We studied growth of Little Penguin *Eudyptula minor* chicks at Phillip Island, Victoria, Australia, in 10 breeding seasons (2000-09). Breeding dates varied by two months among years and chick survival varied from 15% to 90%, probably reflecting differences in food availability. Chicks were weighed every 2-3 days from the end of the guard stage (i.e., from age about 13 d). Body-mass data were fitted to a multi-parameter model describing the post-peak recession in mass prior to fledging. Hatching date advanced with increasing parental age within each year. Most of the growth parameters were independently related to hatching date and parental age, being better (more rapid growth, higher peak and fledging masses) among chicks hatched earlier and chicks with older parents. Chick growth parameters improved with parental age in the early years of breeding (ages 3-7 y), levelled off around the median age of breeding (ages 8-10 y), and declined significantly among the older birds (ages 11-16 y). After controlling for other factors, growth parameters varied markedly among years, and the performance of individual pairs was consistent in successive years. These findings about variation in chick growth extend earlier findings about variation in breeding dates and productivity.

Links between the non-breeding season and subsequent reproductive performance in an income breeder: the little penguin *Eudyptula minor*

Salton, Marcus and **André Chiaradia** [Research Department, Phillip Island Nature Parks, PO Box 97 Cowes, Victoria, Australia], **Claire Saraux** [Institut Pluridisciplinaire Hubert Curien UMR7178 CNRS, 23 rue Becquerel, 67087 Strasbourg, France ; AgroParisTech ENGREF, 19 avenue du Maine, Paris, France] and **Peter Dann** [Research Department, Phillip Island Nature Parks, PO Box 97 Cowes, Victoria, Australia]

Links between changes in resource availability during the non-breeding season and reproductive performance are expected for an animal whose performance is dependent on pre-breeding body reserves (capital breeder) but less so for an animal that can rapidly restore body reserves during breeding (income breeder). We examined non-breeding season body mass in relation to subsequent timing of laying and breeding success of an income breeder, the little penguin *Eudyptula minor* from 2001 to 2008. Body mass varied among years and within years, in both males and females. We suggest non-breeding season body mass can indicate changes in resource availability throughout this time of year. Mass, year and interactions between mass, year and sex explained variability in timing of laying and breeding success, albeit weakly (up to 15% of variability). This indicates that a significant link between non-breeding season body mass and subsequent reproductive performance can occur in some years and within a year it can be dependent on sex. Thus, differences between capital and income breeders appear more complex than suggested in foraging ecology theory alone.

Location, location, location - it makes all the difference to nesting success of little penguins in Tasmania.

Marker, Perviz [School of Zoology, University of Tasmania, Private Bag 05,
Hobart TAS Australia]

Little Penguins, *Eudyptula minor*, breed in a variety of habitats on land. The characteristics of the nesting habitat: vegetation cover and substrate, as well as the degree of human disturbance and proximity to urban development may all have a significant influence on their breeding success. GPS and GIS have been widely used to track and analyse the movements of birds at sea but these tools can also be very useful for investigating habitat requirements of birds in terrestrial breeding colonies. This project combines two scales of data and analysis – landscape GIS layers and fine scale on-ground data collected using Differential GPS at a decimetre level. The breeding habitat of several Little Penguins colonies in North West Tasmania, Australia has been mapped. A combination of spatial and multivariate analysis was used to investigate the range of habitats in which Little Penguins nest. The density of nesting burrows is highest in sites with greater vegetation cover and with a substrate in which the penguins can burrow easily. The significance of this may have implications for land managers and conservation of Little Penguin habitat.

The impact of triumph displays on “eavesdropping” little blue penguins

Mouterde, S., J.R. Waas, D. Duganzich, L.M. Molles, and S. Helps and F. Helps.
[Department of Biological Sciences, University of Waikato, New Zealand]

While post-conflict “triumph displays” have been described for many species, no experiment has yet assessed one of the main hypotheses explaining their existence: advertising victory to social eavesdroppers. We used playback to simulate an alternating calling match between two male little blue penguins (*Eudyptula minor*), followed by the sounds of a fight, and finally, the triumph call of one of the males; 5 min later, territorial birds occupying burrows neighbouring the playback site were played the call of either the simulated “victor” or “loser.” By recording the neighbour’s heart rate and behaviour, we discovered that territorial males displayed higher heart rates and were less likely to vocalize in response to playback of the victor’s call. No differences were detected for females – their heart rate increased equally when they heard either call type, and they never called in response to playback. By advertising their victories, males may establish a “reputation” for winning fights, potentially reducing the likelihood of being challenged by eavesdroppers in future contests.

Patterns of attendance of African penguins at colonies

Makhado, A.B. [Marine and Coastal Management, Private Bag X2, Roggebay, 8012, Cape Town, South Africa; Animal Demography Unit, Department of Statistical Sciences, University of Cape Town, Rondebosch 7701, South Africa], **B. Barham** [H H Wills Physics Laboratory, University of Bristol, Tyndall Avenue, Bristol BS8 1TL, UK], **R.J.M. Crawford** [Marine and Coastal Management, Private Bag X2, Roggebay, 8012, Cape Town, South Africa; Animal Demography Unit, Department of Statistical Sciences, University of Cape Town, Rondebosch 7701, South Africa], **S. Hampton** and **C. Le Bohec** [Animal Demography Unit, Department of Statistical Sciences, University of Cape Town, Rondebosch 7701, South Africa], **N. Parsons** [Marine and Coastal Management, Private Bag X2, Roggebay, 8012, Cape Town, South Africa], **L.G. Underhill** [Animal Demography Unit, Department of Statistical Sciences, University of Cape Town, Rondebosch 7701, South Africa], **L. Upfold** [Marine and Coastal Management, Private Bag X2, Roggebay, 8012, Cape Town, South Africa]

Attendance of African Penguins *Spheniscus demersus* at the two largest colonies in South Africa's Western Cape was investigated from the deployment of transponders on breeding adults and the use of automatic stations to detect when penguins enter or leave the colony. Mean lengths of trips away from the islands were related to the annual cycle of the penguins, including periods of fattening before and after moult and the incubation, guard and crèche stages of breeding. Times of departure to sea and return to the island were related to day length and highlight periods when penguins will be most susceptible to predation around islands by Cape fur seals *Arctocephalus pusillus pusillus* and hence when observations of predation should be conducted to estimate mortality caused by such predation. Although most birds showed fidelity to paths used to access breeding colonies, on occasion alternative pathways were used. This is a behaviour that needs to be accounted for in estimating survival rates from transponder data. The relative influences of food availability and time available for foraging on the timing of breeding are considered.

Spatial and temporal variation in growth and condition of African penguin chicks at five colonies in South Africa

Sherley, Richard B. [Centre for Behavioural Biology, School of Biological Sciences, University of Bristol, Woodland Road, Bristol, UK; Animal Demography Unit, Department of Zoology, University of Cape Town, Rondebosch 7701, South Africa], **Lauren Waller** [Animal Demography Unit, Department of Zoology, University of Cape Town, Rondebosch 7701, South Africa; CapeNature, 16 Seventeenth Avenue, Voëlklip, Hermanus 7200, South Africa.], and **Les G. Underhill** and **Alwyn Lubbe** [Animal Demography Unit, Department of Zoology, University of Cape Town, Rondebosch 7701, South Africa]

Seabirds show high plasticity in chick growth, which can be constrained by both food availability and type. We show that growth rates and body condition are related to breeding productivity of the *Vulnerable African* penguin *Spheniscus demersus* both spatially and temporally.

Data were available from five penguin colonies (Robben, Dassen, Dyer, St. Croix, Bird islands) in both 2008 and 2009, and from a selection of these colonies in various years from 1989 to 2004. Gompertz growth coefficients were calculated for all years and body conditions for each chick in 2004, 2008 and 2009.

Growth was generally poorer in years of population decrease than in periods of recovery and both growth and body condition were poorer in 2009 than in 2008. Overall, growth and condition peaked in April and June respectively and agreement between monthly variation in growth and condition was high (Pearson's correlation co-efficient = 0.41, $p < 0.001$). Monthly fluctuations within and between years even at colonies in close proximity supported the notion that feeding conditions vary unpredictably.

In addition, annual growth rates at Dassen Island were related to the availability of sardine in the previous year, suggesting that breeding productivity depends on adults attaining adequate condition prior to breeding.

African penguin breeders and adult moulters: colony relationships to surrounding fish stocks

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African penguin (*Spheniscus demersus*) populations have shown a sustained population decline from 2004, to the extent that the 2009 breeding census was the lowest on record since regular surveys began in the 1950s. The breeding population at Dassen Island for example, historically the largest African penguin colony, dropped by 50% from 2006 to 2007.

Previous studies have linked the overall trends in African penguins to the overall abundance and distribution of the pelagic sardine and anchovy biomass.

Each year since 1984, pelagic fish recruitment surveys were conducted in May, and fish biomass surveys conducted in November along the western and southern coastline of South Africa. Surveys were performed within the same boundaries (strata) each year.

This study looks at the relationship between the breeding population and number of adult moulters of African penguins at five Island colonies (Dassen, Robben, Dyer, St Croix and Bird Islands), and two mainland colonies (Boulders and Stony Point). The African penguin colonies at each location are shown to have different and unexpected relationships to the fish abundance within their relevant strata. The results are considered in terms of spatial management strategies required for the conservation of the African penguin.

Parental behavior determines egg temperature and incubation period in Magellanic penguins

Rebstock, Ginger A. and P. Dee Boersma [Department of Biology, University of Washington, USA and the Wildlife Conservation Society, USA]

Magellanic penguins (*Spheniscus magellanicus*) lay two eggs, with the incubation period of the second egg two days shorter than that of the first egg. We hypothesized that incubation behavior of the adults controls the incubation period by controlling egg temperature. We tested this hypothesis by swapping first and second eggs between nests so that first eggs were incubated immediately and second eggs had delayed incubation. We returned the eggs to their original nests after the second egg was laid. In addition, we removed first eggs and placed them in storage, replacing them with artificial eggs, until the second eggs were laid. As predicted, the incubation period of the swapped first eggs decreased significantly to 39 days compared to 41 days in control eggs. Incubation period of second eggs increased significantly to 40 days compared to 39 days. Incubation period of first eggs kept in storage increased significantly to 43 days, with 30 of 45 eggs hatching after the second egg in their nests. Swapped first eggs developed as rapidly as control second eggs and swapped second eggs developed as slowly as control first eggs, showing that adults' attention to eggs, not some intrinsic property of the eggs, determines incubation period.

Sympatric distribution of Magellanic and Humboldt penguins in southern Chile: ecological implications of coexistence and hybridization

Hiriart-Bertrand, Luciano [Center for Advanced Studies in Ecology and Biodiversity (CASEB), Pontificia Universidad Catolica, Chile], **Alejandro Simeone** [Departamento de Ecología y Biodiversidad, Facultad de Recursos Naturales, Universidad Andres Bello, Chile]

The importance of mixed colonies of *Spheniscus* penguins in southern Chile has received little attention although first mixed colonies were reported in the mid-1980s. The sympatric distribution of Humboldt (*Spheniscus humboldt*) and Magellanic penguins (*S. magellanicus*) along the Chilean coast is still confuse and only few colonies containing both species have been reported in the last years. Information about these colonies is mostly restricted to population numbers and threats. During fieldwork at Puniuil and Metalqui Islands (42degrees S) in the 2008-2009 breeding season we reported for the first time the occurrence of mixed (i.e., Humboldt-Magellanic) breeding pairs and phenotypic hybrids showing intermediate characters of both nominate species. These records show an important breeding interaction between both species, but we still ignore the proportion of hybrids and heterospecific pairs among the populations in the region. We discuss the relevance of hybridization and coexistence and their potential consequences in speciation and possible mechanisms of adaptation both at land (breeding sites) and at sea (feeding areas).

Creating connections between penguins and the public: the role of zoos and aquaria in facilitating research and communicating results

Henry, Linda and Lauren DuBois [SeaWorld California, USA]

Penguins continue to be a popular attraction for zoo and aquarium visitors. Despite their popularity many penguin species are in decline; eleven of the world's 18 species are listed as vulnerable or endangered. The World Wildlife Fund has named the Magellanic penguin one of its "10 Species to Watch in 2010" and in their recent report, Species and Climate Change, the IUCN has listed emperor penguins among ten climate change icons. The general public has been identified as an important stakeholder in the process to reverse the decrease in the world's penguin populations. Because penguins often evoke emotional responses from zoo visitors, a foundation for delivering effective conservation messages can be established, especially through program animal interactions and direct contact with zoo professionals. Zoos and Aquaria have a fundamental role in connecting people with wildlife to improve visitor knowledge of animals and their conservation needs. The general public can be encouraged, through contact with penguins, to understand that each person has a responsibility to take action for change. Penguin researchers have an opportunity to use zoos and aquaria displaying penguins as an important medium for conveying timely information about ongoing penguin research and outcomes to the public. In this way, lifelong associations can be established between penguins, zoos and aquaria and researchers in the field to build a broad-based alliance for environmental change. We review of the scope of programs in North American zoos and aquaria, how they develop connections, deliver messages and discuss opportunities for field biologists to participate in and contribute to these efforts.

Penguins - marine ambassadors for conservation

Urban, Ric [Newport Aquarium, One Aquarium Way, Newport, KY, USA]

Today's zoo and aquarium guests want more from their visit. Our guests want to be closer to the animals and learn more about the animals we care for; this includes penguins. Penguins are popular and charismatic animals. Penguins are attractive ambassadors for conservation drawing crowds at special events, classroom activities and radio and television interviews.

At the Newport Aquarium, we used a traditional behind the scenes encounter and created an experience that generates revenue to support conservation programs around the world. Nine African Penguins are ambassadors for Penguin Conservation and Marine Awareness. Our African Penguin Ambassadors have had over 30,000 special guests visit generating over \$100,000 for penguin conservation programs in 3 years.

The Newport Aquarium model has been used by other zoos and aquariums to enhance existing penguin programs or create new experiences. After one of our encounters, our guests become empowered to act and join us as partners in our efforts to protect our marine environments and the wonderful animals that depend on the oceans to survive.

Ambassadors for the plight of the African penguin at Mystic Aquarium

Misslin-Dunn, Sarah, Laurie Macha, Becky Giantonio, and Mike Osborn

[Mystic Aquarium, a Division of Sea Research Foundation, Inc., Mystic, CT, USA]

Mystic Aquarium, a division of Sea Research Foundation, Inc., has exhibited African penguins (*Spheniscus demersus*) since 1989 and has participated in the U.S. Species Survival Plan for African penguins. Over the past decade, the aquarium has contributed to research and education to raise a higher public awareness to the plight of the African penguin. The Aquarium has prioritized conservation efforts by sending staff to South Africa and Peru to assist with oil spills, research projects and guano harvest monitoring. The research department at Mystic Aquarium has conducted valuable studies on the captive care of penguins as well as provided sample data to complement ongoing field research. Research, education and conservation efforts are possible through the development of several unique programs (raising more than \$265, 00.00); a Penguin Encounter program, penguin night functions, a fundraising campaign, an annual run/walk, partnerships with conservation-focused organizations and media appearances.

The African penguins at Mystic Aquarium have become ambassadors for those in South Africa because of these programs. The Aquarium plans to continue and expand its efforts to help support ongoing research in South Africa. Mystic Aquarium hopes to become a leader, inspiring organizations and researchers to help prevent the further depletion of the African penguin.

Successful management in captive penguin colonies

Jarvis, Sharon [Sea World Florida]

An overview of the original large importations and quarantines of penguin eggs collected from the wild by SeaWorld and the ensuing populations, reproduction and management of those penguins. The focus will be on successful management techniques including, basic husbandry, reproduction, flock management, shipping techniques and nutrition and training for husbandry purposes.

Penguin research and conservation by AZA institutions

Schneider, Tom [Detroit Zoological Society]

AZA accredited zoos and aquariums have been involved in a number of field conservation and research projects including assisting in the 2000 South African oil spill recovery, census of Humboldt penguin populations, and health assessments of Galapago penguins. This presentation will describe the different conservation and research projects that zoos have organized, participated in, or supported in the last twenty years.

Dietary salt supplementation for African penguins (*Spheniscus demersus*) housed in freshwater habitats—yes or no?

Mazzaro, Lisa, A. Tuttle, and J. Lawrence Dunn [Mystic Aquarium, a Division of Sea Research Foundation, Inc., Mystic, CT, USA], **Jeff Wyatt** [Seneca Park Zoo, Rochester, NY, USA], **Jeremy Goodman** [Potawatomi Zoo, South Bend IN, USA], and **Edmund Kadyszewski** [Pfizer, Groton, CT, USA]

Comparing plasma electrolyte concentrations, this study addresses whether electrolytes of salt-supplemented penguins maintained in freshwater differ from those of non-supplemented conspecifics.

Thirty-eight penguins from four facilities were utilized. Additionally, electrolyte data from free-ranging birds (n=20), long-term residents (n=13) and rehabilitated oil spill birds (n=47) in South Africa were compared. Assessment of normality of data used the Shapiro-Wilk test and comparisons of means between groups and between time periods used analysis of variance (ANOVA) and repeated measures ANOVA.

Comparison of electrolytes of salt-supplemented versus unsupplemented birds showed no differences between groups. The temporal pattern of electrolyte values over the study was the same for both groups suggesting that supplementation has no lasting effect on serum electrolytes and that a natural seasonal variation in electrolyte levels may exist in this species. Similarly in SA healthy penguins had equivalent electrolyte levels. Oil-contaminated birds had significantly lower sodium and higher potassium concentrations. Comparing U.S. birds and healthy SA birds showed no significant difference in plasma sodium or chloride concentrations, but SA birds exhibited significantly higher potassium concentrations likely resulting from different sample handling techniques.

This study supports the hypothesis that African penguins maintained in freshwater exhibits, on similar diets, do not require salt supplementation.

Eastern Equine Encephalitis infection in a flock of African penguins (*Spheniscus demersus*)

Tuttle, Allison D. and **J. Lawrence Dunn** [Sea Research Foundation's Mystic Aquarium, Mystic, CT, USA], **Theodore G. Andreadis** [The CT Agricultural Experiment Station, New Haven, CT, USA], and **Salvatore Frasca** [University of Connecticut, Department of Pathobiology, Storrs, CT, USA]

Eastern Equine Encephalitis (EEE) was diagnosed in a flock of African penguins in Connecticut. Diagnosis was based on history, clinical signs, serology, virus isolation, RT-PCR and histopathology. One affected penguin exhibited no clinical signs; however, the majority had clinical signs including anorexia, behavior changes, depression, regurgitation, and ataxia. A small percentage of penguins additionally exhibited recumbency, vomiting, seizures, and diarrhea. While penguins recovered in 12 (+/- 5) days, 50% of affected birds maintained a subtle ataxia. Hematologic changes consisted of an initial heterophilic leukocytosis and regenerative anemia followed by increases in absolute lymphocyte and monocyte counts. Common plasma chemistry abnormalities included liver and muscle enzyme elevations, decreased electrolytes, hyperglycemia, and elevated globulin. Resolution of bloodwork abnormalities occurred in 67 (+/- 24) days. Treatments consisted of supportive care including antimicrobials, fluids and nutrition, and anti-convulsants where necessary. All infected birds survived except one juvenile bird that was euthanized due to severe disease and lack of therapeutic response. The high morbidity of EEE disease in penguins emphasizes the potential severity of arbovirus infections, suggests a potential need for EEE vaccination of penguins maintained in endemic areas, and stresses the importance of mosquito control at zoological institutions in the prevention of arbovirus infections.

An investigation into the prevalence of *Leucocytozoon* in the endangered yellow-eyed penguin (*Megadyptes antipodes*) on Enderby Island

Argilla, Lisa S. [New Zealand Wildlife Health Centre, Massey University, New Zealand]

The Yellow-eyed Penguin (*Megadyptes antipodes*), or Hoiho, is endemic to New Zealand and is one of the rarest species of penguin. Over the past 30 years, yellow-eyed penguins have suffered major population declines with no single cause established. *Leucocytozoon* was first identified in yellow-eyed penguins in 2005. During the 2006/07 and 2007/08 breeding seasons, *Leucocytozoon* was found in adults and chicks from Stewart island and chicks from Codfish island but was absent from mainland New Zealand bird. The species of *Leucocytozoon* that infects yellow-eyed penguins is genetically different to *Leucocytozoon tawaki* that has been found in Fiordland crested Penguins. During the 2008/09 breeding season, samples were collected from yellow-eyed penguins on Enderby Island to investigate the prevalence of *Leucocytozoon*. During this season, a high mortality was seen in both mainland yellow-eyed penguins as well as those on Enderby Island. No single factor was identified as the cause of these mortalities, however, contrary to our expectations there was a very high prevalence of *Leucocytozoon sp.* found in Enderby Island penguins. This finding is significant in being the first record of haemoparasite infection in a sub-Antarctic/Antarctic penguin population.

Ectoparasites of little blue penguins in New Zealand: seasonal trends and host-parasite dynamics

van Rensburg, M. Jansen and **D.H. Brunton** [Ecology and Conservation Group, Institute of Natural Sciences, Massey University, Albany, Auckland, New Zealand], **L. J. Huynen** [Allan Wilson Centre for Molecular Evolution, Massey University, Albany, Auckland, New Zealand], and **B. Gartrell** [Institute of Veterinary and Biomedical Sciences, Massey University, Palmerston North, New Zealand]

Despite the wide distribution of ticks throughout the Spheniscid range, there is a paucity of data relating to seasonal dynamics and virulence. Ectoparasites may have severe effects on their penguin hosts, including reduced reproductive success, increased disease transmission and compromised immunity. Little blue penguins (LBP) are host to several tick species. The distribution and abundance of LBP ticks was surveyed on Tiritiri Matangi Island, Hauraki Gulf, New Zealand, and only *Ixodes eudyptidis* was documented. The tick lifecycle of was investigated over the course of one year, in relation to LBP life stages, body condition and haematological parameters. To investigate the presence of vector-borne diseases, blood samples were screened for *Plasmodium*, *Leucocytozoon*, *Haemoproteus* and *Babesia*. Tick load showed an aggregated distribution and exhibited significant seasonal variation in accordance to LBP life stages. Periods of increased host availability (moult and breeding) had the highest tick abundance. However, tick abundance was not associated with body condition or reproductive success. Haematological parameters of LBP chicks and adult females showed significant changes in relation to tick abundance, but these changes were not evident for adult males. Blood parasite prevalence was low (<1%), determined to be *Plasmodium sp.* infection. No other blood parasites were found.

Feather-loss disorder in African and Magellanic penguins

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A new feather-loss disorder of unknown cause, first reported in African penguin (*Spheniscus demersus*) chicks in 2006 and in Magellanic penguin (*Spheniscus magellanicus*) chicks in 2007, reduced growth and likely survival. The disorder disrupted feather growth in both species, resulting in chicks with bare skin for several weeks.

Feather loss caused most African Penguin chicks to grow adult instead of juvenile plumage. In contrast, Magellanic Penguin chicks grew juvenile plumage, the same as chicks without the disorder. The phase of feather development at which feather loss occurs may explain this disparity. African featherless chicks in the rehabilitation center took 16 days longer to reach release weight than feathered chicks.

Magellanic featherless chicks grew slower and were smaller than feathered chicks. In the African rehabilitation center, mortality rates were similar for featherless and feathered chicks. Unlimited food and time for development supplied by the center likely contributed to featherless chick survival. Feather loss likely increases mortality in the wild because of the higher energy needs of the chick and their longer chick rearing period. The disorder order could be detrimental to Antarctic penguin populations where loss of down would result in death.

Variability of plasma carotenoid levels in the Gentoo penguin (*Pygoscelis papua*): geography, physiology and age

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Birds need to ingest carotenoids to colour their plumage or other integumentary parts. On the other hand, carotenoids have different physiological functions such as the eradication of free radicals and enhancing the immunological system. Penguin offers a good opportunity to study how the levels of carotenoids in plasma are changing in relation to different variables. Carotenoids must be taken from preys as animals cannot synthesize them. Antarctic penguins mainly obtain carotenoids by eating krill (*Euphasia superba*) which store great amounts of astaxanthin. Therefore variations in the abundance and quality of preys in different regions could affect the levels of carotenoids in different populations. On the other hand, variations affecting foraging activity and/or physiological demands between different situations such as breeding/ moulting or differences in diet as occurs between adults and chicks could also affect the levels of circulating carotenoids. In this work we study variations in the level of circulating carotenoids in relation to geography along the Antarctic Peninsula, physiology comparing breeding versus moulting individuals and age comparing adults and chicks in the gentoo penguin (*Pygoscelis papua*). Our results show differences in carotenoid level being higher in the northern populations and during the breeding phase. Chicks showed higher level of carotenoids in plasma than adults.

The gastrointestinal microbiota of king penguins (*Aptenodytes patagonicus*) and the influence of geographical separation.

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The gastrointestinal tract is a diverse and complex ecosystem is colonised by hundreds of different species of micro-organisms. The microbiota provides nutrition to the host by the secretion of nutrients, vitamins, amino acids and short chain fatty acids. These compounds contribute to the energy supply for the animal and can also influence the type of microbiota present. The intestinal flora is also responsible for the establishment and maintenance of the host's immune system.

Because of the importance that the gut microbiota plays in the conversion of food to energy and immune system function, it is important to understand what influences the gut microbiota of penguins. It has been established that dietary changes, antibiotics and the environment we live in can influence the composition of the gastrointestinal microbiota of humans and avian species of commercial importance. However, there is little to no literature that has investigated what influences the gastrointestinal microbiota in penguins. The gastrointestinal microbiota of king penguins was examined to determine the dominant microbiota and to see if whether geographical separation influences the microbiota of two king penguin populations.

Faecal samples from two king penguin populations with considerable geographical separation (~6000km) but consume a similar diet were analysed using 16S rRNA group specific primers. A database of bacteria present in the gastrointestinal tract has been developed using the 454 sequencer, which has yielded over 50,000 bacteria sequences from each location. The predominant bacterial groups isolated from the samples were from the phyla Bacteroidetes and Firmicutes. *Escherichia coli*, *Bifidobacteria*, *Staphylococcus* and *Lactobacillus* spp were present but not are considered to be predominant groups. Differences in diversity, species richness and quantification of the predominant bacteria groups were examined using PCR-DGGE, and quantitative Real Time PCR.

Is yolk androgen deposition in rockhopper penguins a maternal favoritism strategy?

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Yolk androgens have been shown to influence hatching time and to enhance chick survival and growth. The hatching asynchrony adjustment hypothesis states that females increase yolk androgen levels over the laying sequence to offset the disadvantage of later hatched chicks in species exhibiting no brood reduction while females decrease yolk androgen levels in species exhibiting brood reduction. We studied maternal deposition of yolk androgens in eggs of southern rockhopper penguins (*Eudyptes chrysocome chrysocome*). Contrary to other avian models, laying and hatching sequences do not coincide in this species, which exhibits reversed hatching asynchrony. This provides a unique model to test whether the first egg to hatch (B-egg), which is the most likely to survive, is favored over the second egg to hatch (A-egg). We found that B-eggs have higher egg and yolk masses and yolk androgen levels than A-eggs. This was consistently observed for the three androgens analyzed (testosterone, androstenedione and 5 α -dihydrotestosterone). We also examined the effects of human disturbance and laying date on androgen deposition. Both appeared to affect A- and B-eggs differently. These results support the hatching asynchrony adjustment hypothesis and allow proposing a new hypothesis to explain the reversed hatching asynchrony observed uniquely in crested penguins.

The effect of stress on the faecal bacteria of Adélie penguins.

Banks, Jonathan, Craig Cary, Ian Hogg, and Joe Waas [Department of Biological Sciences, University of Waikato, Private Bag 3105 Waikato Mail Centre, Hamilton 3240 New Zealand]

Stressors, such as human disturbance, produce changes to the behaviour and biochemistry of animals. The stress response can be adaptive in the short term, however chronic stress can be maladaptive for an organism, altering an organism's growth, metabolism and reproduction. Stress activates the hypothalamic-pituitary-adrenal (HPA) axis of an animal resulting in the secretion of steroid hormones from the adrenal gland. Chronic stress can lead to prolonged elevation of glucocorticoid stress hormone concentrations resulting in suppression of the immune system. We investigated the effect that no, low, moderate or high levels of experimental disturbance (close approach of a human) had on the faecal bacterial communities of Adélie penguins. Using genetic methods (automated ribosomal intergenic spacer analysis, ARISA) to assess faecal bacterial community composition, we found that the levels of disturbance to which we subjected the penguins were not associated with significant changes in the composition, abundance or diversity of the faecal flora of Adélie penguins.

Passage from shore to marine life increases lipid oxidative capacity in juvenile king penguins.

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Passage from shore to marine life induces several new energy constraints, to which penguins have to develop important metabolic and thermogenic capacities.

The aim of our study was to study the ability of lipid oxidation in two king penguins (*Aptenodytes patagonicus*) groups. 1) The never immersed (NI) group consisted of king penguins in the final stage of moulting and therefore not adapted to marine life. 2) The naturally adapted (NA) group consisted of juvenile king penguins that had accomplished their passage to marine life. This investigation was conducted on the Crozet archipelago (Possession Island).

Whole-animal metabolic rate was measured by indirect calorimetry before, during and after infusion of triglyceride solution (Intralipide 20%) and muscle mitochondrial metabolism measured using palmitoyl-carnitine.

In vivo, we found an increased metabolic rate in king penguins during lipids infusion (+9% and +12% in NI and NA groups, respectively), which remained elevated in NA penguins only. This is related with an *in vitro* increased capacity of mitochondria to produce ATP from lipid.

In conclusion, once adapted to marine life, king penguins exhibited adaptative traits that economically use lipids to provide useable energy in order to both support long distances swim and survive in cold water.

Foraging areas of little penguins and the distribution of their main prey in winter: do the penguins know what they are doing?

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In winter non-breeding periods, seabirds often have higher energetic costs, reduced survival and uncertain or reduced food availability. This has led seabird biologists to hypothesize that food availability in winter may be a factor limiting the size of some populations. Although there are numerous studies on the foraging areas of breeding seabirds, there are many fewer on where seabirds forage in winter and still fewer that sample prey abundance simultaneously.

Little Penguins *Eudyptula minor* are inshore foragers and resident in south-eastern Australia throughout the year. In winter 2008 and 2009, we determined the foraging areas of Little Penguins in Port Phillip Bay and the distribution and abundance of their main prey, anchovies *Engraulis australis*, there.

Forty-six Little Penguins were satellite-tracked in June-August 2008 and 14 in June-July 2009. Anchovy abundance and distribution were sampled by sonar and trawling at the same time as foraging locations of penguins in Port Phillip Bay were determined. Anchovy abundance varied greatly between sites, but the time spent-in-area distribution of the penguins overlapped almost exactly with the distribution of anchovy in both years. Penguins generally went direct to where the anchovies were suggesting that they had some spatial memory of feeding areas.

Post-moult dispersal of sympatrically breeding Humboldt and Magellanic penguins in south-central Chile

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Ten Humboldt (*Spheniscus humboldti*) and eight Magellanic Penguins (*S. magellanicus*) were successfully equipped with satellite transmitters in March 2009 at Puñihuil Islets, Chile, to follow their post-moult dispersal. There were no significant differences in the migration patterns observed between species and sexes. Overall, the migration of Humboldt and Magellanic Penguins could be followed for a mean period of 49 ± 18 days (range: 25 – 93) and 57 ± 12 days (range 35 – 68), respectively. Maximum distance to the colony ranged between 6 and 1036 km in Humboldt and between 17 and 927 km in Magellanic Penguins. The total minimum distance covered was 8014 km in Humboldt and 9247 km in Magellanic Penguins, the mean daily distance covered was 21.9 ± 12 km (Maximum 106 km) and 22.0 ± 8 km (Maximum 115 km), respectively.

Irrespective of species and sex, two different migration patterns were apparent. Birds either remained at the breeding site, presumably performing daily foraging trips, or migrated north. However, most of the latter turned south again during the course of their migration and, in some instances, returned to the breeding site. Overall, the post-moult dispersal was restricted to a coastal area stretching 1000 km from the breeding site at 42°S to about 33°S. The observed migratory patterns are discussed with respect oceanographic parameters and artisanal fishing activities.

Foraging behaviour during chick rearing of sympatrically breeding Humboldt and Magellanic penguins in southern Chile

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Humboldt and Magellanic penguins breed sympatrically at Puñihuil Islets in Chile. As these are two closely related species with comparable food requirements, we studied the degree of resource partitioning. Sex- and species-specific foraging areas and diving behaviour were investigated during the chick-rearing period using GPS-TDlog and TDRs. Penguins performed mainly daily foraging trips close to the colony. Maximum distance to the colony did not significantly differ between species and sexes (average 8.8 ± 3.2 km). Foraging trip and diving characteristics also revealed no significant interspecific differences. The major differences observed were sex-specific, independently of species. Trip duration (range: 2.3 to 26 hs) was shorter in females while the diving rate (range: 13 to 48 dives per hour) was higher than in males. Mean dive duration (range: 45 to 91 sec) was higher in males than in females which is in accordance with the slight sexual dimorphism found in these species. Mean dive depth ranged from 9 to 37 m, maximum depth attained was 70 meters and maximum dive duration recorded was 270 s. Interestingly, all birds showed a high value of intra depth zone dives (more than 70%), indicative of benthic feeding. In contrast to these findings, previous studies indicated a high amount of pelagic fish in their diet. Magellanic penguin's males performed less intra depth zone dives, this being the only sex-species difference. In conclusion, in areas where food is not limited, variations in the diving behaviour are likely to be more sex-specific rather than interspecific.

A new approach to track analysis: evaluating the scales of movement of foraging penguins

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Quantifying spatial patterns of animal movement, particularly searching for prey, is of primary importance for understanding an animal's foraging strategy. Evaluating the scale of movement provides insight into how animals perceive their environment. We present a new track analysis algorithm, the distance-ratio scale (DRS) method, which is based on the straightness of the track, in relation to a pre-defined tolerance. We present a graphical method which conveniently assesses the scales at which animals seem to be operating. Fine scale DRS identifies active feeding zones. Coarse scale DRS indicates long distance movement between breeding colony and foraging areas, or between feeding patches. We apply the method to GPS tracks of African and Galapagos Penguins, and compare their foraging strategies.

Year-round foraging behaviour and energetics of macaroni penguins

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We have used implanted data loggers to study the physiology, behaviour and energetics of macaroni penguins, *Eudyptes chrysolophus*, throughout the year. We found that macaroni penguins have increased diving capacity (greater depth and duration) during winter and this seems to be related to a reduction in the minimum (resting) rate of oxygen consumption during that time. From our own data and values from the literature on a number of other parameters, we have produced an algorithm to predict foraging success and daily changes in body mass of breeding pairs of macaroni penguins. Together, parents provide only 15% of the food they capture during the breeding period to their chick, but males and females have different breeding strategies. Males stay ashore during the brood period, leaving the female to provide for the chick. As a result of this behaviour, the male provides only about 30% of the food for the chick. During the active phases of the breeding season, daily energy expenditure of either sex is about 4 times their resting metabolic rate, despite considerable differences in behaviour and food intake. This is in accord with established theory and suggests that there is a metabolic ceiling during the summer period.

King penguins learn air load management with age

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Diving efficiency of marine animals is primarily determined by their physiological and mechanical characteristics. This efficiency is expressed through parameters such as wing or feet beats, buoyancy, or body angle, all of which can be modulated according to resource availability and diving depth, including current, and the targeted maximum depth. Here we investigated through these parameters how foraging abilities can increase with an individual's age and experience.

Long-lived seabirds, such as deep-diving penguins, are good models to study behavioral changes in diving over the course of aging. During the austral summers of 2007 to 2010, we deployed small accelerometers on young (5 year old) and middle-aged (8-9 year old) king penguins breeding in a colony of the Crozet Archipelago, Indian Ocean. There were no differences between the two age classes in classical dive parameters such as maximum depth, total dive duration and duration of each dive phase. Acceleration was recorded along the longitudinal and dorso-ventral axes of birds at 16 Hz and pressure was measured every second. Young king penguins flap their flippers at a higher frequency during the descent phase than middle-aged birds. In addition, young birds returning to the surface stopped beating their flippers at a deeper depth than older individuals, suggesting that young individuals loaded more air than they needed. Learning to optimally manage air loading could be the determinant factor explaining the improvement of foraging performances with age.

The role of shell grit ingestion in the reproductive biology of little penguins (*Eudyptula minor*)

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Some seabirds eat seashell grit before laying eggs, but it is unclear whether this is related to egg formation or to replace calcium in the body reserves. We investigated whether little penguins, *Eudyptula minor*, eat seashell grit and whether the extra calcium ingested resulted in an increase in eggshell thickness and/or calcium concentration in the eggshells. We examined the consumption of grit by adult birds by direct observation in 2007 and stomach contents from long term data (1986-1987 & 2001-2005). In addition, we analysed attendance data recorded over three seasons (2005 to 2008) on the frequency of multiple colony-shore-colony trips at each night. Overall, females comprised of 84% (n=101) of the birds making colony-shore-colony trips. Most multiple trips were inside the pre-laying period, with the frequency of trips peaking two to three days prior to laying. There was no difference in eggshell thickness or calcium concentration between eggshells from hatched and abandoned eggs; suggesting that embryos may not rely on their eggshell as a source of calcium. Further, grit ingestion was not directly related to egg formation, suggesting that seashell grit may be ingested by females at a crucial time of high calcium demand to replace the reserves in the body.

2008: The year of the global financial crisis and the Perth penguin crisis?

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From 2006-2009, the Little Penguin population in Perth was studied as part of a Population Viability Analysis project. Within this period, 2008 was found to be a poor year for the Little Penguins on both Penguin and Garden islands, Western Australia, but to a varying extent. On Penguin Island:

- a higher than average number of deaths were recorded during December 2007 and January 2008;
- egg lay was delayed;
- breeding parameters were lower, but interestingly the foraging range of the penguins did not significantly differ between years; and
- using a combination of Mark-Recapture methods and counts at arrival points around the island, the number of penguins estimated to be on the island was substantially lower than in 2007.

On Garden Island, breeding was only impacted in the latter half of the year.

The downturn in the penguin economy on Penguin Island began with higher than average terrestrial temperatures, suggesting a long term negative impact of climate change. But is it possible to piece together the effect of other causative factors such as a persistent strong Leeuwin Current, rainfall, wind speed and predatory fish on the availability of prey fish stocks and the 2008 downturn for both colonies? Or is it like trying to put together a jigsaw blindfolded, and if so, can we effectively manage these iconic populations?

Are penguins in Antarctica in danger from krill fishing?

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For several penguin species in Antarctica, krill is the most abundant food source. Thus, penguins depend on krill being within reach of their colonies in order to feed and rear their offspring during the summer. The Antarctic krill fishery is the largest fishery in the Southern Ocean and is managed by the Convention for the Conservation of Antarctic Marine Living Organisms (CCAMLR). Current krill fishing operations occur in the Scotia Sea region, mostly in coastal areas, in total overlap with the foraging ranges of local penguin colonies. Interest in krill fishing is growing and an expansion of the fishery seems imminent.

The current temperature increase in the Antarctic Peninsula area is resulting in a massive reduction of sea ice, followed by a reduction of ice algae, with a consequent local reduction of krill abundance. Concentrated krill fishing also contributes to the local reduction of krill availability. In spite of existing conservation measures established by CCAMLR, there is a pressing need to take further action to protect penguin species from the effects of climate change and concentrated krill fishing in Antarctica.

In summary, this presentation will provide up-to-date information on the conservation challenges regarding krill fishing and penguin species in Antarctica.

Stable isotopes reveal regional variation in the pre-breeding diets and foraging habitats of sympatrically breeding *Pygoscelis* penguins in the Antarctic Peninsula.

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Little is known about the diets and foraging areas of Adélie (*Pygoscelis adeliae*) and Gentoo (*P. papua*) penguins outside of the breeding season. We used stable isotope analysis of eggshells to examine the pre-breeding diets and foraging habitats of female Adélie and Gentoo penguins from 21 breeding locations along the Eastern and Western Antarctic Peninsula (AP), South Shetland (SS) and South Orkney (SO) Islands. Eggshell ^{13}C and ^{15}N values differed between species, with Gentoo penguins exhibiting significantly higher isotopic values than Adélie penguins. This indicates that Gentoo penguins fed at more inshore, benthic habitats and consumed a higher percentage of fish than Adélie penguins. While little spatial variation in Gentoo penguin eggshell isotopic values were observed, Adélie penguin eggshell values varied across the four breeding regions examined. Adélie penguin eggshells from the Eastern AP, SS and SO shared similar isotopic signatures and were significantly lower in both ^{13}C and ^{15}N values than eggshells from birds breeding along the Western AP. Our findings suggest that Adélie penguin populations that are geographically separated during the breeding season by the “Adélie Gap”, a 400 km region along the Western AP devoid of breeding Adélie penguins, also inhabit geographically distinct habitats prior to breeding.

Artificial burrows for Humboldt penguins: first attempt for increasing breeding habitat in Chile

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Pajaro Niño is one of the two major Humboldt Penguin (*Spheniscus humboldti*) colonies in central Chile (33°21'S, 71°41'W). By 1996 it supported a breeding population of 326 pairs, from which 82 used dirt burrows. By 2008, only 3 burrows were available to penguins because most collapsed due to rains or were trampled by Peruvian Pelicans (*Pelecanus thagus*). In March 2009 we installed 24 artificial burrows at this colony where natural burrows used to exist. Artificial burrows were made from plastic rubbish bin halves. For each artificial nest there was a control (natural) nest and both types were checked at 15-day intervals. During the 2009 (Austral) autumn breeding season, no artificial burrows were occupied; 2 control nests presented adult birds, but no clutches were recorded. During the spring season 7 control nests were occupied (2 clutches recorded) and 5 artificial burrows presented birds (one clutch recorded). All birds at artificial burrows were subsequently displaced by nesting pelicans, but no collapsed penguin burrows were recorded. By March 2010 we plan to duplicate the number of artificial burrows and use decoys to attract penguins to new nesting sites.

Foraging strategies and oxidative stress: a pair affair in the Adélie penguin

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The study of oxidative stress is of growing interest in behavioural ecology since it may affect many components of life-histories such as growth, immunity, sexual signalling or foraging behaviour. In this study, we examined the relationship between foraging behaviour and the oxidative status in pairs of Adélie penguins (*Pygoscelis adeliae*) during the chick-rearing period. Foraging trip duration was not related to oxidative status. In contrast, spatial distribution (estimated through plasma C values) was positively correlated with oxidative damage. Within pairs, mates exhibited the same C values and oxidative status, suggesting that they use the same ecological niche and therefore experience the same oxidative stress. To explain the relationship between C values and oxidative status, two hypotheses can be proposed: (1) penguins feeding on prey enriched in C (presumably in coastal areas) also feed on prey depleted in antioxidants, (2) low-quality birds with low antioxidant capacity and therefore high oxidative damage are constrained to forage in coastal areas.

Foraging success of Adélie penguins as determined by fine-scale oceanographic features of the SW Ross Sea

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In theory, seabird foraging locations should indicate where patchily distributed prey resources are available in the ocean. However, determining whether seabirds are actually foraging, and whether they are foraging successfully remains difficult, so interpretation of foraging location data can be problematic. In 2005 the Splash tag became available, combining an Argos satellite tracking device with an archival time-depth recorder (TDR) in a package suitable for deployment on penguins. Since this tag collects spatial and diving data simultaneously, it enables us to match penguin at-sea positions with diving patterns, which have been shown by other researchers to be associated with specific penguin behaviors reflected by dive shapes and number of undulations. We deployed Splash tags on 195 randomly chosen breeding Adélie Penguins (*Pygoscelis adeliae*) on Ross Island (3 different colonies) over the span of four austral summers. The tags were deployed for a single foraging trip per bird starting on median hatch day and ending ~5-10 days past mean crèche day. Satellite data were filtered and interpolated according to maximum known swimming speed and turning angle using the *argosfilter* package for R. Foraging locations as determined using undulations as the main predictor were not exclusively located in “foraging clusters” as has been previously assumed; >60% of foraging locations occurred outside of clusters. We present results from generalized linear mixed models exploring the relationship between all foraging locations and oceanographic features (weekly chlorophyll and sea ice concentration and extent) and discuss the implications for interpretation of seabird foraging location data collected using other methods.

An observation of between-mates feeding behavior in chick-guarding chinstrap penguins

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In many different groups of birds, males feed females during courtship or incubation. This “courtship feeding” by males is of considerable energetic benefit to females. However, few studies observed feeding by an adult to its own mate during chick-rearing period, even in a species with courtship feeding occurring regularly during courtship or incubation periods. We observed a male chinstrap penguin (*Pygoscelis antarctica*), in which obvious courtship feeding behavior has not been reported, feed its own mate during chick guarding stage. After being fed by the male, the female fed the food to its chick. This observation was carried out in a colony at Barton Peninsula (62°14'S, 58°46'W) of King George Island, South Shetland Islands, Antarctica, on 9 January 2007 around 15:00 LMT. The feeding lasted over 20 min. Our observation indicates that the behavioral pattern of begging food occurring only in chicks may be retained but usually restrained in adult penguins which do not show obvious courtship feeding behavior. The accumulation of these rare observations may help understand the development and evolution of courtship feeding occurring regularly in many bird species.

From one dive to the next: using time series analysis for penguin dive behavior.

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The nature of how behavior at a time step influences the next is of great interest to behavioral ecologists, but rarely used for comparisons between animals. Time Depth Recorders (TDR) and other archival tags have been widely used to infer patterns of diving and foraging. However, while we can extract variables that describe individual dives, how runs of dives may indicate behaviors and how one dive influences the next, are not fully understood. Treating TDR data as time series, we examine patterns of autocorrelation to investigate structure in the timing of behavior. We fit an oscillating best-fit curve to the autocorrelation and use the parameters of this curve to investigate differences in strategy of 129 foraging macaroni penguins (*Eudyptes chrysolophus*) of both sexes. We find inter-annual differences in autocorrelation parameters as well as differences between reproductive stages. In contrast to other studies of macaroni penguin diving based on depth analysis, we find no differences between the sexes. We mimicked changes in the various parameters by simulation of dive profiles, and used these to infer biological meaning from the parameters. As this technique makes very few assumptions about how to identify a dive or cluster of dives, we suggest that it is a useful first characterization of diving or cyclical behavior in a wide range of animals.

Penguin status in troubled oceans

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Marine and coastal ecosystems are undergoing unprecedented alterations in their processes and structure. Penguins are sensitive species impacted by these phenomena. As top predators, they are key constituents of marine ecosystems, and are indicators of the oceanic and coastal ecosystem health. We integrated the most updated information on distribution, abundance and trends for all penguin species. IUCN has listed 60% of the 18 penguin species as vulnerable or endangered. Some species are at their lowest recorded populations: Galapagos, yellow-eyed, and Fiordland, with their restricted ranges, have less than 3,000 pairs; Humboldt, Snares and African, have less than 30,000 pairs. Even abundant species like the macaroni, and the two rockhopper species are in steep decline. Around 80% of the threatened species occur on islands, increasing their vulnerability to threats such as introduced predators. Threatened penguins are mainly concentrated in New Zealand, East-Pacific Coast (Galapagos and Peru-Chile), and South-Africa. The status of penguin species is not improving. Anthropogenic sources of mortality are likely to increase and are drivers of penguin decline. Oceanic threats include climate change, marine pollution, and fisheries mismanagement. Prey availability potentially linked to climate variation is one of the most commonly suggested causes of population decline. Human activities, including irresponsible tourism, coastal development, and introduced predators, have a major impact on penguin populations. Larger scale ecosystem-based conservation planning and more focused local efforts are needed for the successful conservation of many penguin species.

Mystery and speculation about variability in Ross Sea emperor penguin colonies

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From 2000 to 2008 there has been a nearly continuous record of population size of some of the seven Ross Sea emperor penguin colonies. The record also extends back to 1983, but with frequent breaks until 2000. With the exception of the Pointe Géologie colony, these are the longest records for any other emperor penguin colonies. It is also the only set of data that includes multiple colonies. These data were collected from a mix of aerial photographs and ground counts until 2000. Since then, all data were obtained by aerial photographs. There has also been a shift away from late season (December) counts of chicks, to early season (October/November) counts of adults. Unlike the Pointe Géologie colony, there are large variations in the size of colonies from year to year. In two sequential years, the smallest colony has ranged from 1200 to 0 chicks fledged, and the largest colony from over 31,000 to 20,202 adults present. The former was due to a cataclysmic event, but the cause of the latter is uncertain. This is the more common occurrence. It may be a result of birds failing to breed, or switching to another breeding site.

Global Penguin Society: the penguin advocacy for the oceans

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The fragile conservation status of most penguin populations mirrors the Southern Oceans condition and the world's oceans problems. Variations in ecosystem structure and processes, caused mainly by climate change, pollution, and fisheries mismanagement impoverish living systems. Penguins are impacted by these alterations: 60% of penguin species are considered vulnerable or endangered (IUCN). Penguins can serve as cost-effective indicators of the health of the oceans, providing insight into the magnitude and location of marine conservation needs. As charismatic, seascape species, penguins can increase awareness of ocean health, causing reconsideration of policies and behaviors harming penguins. Penguins also can foster public and political support for integrated ocean conservation. The Global Penguin Society, a new international, science-based conservation coalition, is dedicated to the survival and protection of the world's penguin species. GPS has three inter-related components: science, management and education. GPS seeks to integrate synergistically research and conservation groups, speeding penguin and ocean conservation efforts. The coalition supports science needed for the conservation and adequate management of penguins and marine environments at local and global scales. GPS helps assessing the status of penguin populations, educating and advising governments and communities, linking people to policy, promoting and helping consolidate marine conservation initiatives, and campaigning through the media to make a change for ocean conservation for and through the penguins.

Can tracking data and habitat preference models be used to design marine protected area networks for penguins?

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Effective conservation of penguins depends on designing a network of protected sites that safeguards marine food supplies as well as colony sites. Bio-logging studies of penguin movements can provide data required to inform this process, but these have only been conducted at a relatively small number of sites owing to logistic constraints. Designing a network of marine protected areas around important colonies throughout a species range therefore depends on modelling the habitat preferences in order to predict the distribution of penguins around each. To demonstrate this approach, the foraging movements of gentoo penguins breeding on Bird Island, South Georgia, were tracked using rapid-acquisition GPS loggers and time-depth recorders. Generalised additive mixed models were used to investigate associations between sea depth and dive locations within the bounds imposed by central-place foraging constraints. The model predictions will be tested using independent tracking data from Maiviken on mainland South Georgia. The utility of these models for predicting penguin foraging distribution around colonies lacking empirical tracking data will be discussed.

The oiled penguin problem in South Africa: recent evidence for sunken ships, natural seeps, and chronic oil dumping

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Oil fingerprinting enhances our ability to identify oil types and compare various samples to determine whether they originated from the same or difference sources. It is a valuable tool to support enforcement of illegally discharged bilge oil or other fuel in the environment through forensic analysis; to determine the source of the oil; to determine if there may be more than one spill; and/or to determine the type of oil to help inspectors or investigators narrow the search for a vessel. While this process may be cost prohibitive for every spill, it serves as another tool to aid in the identification and subsequent enforcement of polluters.

In collaboration with the Ontario Veterinary College at the University of Guelph, Environment Canada, and the Southern African Foundation for the Conservation of Coastal Birds (SANCCOB), oil from 171 African Penguins (*Spheniscus demersus*) admitted to SANCCOB for rehabilitation was analyzed using gas chromatography. Twenty-five different sources of oil were identified. In several cases, oil spread over time and place likely originated from the same source, which suggests a sunken ship or a natural seep as the cause. Additionally, 20 samples were unique in place but not time, which speaks to the ongoing discussion of the prevalence of oil dumping in the region. Similarities between the oil from African Penguins and oil analyzed from Magellanic penguins in South America and seabirds in Canada are discussed.

Return of the pink brigade: monitoring rehabilitation success and return of African penguins oiled in Namibia and released in South Africa after rehabilitation

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Following an oil spill along the southern coast of Namibia in April 2009, 129 of the 171 African Penguins oiled and subsequently cleaned in Lüderitz, Namibia, were transferred to the SANCCOB rehabilitation centre in Cape Town, South Africa, for further rehabilitation. Of 42 penguins rehabilitated in Namibia, 40 survived and were released locally. Altogether 113 of the 125 penguins that survived the rehabilitation process at SANCCOB were released in Cape Town; the remainder were repatriated by air and released near Lüderitz. Each penguin released in Cape Town was marked with a steel flipper band and a spot of pink dye on the chest to facilitate the monitoring of these penguins following their release. The first penguin was seen back in Namibia at Mercury Island 14 days after release, having covered a linear distance of 1000 km. By January 2010, eight months after being released in Cape Town, 50% of the “pink” penguins had been seen back on the Namibian islands. We report back on the most recent observed return rates and initial breeding efforts of penguins released in Cape Town, and compare them with those of penguins released locally and those recorded after previous spills affecting African Penguins.

Petroleum discharge no longer a major mortality factor for Magellanic penguins along Chubut coast

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We counted carcasses of Magellanic penguins at 8 to 17 sections along the coast of Chubut, Argentina, in March for 14 years between 1982 and 2009. An average of $44.9 \pm 15.4\%$ of the penguins were oiled between 1982 and 1990 ($N = 3115$ dead penguins). The majority of dead adults ($67 \pm 12.7\%$, $N = 888$, 1986-1990) had petroleum on 10% or more of their body suggesting that petroleum pollution was a major cause of mortality. Of the dead fledglings, $38 \pm 24.1\%$ were oiled ($N = 611$). Starvation and predation were more important than petroleum pollution in fledgling deaths. By 1990 the number of dead penguins with petroleum declined to 20%. Since 2001, we have found 0-2 (0-6.9%, $N = 20$ -260) dead penguins with petroleum per year. The drop in the percent of oiled penguins is consistent with a decrease in illegal dumping. The number of dead penguins dropped from 49/km in 1982 to 5/km in 2003 to $< 1.5/\text{km}$ in 2005, 2007 and 2009. The decline in dead penguins on the beach reflects both a decline in the Magellanic population and a decline in the frequency and proximity to the coast of petroleum discharge.

Mortality of *Spheniscus* penguins in gill nets in Chile, a conservation problem that requires an urgent regulation

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Along the extensive Chilean coast in the Southeastern Pacific, gill nets are extensively used by artisanal fisheries and are known to interact with diving seabirds such as cormorants and penguins. Although not much published reports are known for the area, it is well known that incidental entanglement of seabirds is a generalized and chronic conservation problem. In this presentation I summarized both published and unpublished reports of mortalities of Humboldt (*Spheniscus humboldti*) and Magellanic penguins (*S. magellanicus*) between Coquimbo (30°S) and Valdivia (40°S). Three main conclusions are evident: a) mortalities occur year round ranging from <10 individuals to >1,000 birds in single fishing events, b) mortalities concentrate during austral autumn and winter coinciding with the onset of penguin migration and post-breeding dispersal, c) although several fisheries may be involved, that of the Corvina Drum (*Cilus gilberti*) is one of the biggest threats to penguins in Chile. Although models indicate that <1% of adult mortality is required to reverse population decline in the Humboldt Penguin, current rates of mortality seem largely to exceed this value.

Hand-rearing and release of African penguin chicks abandoned by moulting parents in the Western Cape, South Africa, 2001-2009

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Hand-rearing of African penguin *Spheniscus demersus* chicks has become a standard conservation intervention in South Africa due to demonstration of later breeding by birds hand-reared as chicks and returned to the wild. Adult birds moult between September and January and at this time abandoned chicks are often admitted to SANCCOB for hand-rearing. From 2001 to 2005, an average of 61 chicks was admitted each year due to abandonment by moulting parents, with a release rate of 54%. From 2006 to 2009, a total of 1 559 chicks (841 in 2006, and 481 in 2007) were removed from colonies, because they had been abandoned by parents, with an average release rate of 85%. These chicks were from the Dyer Island, Betty's Bay and Robben Island colonies. Veterinary concerns during hand-rearing of chicks include avian malaria, airsacculitis and pneumonia, aspergillosis, feather-loss and bumblefoot. Released birds are monitored as part of a research program to identify factors that influence selection of breeding colony. It is hoped that this will provide information on how captive rearing of birds may be used to bolster declining colonies or establish new ones in favourable localities, e.g. close to forage food resources.

Magellanic penguins pair assortatively by strength of cell-mediated immune response

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A strong immune system can increase an individual's reproductive fitness. Consequently, if immune system strength can be perceived, then immune system strength should be important during mate selection. We predicted that Magellanic penguins (*Spheniscus magellanicus*) would pair assortatively based on immune system strength. To test this hypothesis, we measured T-cell-mediated immunity response to a novel antigen using the phytohaemagglutinin (PHA) skin test during incubation in two breeding seasons. We also measured several physiological and other characters that might signal or reflect immunocompetence, including size, age, nest quality, and reproductive success. We found that Magellanic penguins mated assortatively by strength of immune system. We found no correlation between immune response and size, age, nest quality, or reproductive success because of high variability in these parameters.

The 'ecology of fear' and the natural history patterns of Antarctic penguins

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The fear of predation among mesopredators, and not merely the direct avoidance of being eaten, is an important component of ecosystem structuring revealed recently as top predators are re-introduced into foodwebs in which they had been absent for most of the period during which modern ecology has developed. Detecting the influence of predation fear without such 'experiments' is a daunting task, but by inference it appears to be important in the life history strategies of penguins. Herein, we present data on aspects of foraging in relation to light levels for Adélie (*Pygoscelis adeliae*) penguins and review similar information available for emperors (*Aptenodytes forsteri*). Ironically, both species forage at depths where there is very little or no light, yet each avoids entering the ocean in the dark of night or in coming ashore in the dark. We then propose this is due to fear of predation, and not to an inability to detect prey in the dark, and further propose that this fear affects large-scale post-breeding movements in both species as well, similar to the effect recently observed of newly instituted predation pressure on shorebird species.

Social stress in a colonial seabird: heart rate responses of breeding penguins to their aggressive conspecifics

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In group-living species relying on limited energy budgets during specific life history stages, the energy invested into the social domain may be constrained by that invested into other activities, and habituation to chronic social stressors may be adaptive. Our study monitored the social sensitivity of free living king penguins breeding under strong energy constraints in a highly aggressive colonial environment. Heart rate (HR) was recorded along side behaviour in 11 incubating adults throughout the breeding season. We considered a total of 365 aggressive encounters in which birds were either actors (203 events) or bystanders (i.e. observers, 162 events). We show that agonistic encounters provoked significant increases in the HR of breeding adults, even in bystanders which were not directly concerned by aggressive situations. Whereas the aggressive context (i.e. length, intensity of interactions, number of individuals involved, threat displays or physical attacks) significantly influenced the HR response in actors, this was not the case for bystanders, for which only the duration of aggressions seemed to matter. Our results suggest a role for individual motivation and social sensitivity and underline the importance of individual assessment of social contexts in modulating physiological responses to the social environment, especially when breeding on a tight energy budget.

Approaching penguins for identification: is a robot less stressing than humans?

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Population studies on penguins traditionally require marking individuals and then closely approaching them for accurate identification, location and determination of breeding status. Such approaches might induce significant stress and have deleterious effects on energy balance. To assess this stress response, we compared the heart rate (HR) response of incubating king penguins to approaches at different distances (from the distance of alertness to that of fleeing and during brief contact) when birds were approached to be identified by Radiofrequency identification (RFID) either by humans or by a custom built radio-controlled robot. Approaching penguins by humans or robot induced moderate HR increases, by 30 bpm at 8 m to 45 bpm at contact. The HR response was slightly lower during robot than human approach. From the increase in heart beats during approach, and assuming the energy expenditure *vs* HR relationship previously determined in incubating king penguins presently applies, we estimated that an approach to contact by humans or robot induced at most a 0.04% increase in daily energy expenditure. Thus, while leading to a limited but significant HR increase, approaching a king penguin up to brief contact probably has a very limited impact on its energy budget.

Ecotourism effects on Magellanic penguins at San Lorenzo colony, Peninsula Valdés, Argentina

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The continuous increase of tourist visitation in penguin breeding colonies has generated the need of monitoring the potential negative effects of tourism in order to develop the industry in a sustainable way. The overall objective of our research was to study if tourism had an impact on the Magellanic penguins (*Spheniscus magellanicus*) breeding at the San Lorenzo colony, Peninsula Valdes, Chubut, Argentina. We measured the effects of tourist visitation on biological and physiological parameters along four breeding seasons by comparing visited areas with undisturbed ones. We studied 1) the effects of the visits on the breeding success of the birds; 2) the effects of the visits in the growth rate of the chicks; 3) the effects of the visits on the behavior; and 4) the physiological consequences of living in tourist visited areas (stress hormones and heart rate). We found no differences in breeding success or growth of chicks between areas. Penguins in the undisturbed areas reacted at greater distances than penguins in the tourist area. The baseline and the integrated corticosterone levels were similar between areas. There was no relationship between heart rate and group size, however there was a great variation among individuals, so further analysis must be done. So far, we have not seen obvious adverse effects on the penguin in the short term.

Behavior and hormonal responses to tourism stress differ with variable history of visitation to magellanic penguin colonies

Walker, Brian [Department of Biology, Fairfield University, Fairfield, CT, USA] and **Cecilia Villanueva** [Centro Nacional Patagonica – CONICET, Puerto Madryn, Chubut, Argentina]

We examine how Magellanic penguins (*Spheniscus magellanicus*) in two colonies with different histories of tourist visitation compare in responses to disturbances. Punta Tombo, in south central Chubut, Argentina, has a 30+ year history of tourist visitation and over 150,000 visitors annually. In contrast, San Lorenzo, located 300 km. north of Punta Tombo, has been open to tourists for 9 years, and only 10,000 people visiting annually. For adult penguins in both colonies, behavioral habituation – i.e., lack of any overt aggressive behavior – is apparent in penguins living in tourist areas, as opposed to penguins in non-disturbed areas. In contrast, there is a significant difference in the glucocorticoid response to acute stress in the two colonies. Tourist-exposed penguins in Tombo have reduced adrenal functionality when captured and held (as compared to undisturbed birds) whereas penguins in new-disturbed San Lorenzo show no differences in acute responses between visited and non-visited birds. Additionally, newly hatched chicks at Punta Tombo show an adult-like stress response immediately after hatch. This is unexpected in semi-altricial chicks that usually have a reduced stress response at hatching. In contrast, newly-hatched chicks at San Lorenzo show no increased expression of the stress response.

Age-related variation in survival and movement rates of the Adélie penguin in response to colony size and breeding status.

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We have recently shown that survival and movement probabilities of adult breeding Adélie penguins vary between colonies of different sizes and among years or in relation to environmental disturbance. However key demographic parameters still need to be established as the foundation for future population modeling, specifically, age-related variation in survival, and rates of natal philopatry. Age-at-first-reproduction for this species is highly variable (3-7 years) and the environmental factors that may affect this parameter are not well understood. Here we present age-related survival and movement rates during 13 years of varying environmental conditions for Adélie penguins from a 3-colony system in the Ross Sea. In addition, we investigated differences in survival and philopatry in relation to breeding status, and estimate the probability of transitioning from a non-breeder to a breeder in relation to age and how that probability varies by time. Understanding the complex age-related demographics of this long-lived seabird is the key to understanding how resilient this species may or may not be to environmental variation, including climate change.

Modeling of top predators to inform conservation spatial planning in the Ross Sea, Antarctica

Ballard, Grant and **Dennis Jongsomjit** [PRBO Conservation Science], **Viola Toniolo** [Stanford University], and **David G. Ainley** [H.T. Harvey & Associates]

Recent analysis indicated the Ross Sea to be Earth's least anthropogenically affected stretch of marine waters. Likely it is the last having a full suite of top predators and therefore has a columnar rather than the pyramidal trophic structure now found in most other oceans. To define provisional conservation area boundaries, we used Maxent to model the distribution of several top predators: Antarctic minke whales, Antarctic toothfish, crabeater seals, Adélie and emperor penguins, and three species of petrels/albatross. Data were obtained from continuous at-sea surveys, as well as CPUE in a newly-arrived fishery. Co-variates in the modelling included bathymetry, rate of change in bathymetry, proximity to the shelfbreak front, prevalence of Circumpolar Deep Water, chlorophyll and krill abundance. Validation of models for crabeater seals and penguins was accomplished in part by analysis of extensive satellite tracking data. The primary importance of the enhanced productivity characterizing the Ross Sea continental shelf and the Antarctic shelfbreak front was clearly evident. We propose that conservation area boundaries currently under consideration by CCAMLR and Birdlife International contain the shelf and slope, a relatively small (3.2%) but ecologically significant portion of the Southern Ocean.

South Africa's penguins collapse following intensified competition with fisheries for food, thought attributable to environmental change

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Numbers of African Penguins *Spheniscus demersus* breeding in South Africa collapsed from 57 000 pairs in 2001 to 21 000 pairs in 2009. Their main food is anchovy *Engraulis encrasicolus* and sardine *Sardinops sagax*, which are also targeted by fisheries. In the east, numbers of penguins halved between 2001 and 2003, following a large increase in that area's catch of sardine. In the west, numbers fell by 70% between 2004 and 2009, after an eastward shift in the distribution of prey. First-time breeders may recruit to colonies where conditions are favourable at the time. However, the shift to the east also increased distances between fish processing plants and fish. Fishers caught as much fish as possible near to processing plants and heavily out-competed penguins for food. From 1999–2006, more than 450 000 t of fish were caught within 20 miles of Dassen Island, then the largest colony, including 30% of the overall catch of anchovy in 2006, and the colony decreased by 80%. At Dyer Island, where the eastward displacement of prey should have enhanced its availability, more than 200 000 t of sardine were harvested within 20 miles of the island from 2002–2004.

Magellanic penguin (*Spheniscus magellanicus*) northward distribution changes in Patagonia

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Magellanic penguins (*Spheniscus magellanicus*) have 63 colonies distributed along 4000 km of coastline in Patagonia, Argentina, with 950,000 breeding pairs. We estimated population size and breeding success at large colonies scattered along Northern and Central Patagonia and assessed trends. To evaluate dispersion we searched five colonies for penguins hatched and banded between 1983 and 2009 at Punta Tombo. Northern colonies increased steadily. Río Negro, increased from 22 breeding pairs in 2002 to 3,751 in 2009. , San Lorenzo (Peninsula Valdes) incremented from 93 breeding pairs in 1977 to around 100,000 in 2008. In Central Patagonia, the biggest colonies declined, including the largest colony in the world, Punta Tombo. Isla Leones decreased from 96,287 pairs in 1995 to 47,492 in 2009. Islas Vernacci, an order of magnitude smaller grew from 21,868 pairs in 1993 to 27,736 in 2008. Breeding success was higher in northern colonies. Out of 82,695 birds checked, we found three penguins breeding in the Peninsula Valdes that hatched at Punta Tombo in 1988 and 1991. Dispersal might be an important driver on colonies that are expanding at the northern part of the Magellanic penguin's breeding range and in the decline of penguins in the central part of their range.

Breeding behaviour of the Galápagos penguin (*Spheniscus mendiculus*): implications for conservation

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In 2004 and 2005 we studied the breeding behaviour of the Galápagos penguin, *Spheniscus mendiculus*, an endemic and endangered species in the Galápagos Islands with a current population of less than 2000 individuals. A total of 115 nests at 17 different locations was found across the penguin's distributional range in the archipelago. Breeding sites ranged in size from one to 43 nests. Twelve breeding sites (71 %) were found on Isabela Island with the highest aggregations of active nests (85 %, $n = 98$) concentrated in the island's southwest. At the penguin's two main breeding sites, Caleta Iguana and Playa de los Perros, we identified two well-defined breeding peaks: March to May and July to September. In 2004, the monitored nests at Caleta Iguana showed that 54 % ($n = 15$) of the adults bred once, while 43 % ($n = 12$) of the adults bred twice and one pair laid three clutches. In 2005, 41 % ($n = 7$) birds bred once and 59 % ($n = 10$) bred twice.

All nest sites occurred within the Galápagos National Park. However, a spatial evaluation of nest sites in relation to the protection provided by the zoning of the Galápagos Marine Reserve raised serious concerns, because only 29 nests (25 %) were afforded the highest protection level, while 86 nests (75 %) were found in areas designated for extractive uses such as fishing.

The marine life of the smallest penguin *Eudyptula minor* in a changing world

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Penguins must breed on land or ice but rely totally on the ocean for their food supply. However, there is disproportionately less information available on their marine life cycles. Long-term datasets on their marine phase can assist to monitor or predict the impact of climatic changes in the oceans. Most studies on their foraging strategy are biased towards pelagic species with relatively less information on inshore birds. Strategies used by pelagic penguins may not be similar of inshore species, which spend their lives in a smaller area, may not migrate and may be more sensitive to changes at local rather than large scales. Here, we summarise the results of a long-term study of the foraging ecology of the smallest penguin *Eudyptula minor* by examining its diet (conventional and isotopic methods), diving behaviour and foraging plasticity. Parents can decrease food provisioning, increase diving effort and simplify their trophic breadth in response to years of low breeding success. Further, we have detected penguins fishing up the food web after a massive mortality of a key lower trophic-level prey and discovered that foraging success decreases when thermoclines are absent in the penguin's foraging zone – an event that could become more frequent due to climate change.

Shifting ice, missing fish-population genetics of the Gentoo penguin.

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The Scotia Arc and the Antarctic Peninsula are subject to rapid climate change that has already impacted on penguins; we are seeing the creation of new colonies, while established colonies are declining. Contrasting trends in population size in different geographic localities raises questions as to whether shifts in geographic distribution are occurring amongst penguin populations through migration or whether observed changes are a result of increases or decreases in reproductive success and survival in colonies from different areas. Levels of migration and structure in populations can be important information for developing effective conservation strategies. In particular they can help to determine the nature and location of protected areas. Gentoo penguins (*Pygoscelis papua*) have the largest latitudinal ranges of any penguins, but despite this geographic distribution, they are thought to be largely faithful to their natal colonies. Population genetics is one way in which we can gain information about population sizes and structure in time to meet the pressing environmental concerns. We sampled populations of penguins across the Scotia Arc and down the Antarctic Peninsula, and genotyped these samples using previously identified microsatellite loci for penguins. We report the population structure and rates of migration between these regions and discuss the implications for penguin conservation in a changing climate.

Population status, diet and conservation of rockhopper and Gentoo penguins at the Falkland Islands

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The Falkland Islands host several globally important seabird populations including approximately 20% of the world's southern rockhopper penguin *Eudyptes chrysocome chrysocome* and 21% of the global gentoo penguin *Pygoscelis papua* population. Large fluctuations in the Falkland Islands populations are likely to impact the global conservation status of these species.

We report on results of three (1995, 2000, 2005) whole islands/archipelago-wide censuses of rockhopper penguins and gentoo penguins at the Falkland Islands. We also present results from selected annual monitoring sites (1993-2009) and explore inter-annual variability in breeding pairs, breeding success and diet (1986 – 2000), in relation to environmental indices.

Results of this study indicate a high level of resilience in gentoo penguins to large scale population perturbations in the Falkland Islands. The situation for the globally threatened rockhopper penguin, on the other hand, continues to deteriorate. Rockhopper penguins have been the focus of recent international concern and have prompted new conservation efforts owing to marked population declines throughout its range, including the Falkland Islands. The current Falkland Island population estimate is 211,000 breeding pairs. It is imperative that we improve our understanding of the causal mechanism/s associated with the long-term decline of this species.

Climate change winners and losers: regional-scale patterns of population change among pygoscelid penguins on the Antarctic Peninsula

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Life history differences among the congeneric and sympatrically breeding chinstrap, Adélie, and gentoo penguins significantly influence their responses to the rapid climate change now occurring on the Western Antarctic Peninsula (WAP). The Antarctic Site Inventory project has been monitoring these penguins since 1994 at over 125 locations. We use this data, along with a series of statistical models designed to overcome the opportunistic nature of the data collection, to understand the regional scale dynamics of these three populations during a period of rapid environmental flux. We find clear regional-scale patterns of population change including a sharp decline in the sea-ice-dependent Adélie penguins along the WAP and concurrent increases and range expansion in populations of the sub-Antarctic gentoo penguin. Declining Adélie penguin populations are strongly correlated with spatial variability in chlorophyll-a and declining mid-winter sea ice, whereas gentoo penguin increases appear to be driven by the addition of available breeding habitat at the southern periphery of their breeding range. Additional analyses of penguin diet and phenotypic plasticity in breeding phenology all support our conclusion that gentoo penguins are clear climate change winners in this region, while Adélie penguins on the WAP are losing ground as the Peninsula continues to warm.

Behavioral plasticity of Adélie penguins in response to varying sea-ice conditions.

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The ability of individual seabirds to adjust their behavior in response to the conditions they experience is an example of phenotypic plasticity, which likely has important consequences on seabird population's capability to cope with environmental change. To date, however, empirical studies of between individual variation in behavioral reaction norms are lacking. Here, we propose to examine the relationship between a behavioral trait, foraging efficiency, and an environmental variable, sea-ice concentration, in the Adélie penguin *Pygoscelis adeliae*. Based on a 13-yr, individual-based longitudinal data set on foraging parameters of pit-tagged individuals, we tested for and described individual plasticity in foraging efficiency using random regression models. Adélie penguins show substantial phenotypic plasticity in foraging efficiency, suggesting that at least part of the population can cope with a wide range of sea ice concentration levels.

However, further analyses would be needed for predicting the population's response to ongoing climate change.

Plasticity in the natural history patterns of Adélie penguins: results of a millennial-scale natural experiment

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After 5 years investigating the natural history and demographics of an Adélie penguin metapopulation in the Ross Sea, two very large icebergs altered local habitat to provide a “natural experiment” in which to test hypotheses about population structuring, resource competition, and variation in natural history parameters. The icebergs resulted in physical barriers that profoundly changed breeding effort at some colonies. We documented to varying degrees depending on year and colony, changes in breeding phenology, short-term demographic effects of poor reproductive success (0.5 to 0.9 fewer chicks/pair) and chick growth (500 gr less) when the iceberg was present. In addition, intercolony movement of breeding adults and prebreeders increased with added environmental stress, particularly at the smallest colony. Longer-term demographic effects are just being realized, but the negative effects of the iceberg on the short-term natural history of Adélie penguins and their response to environmental variation is important to our understanding the effects of climate change in this and other seabird species.

Breeding population trends of Adélie penguins at Casey over 50 years

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Data on breeding populations of Adélie penguins *Pygoscelis adeliae* from two localities at Casey, East Antarctica, provide information on trends at multi-decadal scales and the impact associated with human disturbance to breeding populations. Data are available from Whitney Point, an Antarctic Specially Protected Area, since 1959/60, and from Shirley Island, adjacent to Casey and subject to human visitation each summer, since 1968. The two populations have exhibited marked differences in breeding success and in population trends, with the penguins inside the protected area increasing in numbers more rapidly and exhibiting higher breeding success than the birds on Shirley Island that are subject to low levels of human disturbance.

Variability in the breeding phenology of Adélie penguins at a colony: potential causes and consequences for reproductive success

Emmerson, Louise, Rhonda Pike, Andrew Townsend and Colin Southwell
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In this talk we describe the intra- and inter-annual variability in the timing of breeding phenology over a 16 year period for the Adélie penguin (*Pygoscelis adeliae*) colony at Béchervaise Island, East Antarctica. We provide clear evidence that Adélie penguins have the capacity to adjust the interval between arrival and egg lay in response to arrival dates with a reduced courtship and egg lay period in years when they arrive late. However, the timing of their arrival still sets in motion corresponding later or earlier dates for clutch initiation, departure of parents on foraging trips and chick hatch. We describe which environmental variables are associated with penguin arrival times, in particular, those that delay their arrival, out of a range of broad marine environmental conditions, local weather conditions and broad climatic indices and discuss the impact that late or early arrival has on breeding success. Furthermore we examine what degree of synchrony exists between the penguins and whether this is also associated with reproductive outcomes for this population.

Emperor Island? The demise of the emperors

Phil Trathan and **Peter T Fretwell** [BioSciences Division, British Antarctic Survey, High Cross Madingley Road, Cambridge UK], **Bernard Stonehouse** [Scott Polar Research Institute - now retired]

An increasing number of studies have highlighted the susceptibility of emperor penguins to changes in sea-ice distribution, suggesting that future continued climate change is likely to impact upon their population processes, breeding success and future colony viability. Our recent circumpolar study has further enhanced our understanding of emperor penguin colony distribution, highlighting those colonies that are potentially most vulnerable to future regional climate change effects. One of the most northerly of all emperor penguin colonies is to be found at 67°52 S, 68°43 W west of the Antarctic Peninsula within Marguerite Bay on Emperor Island within the Dion Island group. Here emperor penguins breed habitually on a low rock and shingle isthmus at the southeast end of the island. In this study we examine the population changes observed at this colony since it was first discovered in 1948 and relate them to prevailing regional environmental signals, including air temperature and sea-ice extent from records dating back to the mid 20th century, prior to the date that this colony was first described.

Penguins from space: estimating emperor penguin (*Aptenodytes forsteri*) populations through faecal stains and image recognition analysis of individuals and huddles

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The emperor penguin (*Aptenodytes forsteri*) is a species that is poorly mapped, in large part due to its unique breeding habits and the difficulty in accessing its breeding habitat. However, in a recent study we located almost all of the extant emperor penguin breeding colonies from their faecal stains that show up in the Landsat Image Mosaic of Antarctica. This low resolution resource allowed us to map and assess their breeding distribution, providing a vital geographical resource for future studies of this iconic species that is now believed to be vulnerable to future climate change.

Emperor penguins breed on sea ice, and their colonies exist *in situ* between May and December each year. Faecal staining at these colony locations shows on Landsat imagery as brown patches, this staining can therefore be used as an analogue for colony locations. The whole continental coastline was analysed, and each possible signal was identified visually and checked by spectral analysis. This study identified colony locations of emperor penguins at a total of 38 sites. Of these, 10 were new locations.

Since the publication of this paper we have been working with AGIC to access Digital globe high resolution satellite imagery. This has now revealed a total of 43 sites of which six are new since our earlier study. We confirm that only one colony found in the Landsat survey could not be found with this imagery. All of the previously confirmed locations were captured in a single breeding season.

Adapting the methods of Barber-Meyer et al. (2007), we used pan-sharpened images to estimate population sizes. In this paper we present the latest results from this unique study.

Climate change threatens emperor penguins

Jenouvrier, Stéphanie [Centre d'Etudes Biologiques de Chizé, Centre National de la Recherche Scientifique, F-79360 Villiers en Bois, France; Biology Dept., MS-34, Woods Hole Oceanographic Institution, Woods Hole MA, USA], **Hal Caswell** [Woods Hole Oceanographic Institution, Woods Hole MA, USA] **Christophe Barbraud** [Centre d'Etudes Biologiques de Chizé], **Marika Holland** [Oceanography Section, National Center for Atmospheric Research, Boulder CO, USA], **Julienne Stroeve** [National Snow and Ice Data Center, Boulder CO, USA], **Henri Weimerskirch** [Centre d'Etudes Biologiques de Chizé]

Penguins are affected by climate change. There is a growing demand for accurate forecasts of penguin population responses to climate change to implement necessary conservation policies and procedures to limit greenhouse gas emissions. As concentrations of atmospheric greenhouse gases increase, sea ice extent (SIE) is projected to shrink in Antarctica. Emperor penguins *Aptenodytes forsteri* are extremely sensitive to change in sea ice because they use sea ice as a breeding, foraging and molting habitat. We used a stochastic population model that combines a unique long-term data set (1962- 2005) from a colony in Terre Adélie and projections of SIE from General Circulation Models of Earth's climate included in the Intergovernmental Panel on Climate Change assessment report. We showed that the increased frequency of low SIE will reduce the population viability and that the quasi-extinction probability (a decline of 95% or more) of the population is at least 36% by 2100. To avoid extinction, Emperor penguins will have to adapt, migrate or change the timing of their growth stages.



Poster Abstracts

Environmental enrichment techniques used for Magellanic penguins (*Spheniscus magellanicus*) at the Aquário de São Paulo, São Paulo, Brazil

Barbirato, Mayla, Laura Ippolito, Laura Reisfeld, and Camila Dutra [Aquário de São Paulo, São Paulo, São Paulo, 04275-000, Brazil], **Valeria Ruoppolo** [International Fund for Animal Welfare], and **Manuela Gonçalves Fraga Geronymo Sgai and Cristiane Schilbach Pizzutto** [Departamento de Reprodução Animal – Faculdade de Medicina Veterinária e Zootecnia – Universidade de São Paulo – Brazil]

One of the most important behavior patterns of the Magellanic penguin (*Spheniscus magellanicus*) is that they spend around 80% of their time foraging through the Southwest Atlantic. When in captivity, penguins develop more sedentary habits, followed by behavioral changes including reduced time spent in the water, which can lead to clinical problems, mainly bumblefoot. Daily environmental enrichment techniques were used to stimulate the animals to stay for longer periods of time in the water at Aquário de São Paulo. Data from five Magellanic penguins was recorded for one year. Enrichment items included colored plastic balls and rings, ice blocks with fish, live fish, soap bubbles, colored hula-hoops, nature sounds, shells, pebbles and rocks. Only two items were offered each day. Notes on the interaction and preferences were registered during all enrichment sessions. Preferred items included live fish, ice blocks containing fish, and colored plastic balls and rings. After the routine introduction of environmental enrichment, it was observed that the animals were spending more time in the water and interaction between the individuals had increased, suggesting better quality of life in captive conditions.

Mitochondrial cytochrome oxidase 1 DNA sequences revealed genetic differentiation between Atlantic and Pacific breeding colonies of the Magellanic penguin, (*Spheniscus magellanicus*).

Bouzat, Juan L. and **Gabrielle J. Knafler** [Bowling Green State University, Bowling Green, OH USA], and **P. Dee Boersma** [University of Washington, Seattle, WA USA]

Sequence analysis of the cytochrome oxidase 1 mitochondrial gene of 61 Magellanic penguins revealed limited levels of genetic differentiation between breeding colonies located at the northern distribution range of the Atlantic and Pacific Oceans. An Analysis of Molecular Variance (AMOVA) showed that 4.32% of the total genetic variance resulted from differences between colonies from the Atlantic and Pacific oceans, whereas 3.2% resulted from differences among colonies within ocean basins. Pairwise comparisons of individual colonies revealed that 8 out of 9 possible comparisons of populations from different oceans showed significant genetic differences ($P < 0.001$), while none of the comparisons of colonies from the same ocean were significant. Furthermore, phylogenetic analysis of the sequences did not reveal any apparent phylogeographic pattern. Estimated levels of genetic differentiation between colonies from the Atlantic and the Pacific were slightly higher than those previously reported for three major reproductive regions in the Atlantic Ocean (3.43%).

Helminth parasites of Magellanic penguin (*Spheniscus magellanicus*) from Brazilian coastal zone

Brandão, Martha [Laboratório de Parasitologia de Peixes - Departamento de Parasitologia Animal, Universidade Federal Rural do Rio de Janeiro, Caixa Postal 74.508, Seropédica, Brazil], **Salvatore Siciliano**, [Grupo de Estudos de Aves e Mamíferos Marinhos da Região dos Lagos, Departamento de Endemias, Escola Nacional de Saúde Pública/FIOCRUZ, Rio de Janeiro, RJ, Brazil], and **José L. Luque**, [Laboratório de Parasitologia de Peixes - Departamento de Parasitologia Animal, Universidade Federal Rural do Rio de Janeiro, Caixa Postal 74.508, Seropédica, Brazil]

Magellanic penguin (*Spheniscus magellanicus*), is a South American sphenicid inhabiting in coastal Argentina, Chile and the Falkland Islands, with some migration to Brazil in Atlantic Ocean or until Peru in the Pacific. Winter time in Brazil (June to September) is the period that the Magellanic penguins arrived in Brazilian waters. We collected dead penguins in 2008 and examined 36 stomachs and 45 intestines for helminth parasites. The objective was to identify the helminth fauna of Magellanic penguins in Brazil. *Contracaecum pelagicum* (Nematoda: Anisakidae) was found in 34 (94.4%) stomach samples, two penguins presented one specimen of *Cardiocephaloides physalis* (Digenea: Strigeidae) on its stomach, but this must be a parasite migration after penguin dead. The mean abundance of stomach samples was 106.8 (min.=3, max.=768; DP. 152.36). Helminths found in the intestine was *Tettrabothrius lutzi* (Cestoda: Tettrabothriidae) with 33.3% (N= 15), *C. pelagicum* 64.4% (N= 29), *C. physalis* 51.1% (N= 23) and other two species unidentified presenting 11,11% (N= 5) and 6,67% (N= 3). The parasite species most abundant in intestine was also *C. pelagicum* with mean 90.1 (min.=1, max.=1.209; DP. 226.09). *C. physalis* presents 11.4 of mean abundance (min.=1, max.=41; DP. 10.95), *T. lutzi* presents 156.47 (min.=1, máx.=1,400; DP. 365.82).

Plastic debris in (*Spheniscus magellanicus*) from Brazilian coastal zone

Brandão, Martha [Laboratório de Parasitologia de Peixes - Departamento de Parasitologia Animal, Universidade Federal Rural do Rio de Janeiro, Caixa Postal 74.508, Seropédica, Brazil], **Salvatore Siciliano** and **Victor Vilas-Bôas** [Grupo de Estudos de Aves e Mamíferos Marinhos da Região dos Lagos, Departamento de Endemias, Escola Nacional de Saúde Pública/FIOCRUZ, Rio de Janeiro, RJ, Brazil], and **José L. Luque** [Laboratório de Parasitologia de Peixes - Departamento de Parasitologia Animal, Universidade Federal Rural do Rio de Janeiro, Caixa Postal 74.508, Seropédica, Brazil]

Marine life is threatened by many human impacts such as overexploitation of fishery resources, dumping of waste, pollution, alien species and global climate change. Fishing activities cause many threats to marine biodiversity and also some effects with the use of bottom trawl and gill nets. Debris of those nets is the most common plastic found in the stomach contents of Magellanic penguins (*Spheniscus magellanicus*). Magellanic penguins arrive every winter in Brazilian coast, in 2008 winter many dead penguins were collected for the staff of Study Group on Birds and Marine Mammals of Região dos Lagos – Rio de Janeiro/ Brazil. From 52 penguins 13 (25%) had plastic debris in the stomach and some either in the intestines. One of those had its stomach perforated for a plastic straw and probably this was the cause of its dead. The impacts of plastic debris on marine life are being constantly reported in scientific articles and need urgently effective conservation action.

Inter-tissue comparison of mercury concentrations among the components of penguin eggs

Brasso, Rebecca L., Michael J. Polito, and Steven D. Emslie [Department of Biology and Marine Biology, The University of North Carolina at Wilmington, USA]

There is no known relationship regarding mercury deposition into the major components of penguin eggs (eggshell, membrane, albumen, and yolk). Previous studies on wood ducks (*Aix sponsa*) and Audouin's gulls (*Ichthyophaga audouinii*) found significant relationships between mercury concentrations in eggshell and albumen as well as eggshell and homogenized albumen and yolk. While penguin eggshell and membrane are numerous and well preserved in ornithogenic soils, albumen and yolk samples are limited to chance discovery of undeveloped, abandoned eggs. The main objective of this study is to establish an inter-tissue comparative ratio of mercury concentrations among the components of penguin eggs. Twenty eggs were collected from a captive breeding population of gentoo penguins (*Pygoscelis papua*); the eggshell, membrane, albumen, and yolk were separated and will be individually analyzed for mercury. To determine repeatability in wild birds, individual components of twenty gentoo penguin eggs collected from a wild breeding population in the western Antarctic Peninsula will also be analyzed. As the accessibility of egg tissues at active or abandoned penguin colonies varies, the establishment of consistent relationships among egg components will allow for extrapolation back to whole egg mercury and for results to be comparable with published literature using any egg component.

Reproduction and demography of the Humboldt penguin (*Spheniscus humboldti*) at Punta San Juan, Peru, for the period 2000-2009

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[Proyecto Punta San Juan - Centro para la Sostenibilidad Ambiental, Universidad
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The Humboldt penguin (*Spheniscus humboldti*) is endemic to the Humboldt Current and very sensitive to environmental changes, both anthropogenic and natural. During “El Niño” events, oceanographic conditions significantly affect the penguins’ distribution and reduce their main prey availability, negatively affecting the reproductive success and population dynamics of this species.

The extreme El Niño event of 1997/98, the event of the century, apparently resulted in the loss of close to 50% of the Peruvian population of Humboldt penguins.

This study describes the demography and reproduction of the species for the period 2000-2009, at the most important breeding colony of Peru, at Punta San Juan de Marcona (15 ° 22’S 75 ° 12’W), in the Department of Ica, Peru. Punta San Juan and 32 other sites have recently be integrated into the Peruvian National Protected Area System as a single National Reserve, the System of guano islands, islets and headlands.

Climate change and the little penguin: impacts and adaptation options

Chambers, Lynda E. [Centre for Australian Weather and Climate Research, Bureau of Meteorology, GPO Box 1289, Melbourne, Vic 3001 Australia] and **Peter Dann** [Research Department, Phillip Island Nature Park, PO Box 97, Cowes, Vic 3922 Australia]

Long-term data sets (since 1968) on breeding success and survival, as well as shorter datasets on foraging and breeding distributions (since 1984), were used to assess observed and projected impacts of climate change on Little Penguins on Phillip Island, Australia. Anticipated impacts include: a small loss of breeding habitat due to sea-level rise and associated erosion along creeklines; increased fire risk; increased burrow temperatures and heat-related mortality; altered breeding timing, success and survival associated with increased ocean temperatures and reduced marine productivity. However, a number of adaptation options exist to reduce climatic impacts and increase penguin resilience including: increasing appropriate ground vegetation within breeding habitats to better insulate burrows, placing a high priority on fire response planning and training and encouraging colonization of other suitable breeding areas through active management, in particular eradicating foxes, improving penguin access and optimizing vegetation type and cover for breeding penguins. Continued monitoring of penguin populations will enable judgments to be made on the effectiveness of management actions and inform further adaptation responses.

Retrofitting an existing exhibit in an AZA-accredited zoological facility

Darnell, Geneve [Jacksonville Zoo and Gardens, 370 Zoo Parkway,
Jacksonville FL, USA

It is no surprise that the popularity of the temperate penguins has skyrocketed in the last decade in zoological institutions. The continued growth and appeal in penguins is evident in both the staying power of public interest and the increasing conservation needs of temperate penguins; however, the cost of building a new exhibit in these tough economic times makes it challenging. This paper will discuss how the Jacksonville Zoo and Gardens retrofitted an existing North American river otter exhibit for Magellanic penguins which had distinct advantages over new construction. Included in the retrofit were changes to the physical features of the exhibit and modifications of the holding area to better suit the environmental needs of the birds. Also, due to the prevalence of mosquito born illness in Florida, additional features and protocols had to be incorporated. The results were an exhibit that is priceless.

Pyrosequencing faecal DNA to determine diet of little penguins *Eudyptula minor*: is what goes in what comes out?

Deagle, Bruce E. [Department of Biology, University of Victoria, PO Box 302, Victoria, BC, V8W 3N5, Canada], **André Chiaradia** and **Julie McInnes** [Research Department, Phillip Island Nature Parks, PO Box 97, Cowes, Victoria, 3922, Australia], and **Simon N. Jarman** [Australian Marine Mammal Centre, Australian Antarctic Division, Channel Highway, Kingston, Tasmania, Australia]

An emerging approach for dietary analysis is to amplify DNA barcoding markers from stomach contents or faeces and characterise the amplicons using high-throughput sequencing, using their unique barcode. How these data relate to the proportions of species consumed is unclear since technical and/or biological biases could skew the quantitative signature. Here, we evaluated whether pyrosequencing mtDNA 16S barcodes amplified from the faeces of captive Little penguins *Eudyptula minor* can inform on proportions of species consumed. Penguins were fed a known diet, primary pilchards which were the most common DNA sequence recovered from their faeces. Sequences of three other fish species fed to the penguins in constant proportions (45:35:20) were all detected, but proportions of sequences recovered (60:6:34) were considerably different, probably due to differences in prey digestibility. Correction factors based on relative DNA density in the tissue of the fish did not improve estimates of diet composition. Our results highlight that the DNA sequences recovered in dietary barcoding studies are unlikely to provide a perfect reflection of prey consumed. However, semi-quantitative interpretations of dietary barcoding data can be justified if estimates are given proper confidence intervals. The approach will be particularly valuable in comparative studies when a similar range of prey species are consumed within each group.

Operant conditioning of three species of penguins at Lincoln Park Zoo

Dvorak, Kristin [Lincoln Park Zoo, 2001 North Clark Street, Chicago, IL 60614 USA]

The bird department at Lincoln Park Zoo has an operant conditioning program to improve the care and management of our collection and foster positive interactions between the birds and staff. The Penguin Seabird House is one of the areas where the operant conditioning program was utilized to train three species of penguins: rockhopper penguin (*Eudyptes chrysocome*), chinstrap penguin (*Pygoscelis antarctica*) and king penguin (*Aptenodytes patagonica*). Our goal was to use positive reinforcement to train for basic and advanced husbandry behaviors. We have been successful in obtaining voluntary weights on all the penguins and have trained one king penguin for voluntary nail trim and voluntary blood collection.

Evaluation of potential variables contributing to the development and duration of plantar lesions in a population of aquarium-maintained African penguins (*Spheniscus demersus*)

Erlacher, Claire, Allison D. Tuttle, Tracy Camp, Laurie Macha, Lisa Mazzaro, and J. Lawrence Dunn [Mystic Aquarium, a division of Sea Research Foundation, Inc., Mystic CT, USA]

Bumblefoot (pododermatitis) is commonly due to pressure or trauma on the plantar surface of the avian foot resulting in cracks and callouses in the skin, inflammation, and bacterial infection.¹⁻⁶ The primary purpose of this retrospective study was to evaluate variables potentially contributing to the development and duration of plantar lesions in our population of African penguins (*Spheniscus demersus*) over the past eight years including: weight, age, sex, season, activity, and substrate.

In our population, African penguins spending greater than 50% of their time swimming while on exhibit developed plantar lesions significantly less often than penguins primarily standing on exhibit (swim 21.2%, standing 34.2%). Penguins with a preference for concrete versus grates on exhibit developed lesions that required treatment for a significantly longer duration of time despite identical treatment protocols (concrete = 43.6 days and grates = 32.8 days). Results also indicate that penguins weighting 3.51-4.0kg develop lesions significantly more often than penguins weighing 2.5-3.5kg (2.5-3.5kg = 54.9% and 3.51-4.0kg = 73.6%).

Recommendations for minimizing the formation of plantar lesions in African penguins include training penguins for monthly foot examinations, and replacing smooth surfaces on exhibit with surfaces that provide variable degrees of pressure and texture on the feet.

Enrichment, aggression and nesting material: rockhopper penguins' use of river rocks during the non breeding season at Lincoln Park Zoo

Fuehrmeyer, Christine [Lincoln Park Zoo, 2001 North Clark Street, Chicago IL, USA]

The utilization of river rocks by rockhopper penguins (*Eudyptes crestatus*) during the non-breeding season was studied in 2001 and 2002. The study was conducted in order to enhance the enrichment program and to address the following questions of concern: 1) Are the rockhoppers spending less time swimming since many penguins are defending their collection of rocks? 2) Is there an increased amount of intraspecies aggression when a limited number of rocks are present? Data showed that having access to nesting material during the non breeding season did not affect the amount of time the rockhoppers spent defending their nests nor did it affect the amount of aggression. The results have aided in the success of the enrichment program by encouraging more active behaviors.

Petroleum pollution and penguins: marine conservation tools to reduce the problem

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Petroleum is one of the most common toxic substances released into the marine environment. Accidental pollution is spectacular and receives a lot of attention when the negative effect to the environment is dramatic. The impact of chronic petroleum pollution is often not sensational and hence receives less attention than it deserves. Mortality of penguins from petroleum is a long term and large scale problem. Petroleum pollution has killed thousands of penguins in Africa, Australia and New Zealand, South America, and even Antarctica. The SW-Atlantic, although not well known for petroleum pollution problems, is a chronic source of petroleum discharge. To avoid severe negative impacts of petroleum on penguins and other marine species, planning and implementation strategies should concentrate on minimizing risk associated with petroleum discharge and development. New legislation combined with effective enforcement could reduce petroleum spills, minimize operational discharges from ships and from land-based sources and thereby, decrease the release of petroleum into the ocean. Reduced exposure and vulnerability to petroleum can be achieved through marine conservation tools, such as MPAs or Marine Spatial Planning to minimize risk to wildlife. We review how petroleum pollution has impacted populations of penguins. In addition, we suggest how marine management strategies could mitigate petroleum pollution harm to penguins.

Using nitrogen and carbon isotopes to compare wild and captive penguin colonies

Gifford, S. and **R.W. Fulweiler** [Earth Sciences Department, Boston University, Boston MA USA]

The New England Aquarium (NEAq) penguin exhibit contains four different species of penguins: Rockhopper (*Eudyptes chrysocome*, *Eudyptes moseleyi*), African (*Spheniscus demersus*), and Little Blue (*Eudyptula minor*). Between them, variations in natural habitat and diet exist. At the NEAq all species are combined into a single habitat and fed a slightly altered diet of capelin, herring, and smelt. We have collected samples of food, molting feathers, and guano from the exhibit for N and C isotopic analysis. These data will be compared to isotopic literature values of N and C from penguins in their natural environment. Such a comparison will help us to understand how closely the NEAq aquarium mimics the natural environment and how captivity affects the penguin colonies. In addition, these NEAq samples will be compared to natural samples from two Adélie penguin colonies in the Antarctic. The first colony is located next to Palmer station (an NSF funded laboratory with continual occupants) and the second colony is located on Peterman Island, a non-anthropogenically impacted site some miles away. The isotopic analysis should allow us to distinguish between the site impacted by human nitrogen and the site from a more pristine environment.

African penguin (*Spheniscus demersus*) – the preliminary findings in a guano study (2007-2010) done at the Penguins Eastern Cape Rehabilitation Center (PEC) in South Africa.

Horne, E.C. and B. Bousfield [Penguins Eastern Cape Rehabilitation Center, Cape St. Francis, Eastern Cape, South Africa]

The rehabilitation of African penguins at PEC has given the opportunity for non-invasive research and the identification of the endoparasites and eggs found. Examples of the helminth fauna, their eggs, location found during necropsies, clinical signs and pathogenicity have been recorded. This ongoing research project has identified the trematodes *Cardiocephaloides physalis* and *Renicola sloanei* Wright 1954, the nematodes *Contraceacum* sp. and *Cyathostoma* sp. as well as the cestode *Tetrabothrius* sp. and the presence of coccidia.

Penguins without borders: oiled African penguins rescued and cleaned in Namibia are rehabilitated in South Africa

Kemper, Jessica [Ministry of Fisheries and Marine Resources, Lüderitz Marine Research, PO Box 394, Lüderitz, Namibia], **Venessa Strauss** [Southern African Foundation for the Conservation of Coastal Birds (SANCCOB), PO Box 11114, Bloubergrandt 7443, South Africa], **Katrin Ludynia** [Animal Demography Unit, Department of Zoology, University of Cape Town, Rondebosch 7701, Cape Town, South Africa], **Jean-Paul Roux** [Ministry of Fisheries and Marine Resources, Lüderitz Marine Research, PO Box 394, Lüderitz, Namibia; Animal Demography Unit, Department of Zoology, University of Cape Town, Rondebosch 7701, Cape Town, South Africa], and **Tertius Gous** [Southern African Foundation for the Conservation of Coastal Birds (SANCCOB), PO Box 11114, Bloubergrandt 7443, South Africa]

Altogether 171 African Penguins were oiled in April 2009 along Namibia's southern coast during the country's worst oiling incident affecting penguins in Namibia to date. The birds were rescued from four islands, spanning 150 km of coastline, and were brought to the small Lüderitz seabird rehabilitation facility for cleaning and rehabilitation by staff of the Namibian Ministry of Fisheries and Marine Resources (MFMR). It soon became apparent that the facility was unable to cope with the unprecedented influx of oiled penguins, and the 129 strongest birds were evacuated 1300 km by road to the SANCCOB rehabilitation facility in Cape Town, South Africa, for further rehabilitation. Two penguins died shortly after arrival, and a further two penguins died later. A total of 113 penguins were released in Cape Town; twelve were returned to Namibia by air to be released locally. We detail the first international evacuation operation of African Penguins from Namibia to South Africa. The success of the evacuation operation was due to the prompt initial rescue of the oiled penguins, excellent collaborative efforts between MFMR and SANCCOB, careful preparation of the penguins for the journey, and immediate financial and administrative support from various agencies.

Genotyping of the major histocompatibility complex (MHC) class II DRB1 locus to assess potential mate choice in the Magellanic penguin, *Spheniscus magellanicus*.

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The major histocompatibility complex (MHC) is a highly polymorphic region of the genome that plays an important role in the immune response of most vertebrates. It has been hypothesized that pathogens are responsible for maintaining MHC variability via balancing selection and the development of mate choice. The aim of this study is to determine MHC diversity at the class II DRB1 locus in fifty breeding pairs of the Magellanic penguin, *Spheniscus magellanicus*, and to assess whether disassortative mating preferences based on MHC genetic profiles are observed in this population. Through cloning and sequencing techniques we were able to genotype the MHC class II DRB1 gene in the Magellanic penguin, assess allele frequencies, and evaluate allele sequence divergence within breeding pairs compared to randomly selected pairs. Preliminary sequencing of 460 bp of exon 2 revealed that most individuals were heterozygotes, and alleles showed 20 polymorphic sites (~ 4% sequence divergence). Levels of sequence variation reported in this study suggest that this genetic marker is appropriate to test mate choice hypothesis regarding MHC.

Mega-iceberg experiment: forced variability in sea ice cover affects Adélie penguin foraging efficiency

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and **David G. Ainley** [HT Harvey & Associates, 3150 Almaden Expressway, Suite 145, San Jose CA, USA]

The presence of two mega-icebergs for 5 years in the southern Ross Sea brought anomalous sea-ice conditions that revealed how penguins cope with environmental variability. On average, foraging performance importantly determines breeding success at the population level, but evidence is scarce to show that better breeders (BB) forage differently than poorer breeders (PB). Here, we tested two hypotheses: 1) BB are more efficient foragers than PB and 2) the strength of the relationship is stronger under harsh environmental conditions and stronger resource competition. We used a 10-yr, 3-colony, individual-based longitudinal data set on breeding success and foraging parameters of Adélie penguins on Ross Island. When the normal drift of pack ice was restricted, BB were significantly more efficient than PB at all 3 colonies. Birds from the smallest colony gathered more food per unit of time ($0.6 \pm 0.2 \text{ g.min}^{-1}$) than birds from the medium-sized colony ($0.4 \pm 0.2 \text{ g.min}^{-1}$) and birds from the biggest colony ($0.3 \pm 0.2 \text{ g.min}^{-1}$). This study is the first to demonstrate the importance of “extrinsic” conditions on the relationship between foraging strategy and individual quality.

Influence of nesting habitat on breeding success of African penguins (*Spheniscus demersus*) at Robben Island, South Africa

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From 2001–2009, breeding success of African Penguins *Spheniscus demersus* was monitored at Robben Island, South Africa. About 100 nests were followed each year. The nesting habitat was recorded for each nest monitored: on surface and shaded, on surface but not shaded, in building, in artificial nest box, in artificial burrow. Breeding success was defined as the number of chicks fledged per chick hatched. The overall breeding success was highest in the artificial nest boxes, followed by other shaded sites. Nests that were not shaded performed worst. High temperatures and high insolation at Robben Island caused adults to abandon nesting attempts. The boxes permitted more wind cooling than the burrows but have been known to flip over in exceptionally strong winds. Historical collections of guano have precluded African Penguins from nesting in burrows at many islands, causing them to nest on the surface, where they are more subject to climate extremes (flooding, heat). Climate warming will further stress breeding African Penguins unless alternative suitable nesting habitat can be provided.

Foraging behaviour of rockhopper penguins during different breeding stages at New Island, Falkland Islands

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Changes in numbers of rockhopper penguins (*Eudyptes chrysocome*) are believed to be related to altered environmental conditions and food availability. During the incubation period, birds are known to spend longer periods away from the colony, thus being able to reach more distant and possibly more productive areas at sea. During guard and crèche stages, penguins are limited to foraging areas closer to the colony, having to return more frequently to feed their chicks. We studied the foraging behaviour of rockhopper penguins using GPS data loggers during the entire breeding season 2009-10 at New Island, Falkland Islands. Our aim was to identify differences in foraging behaviour between the breeding stages and relate these to oceanographic and feeding conditions. During incubation, male penguins travelled large distances foraging over the Patagonian shelf. Females during incubation but also during guard and crèche stages presented short foraging trips in close vicinity to the island. The foraging effort was lower during crèche when both partners were involved in chick provisioning. These findings indicate favourable feeding conditions for rockhopper penguins at New Island during this breeding season, compared to other breeding sites in the South Atlantic where birds have been found to stay at sea for longer periods.

The first Namibian Islands' Marine Protected Area: a conservation measure for endangered seabirds in the Benguela Upwelling system

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The northern Benguela Upwelling system supports a range of seabirds, including several globally and locally endangered species. Threats to these species include a lack of food, human disturbance, habitat destruction and severe weather conditions.

Namibia's first Marine Protected Area (MPA) was proclaimed in 2009. It stretches 400 km along the southern Namibian coast and covers almost 10,000 km², including all seabird breeding islands in Namibia. One of the MPA's key objective is to protect the breeding sites as well as foraging areas of three endangered seabirds breeding and feeding along Namibia's coast. Using a zoned approach, the MPA places restrictions on human activities, including fishing, mining, guano harvesting and recreational activities.

We present data on the foraging distribution of endangered African penguins (*Spheniscus demersus*), Cape gannets (*Morus capensis*) and bank cormorants (*Phalacrocorax neglectus*); this information played a crucial role in the design of the MPA. Monitoring programmes to track the species' foraging distributions, diet, breeding success and population trends will be continued to evaluate the MPA's success as a seabird conservation tool. We will give an overview of some of the management measures implemented in the MPA and will highlight some of the potential shortcomings of the MPA.

Status of the CCAMLR database on predator abundance

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The need for region-wide and circum-Antarctic estimates of abundance in predator populations has long been recognized within CCAMLR in order to (1) provide better estimates of the total prey consumption by predators; and (2) provide a baseline position for monitoring the overall status and trends in abundance of key species, together with appropriate confidence intervals on these estimates. As broad-scale surveys are very difficult, a workshop was convened to (1) examine existing data for potential biases and uncertainties, (2) develop, where possible, estimates of abundance and its uncertainty from the existing data, and (3) identify areas where existing data were inadequate or absent. In this poster, we report on the current status of these efforts to catalogue the existing knowledge regarding avian predators in Antarctica and in surrounding sub-Antarctic regions, and to develop methods to standardize census records and account for uncertainties in abundance estimation.

Are fluorescent yellow pigments in penguin feathers effective antiradical (antioxidants) substances? A density functional approximation study of pterins

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Pterins (also known as pteridines) are common animal colorants. Recently, pterins-like pigments have been reported for the first time in yellow feathers of penguins. It was also found that other color structures in penguins (orange beaks) are carotenoid-based. Both, pterins and carotenoids are involved in antiradical activity and as immune enhancers. As not all the antiradical molecules seem to have the same capacity, it is important to compare antiradical ability between pterins and carotenoids in order to understand their functional importance and whether or not the yellow feathers present in penguins can be considered as signals of individual quality. Previous reports suggest different mechanisms that are responsible for scavenging free radicals; these are electron transfer reaction, hydrogen atom transfer (HAT) and radical addition. In this work the capacity to scavenge free radicals (antiradical capacity) of pterins is analyzed, using Density Functional Approximation calculations and considering two possible mechanisms. Results show that the antiradical capacity of those pterins apparently responsible for the production of yellow coloration in penguin feathers is very poor and lower than the antiradical capacity of any carotenoids, vitamins A, C and E, or melatonin, with biapterin and sepiapterin representing the only exceptions.

Seasonal prevalence of viral antibodies in emperor penguins at Auster Colony, Antarctica

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Two previous serological studies showed that many Emperor Penguin chicks in Antarctica have antibodies to infectious bursal disease virus (Garner et al. 1997; Watts et al. 2010), but no adults have been tested before now. Here we present the results of serological testing for antibodies to infectious bursal disease (IBD), avian influenza (AI) and Newcastle's disease (ND) on Emperor Penguins from Auster Colony near Mawson, Station, Antarctica. We sampled 100 adults during courtship/egg laying (May), 200 adults at egg hatching (Aug), 100 young chicks during early crèche (late Sep), and 100 adults and 100 larger chicks in early summer (late Nov) to determine the prevalence of viral antibodies during different times during the breeding cycle. We found no evidence of antibodies to AI or NDV in any of the samples. In contrast, 20% to 25% of the adults were positive for IBDV antibodies up through the hatching period. Once the chicks went to crèche, 54% of younger chicks tested positive. Then 58% of older chicks but only 35% of adults tested positive in late November. These seasonal changes and the presence of antibodies in adults will be discussed in relation to disease issues in general.

The development of prototype magnetic particle technology (MPT) equipment for providing a “quick clean” to oil contaminated wildlife

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and **Rosalind Jessop, Margaret Healy and Peter Dann** [Research Department, Phillip
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For more than a decade, scientists at Victoria University and the Phillip Island Nature Park have been engaged in a collaborative program aimed at advancing the science and technology involved in the rescue and rehabilitation of oiled wildlife, particularly in relation to the Little Penguin (*Eudyptula minor*). A promising development involves the use of oil-sequestering magnetic particles for the removal of contaminants - effectively via a benign dry cleansing process [1, 2]. The application of magnetic particle technology (MPT) to the removal of oil contamination from plumage (“magnetic cleansing”) offers a number of advantages over conventional detergent-based methods. One such advantage is portability - which offers the possibility of providing a “quick clean” to the animal upon first encounter. This could be particularly advantageous when the contaminant is toxic and/or corrosive and where there is a delay in transporting the victim to a treatment centre. The method could also be useful as part of a stabilization protocol when large numbers of affected animals are awaiting treatment. This presentation describes the design, development and testing of prototype technology which would optimize the portability and utility of this method.

What's new in penguin exhibitry? The new Humboldt penguin experience at Woodland Park Zoo in Seattle, Washington USA

Pardo, Celine [Woodland Park Zoo Seattle WA, USA]

On May 1, 2009 a new exhibit housing Humboldt penguins opened at the Woodland Park Zoo in Seattle, Washington. From concept to completion, this state-of-the-art facility combines unique design features promoting sustainability and conservation (both locally and abroad) with an innovative approach to interpretation. The goal of immersing visitors in the environment and story of the plight of the Humboldt penguin is to fulfill the Zoo's mission and further its commitment to the community. The exhibit creates an experience that inspires and encourages visitors to learn, care, and act responsibly toward the conservation of penguins and our shared resources.

As an accredited member of the Association of Zoos and Aquariums, it is also the Zoo's goal for the exhibit to become an established breeding facility in accordance with the Species Survival Plan. With careful attention to detail, the development process included surveying best husbandry practices from other experienced institutions in an effort to address health, safety, and efficiency priorities. This presentation will chronicle the past, present, and future of Humboldt penguin management at the Woodland Park Zoo and detail the highlights and challenges of managing penguins, while creating public awareness, in this one-of-a-kind atmosphere.

Short and long term effect of stomach flushing sampling on breeding and annual return rates of little penguins (*Eudyptula minor*)

Pitt, R [School of Biological Sciences, Monash University, Australia], **A. Chiaradia** [Research Department, Phillip Island Nature Park, Australia], **C. Saraux** [Institut Pluridisciplinaire Hubert Curien, Strasbourg, France], **K.A. Hobson** [Environment Canada, Saskatoon, Saskatchewan, Canada], and **R.D. Reina** [School of Biological Sciences, Monash University, Australia]

The practice of stomach flushing is a technique widely used in many dietary studies. Although perceived as invasive, few studies have investigated short or long term effects of this practice. Here, we examined eight years (2000-07) of stomach flushing data of Little penguins by comparing annual return rates and fledging success between flushed and control (non-flushed) penguins, grouped in three age classes: young (<5y), middle-aged (6-10y) and old (>11y). For penguins sampled at guard and post guard stages, stomach flushing had no effect on breeding success or the annual return rate in the first, second and third years after the sampling date. However, penguins sampled at incubation had 38% lower fledging success and 37% lower return rates than control birds. Between age classes, young flushed birds had a 13% lower return rate than young control birds. Stomach flushed birds that failed to fledge chicks were less likely to return the following year than failed control birds, but there were no differences between successful flushed and control birds. The significant differences detected here indicate that appropriate sampling protocol should minimize short and long term impacts resulting from sampling young penguins and those incubating eggs.

The influence of diet on fatty acids in the yolk of Gentoo penguins, (*Pygoscelis papua*)

Polito, Michael J. and Heather N. Koopman [University of North Carolina Wilmington, Department of Biology and Marine Biology, Wilmington NC, USA]

The use of intrinsic biomarkers, such as fatty acids (FA), to infer the diets of seabirds requires an understanding of how FA signatures are modified from a consumer's diet to its tissues. We examined the influence of diets on the FA signatures in yolk lipids using a captive population of Gentoo penguins (*Pygoscelis papua*). We quantified the FA signatures of both the captive penguins' diets and yolk lipids compared them to the FA signatures of yolk samples collected from a wild population of Gentoo penguins in the Antarctic Peninsula. We found that yolk lipids were composed primarily of three FA (16:0, 18:0, and 18:1n-9) which were found in similar amount in both captive (n=5) and wild (n=20) yolks and provide little or no indication of diet. In contrast, minor FA, such as 20:1n-11 and 20:1n-9, appear to be significantly influenced by diet. The yolks of captive penguins fed herring (high in 20:1n-11 and 20:1n-9) had significantly higher levels of these two FA relative to wild penguins which consume krill that is low in both of these FA. This result suggests that FA analysis of yolk lipids can be used to help quantify the diets of seabirds prior to breeding.

An active community providing education, interpretation and protection at an urban penguin colony

Preston, Tiana J., Kim Cowie and Zoe Hogg [Earthcare St Kilda Inc, PO Box 287, Elwood, VIC, Australia]

Located in a highly urbanised area of Melbourne, Australia, the St Kilda Little penguin colony has grown from a few breeding pairs to approximately 1000 individuals since 1974. Community knowledge of this penguin colony has also grown over this period, with the number of visitors to see the penguins often exceeding 200 people a night. Most of the penguin colony is protected by a fence, but people can still freely walk through 150m of the breakwater, which is home to ~100 penguins. Access to this area is not actively monitored by authorities, and in the past there had been several incidents involving harm to the penguins by people and dogs.

In 2008 the community group Earthcare started a Penguin Guide program that trained volunteers to provide an information and supervision service for visitors to the penguin colony. Volunteers manned the breakwater every evening over summer, answering questions about the penguins, as well as ensuring that disturbance to the penguins was kept to a minimum by removing dogs, instructing people to turn their camera flash off and making sure that people did not approach or touch the penguins. The program was warmly received by visitors and is now run each summer.

Optimal location acquisition rate for tracking penguins over small foraging areas

Preston, Tiana J. [School of Biological Sciences, Monash University, Clayton, Victoria 3800, Australia], **André Chiaradia** [School of Biological Sciences, Monash University, Clayton, Victoria 3800, Australia; Research Department, Phillip Island Nature Parks, P.O. Box 97, Cowes, Victoria 3922, Australia], and **Sherrie Caarels** and **Richard D. Reina** [School of Biological Sciences, Monash University, Clayton, Victoria 3800, Australia]

Remote tracking of penguins has allowed researchers to follow the movements of several penguin species across hundreds of kilometers for the last 20 years. Advances in technology mean that we can now also track species that travel over comparatively small foraging areas at high resolution, such as Little and Galapagos penguins.

We used two biologgging techniques, satellite transmitters and GPS loggers combined with depth recorders, to study the foraging behavior of Little penguins (*Eudyptula minor*). We compared these two techniques by describing foraging parameters of this penguin population operating within approximately 15 km of the colony.

Greater accuracy of GPS locations provided improved confidence in describing penguin location, particularly when interpreting diving behaviour. Many times more locations per day were received by GPS than satellite transmitters (>11,000 compared with ~8), which influenced the calculation of parameters used to describing foraging behaviour. Data from GPS were filtered at several time intervals and the estimates of foraging area size were significantly greater than that calculated by satellite transmitters in all cases. However, there were differences between the GPS results in the calculation of foraging area and distance travelled that may influence the rate of location acquisition in future studies at this scale.

New: miniaturised, solar-powered GPS-Logger

Pütz, Klemens [Antarctic Research Trust, Am Oste-Hamme-Kanal 10, 27432 Bremervörde, Germany] and **Peter Kühne** [Ecklingeröder Straße 21, 37115 Duderstadt, Germany]

Thanks to miniaturisation and technological innovation, biologging could be applied to increasingly smaller animals over the past decades. This has led to substantial growth in our knowledge of animal behaviour and physiological constraints in remote environments. Here, we present a newly developed, solar-powered GPS-datalogger for applications in medium-sized flying and diving animals.

The role of shell grit ingestion in the reproductive biology of little penguins (*Eudyptula minor*)

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Some seabirds eat seashell grit before laying eggs, but it is unclear whether this is related to egg formation or to replace calcium in the body reserves. We investigated whether little penguins, *Eudyptula minor*, eat seashell grit and whether the extra calcium ingested resulted in an increase in eggshell thickness and/or calcium concentration in the eggshells. We examined the consumption of grit by adult birds by direct observation in 2007 and stomach contents from long term data (1986-1987 & 2001-2005). In addition, we analysed attendance data recorded over three seasons (2005 to 2008) on the frequency of multiple colony-shore-colony trips at each night. Overall, females comprised of 84% (n=101) of the birds making colony-shore-colony trips. Most multiple trips were inside the pre-laying period, with the frequency of trips peaking two to three days prior to laying. There was no difference in eggshell thickness or calcium concentration between eggshells from hatched and abandoned eggs; suggesting that embryos may not rely on their eggshell as a source of calcium. Further, grit ingestion was not directly related to egg formation, suggesting that seashell grit may be ingested by females at a crucial time of high calcium demand to replace the reserves in the body.

Bumblefoot treatment alternatives used for Magellanic penguins (*Spheniscus magellanicus*) at the Aquário de São Paulo, São Paulo, Brazil

Reisfeld, Laura [Aquário de São Paulo, São Paulo, Brazil]; **Valeria Ruoppolo** [International Fund for Animal Welfare], **Mayla Barbirato**, **Camila Dutra**, and **Laura Ippolito** [Aquário de São Paulo, São Paulo, Brazil], and **Manuela Gonçalves Fraga Geronymo Sgai** and **Cristiane Schilbach Pizzutto** [Departamento de Reprodução Animal – Faculdade de Medicina Veterinária e Zootecnia – Universidade de São Paulo, Brazil]

Captive penguins are prone to bumblefoot due to changes in their normal activity patterns, prolonged periods of time standing on hard, abrasive surfaces, and decreased time spent swimming. Since July 2008, five Magellanic penguins have been on display at Aquário de São Paulo. Since their arrival, all animals presented some degree of pododermatitis. Changes in the cleaning schedule and substrate were made along with the lesions' treatment, and environmental enrichment items were introduced daily into the pool, decreasing the time the animals spent standing. Detailing the protocol used daily: 1. lesions were cleaned with chlorhexidine solution; 2. the birds were placed in warm and cold chamomile tea footbaths; 3. removed after 15 minutes, the animals received foot massage with DM-GEL® (Vetnil); 4. topical use of banana skin tannin gel on the ulcers. Finally, "boots" using gauze and Vetrap® (3M) were applied to the animals' feet. During treatment, the animals had their lesions photographed and measured three times a week. Measurements taken included: foot diameter, lesions' width and length. After two months, significant improvement was observed in all animals treated. It was noted that a single treatment technique can have less significant results or even be inefficient. However, utilizing a combination of all the above-mentioned treatment along with supportive care and preventive measures, positive results were observed rapidly.

A synthesis of clinical cases observed in Magellanic penguins (*Spheniscus magellanicus*) at the Aquário de São Paulo, São Paulo, Brazil from July 2008 to February 2010

Reisfeld, Laura [Aquário de São Paulo, São Paulo, São Paulo, Brazil], **Valeria Ruoppolo** [International Fund for Animal Welfare], and **Laura Ippolito, Mayla Barbirato, and Camila Dutra** [Aquário de São Paulo, São Paulo, São Paulo, Brazil]

In July 2008, eight wild rehabilitated Magellanic penguins were admitted for public display at the Aquário de São Paulo. The clinical cases observed between July 2008 - February 2010 consisted of infectious and non-infectious diseases. Parasitic infections were observed in all individuals, comprising *Contracaecum pellagicum*, *Strongyloides* sp. and Coccidia. Fungal cultures of tracheal swabs revealed *Candida albicans* and *Trichosporum* sp., for which itraconazol was applied. Bacterial cultures of tracheal swabs revealed *Proteus vulgaris*, *Klebsiella pneumoniae* and *Aeromonas* sp.; *E. coli* and *Staphylococcus* sp. For all bacterial infections, lethargy, dyspnea and anorexia were observed. Antibiotic treatment was selected after proper sensitivity tests and included amoxiciline associated with clavulanic acid and enrofloxacin. Thiamin (vitamin B1) deficiency was observed, even with daily supplementation of 30 mg/bird an hour before feeding. Penguins presented neurological signs, loss of balance, shivering, mydriasis, aggressive behavior, vocalizations and weakness followed by prolonged decubitus. Within the study period, all infectious diseases manifested during the first six months in house, showing that the stress was due to adaptation to the aquarium, and the stress impaired the immunological responses of the penguins.

Conservation of the mixed-species colony of Humboldt and Magellanic penguins at Puñihuil Islands, Southern Chile.

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The relevance of mixed-species colonies of penguins is recognized on the basis of their potential for hybridization, resource partitioning, behavioral interactions and more recently as touristic attractions. The mixed-species colony of Magellanic and Humboldt penguins at Puñihuil Islands (42°S), southern Chile, was assessed to compare their conservation status before and after their formal protection when declared a natural reserve in 1999. We counted nests and breeding pairs in 1997, 2004 and 2008. In 1997, up to 28% of penguin burrows were collapsed due to tourist and goat trampling; after tourist ban and goat removal, collapsed burrows dropped to 3-4%. In 2004, 1207 breeding pairs were counted; in 2008 these figures increased to 1327 nests. We attribute these changes to habitat improvement and conservation due to tourist exclusion of goat removal.

Long-term, at-sea monitoring of little penguins foraging: what does it tell us about environmental change?

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Seabirds use two different ecosystems: they breed on land but rely totally on the ocean for their food supply. However, there is disproportionately less information available on their marine life cycles. Only quite recently, thanks to new techniques, the marine life of seabirds has been revealed. Seabirds, penguins in particular, can be good indicators of the health of marine systems, so the need for long-term datasets on their foraging behaviour is growing, in particular to monitor or predict the impact of climatic changes in the oceans. Most studies on their foraging strategy are biased towards offshore seabirds with relatively less information on inshore species. Strategies used by offshore seabirds may not be the same than that of inshore species, which spend their lives in a much smaller area, may not migrate and may be more sensitive to changes at local rather than large scales. Here, I will summarise the results of a long-term collaborative study between Japan, France and Australia, of the foraging ecology of the smallest penguin *Eudyptula minor* through a bio-logging approach. One of the key points we've identified is that foraging success of birds decreases when thermoclines are absent in the foraging zone of the birds; an event that could become more frequent due to climate change.

Radiation treatment in a chinstrap penguin (*Pygoscelis antarctica*) with squamous cell carcinoma

Round, Debra [Newport Aquarium Newport, KY USA]

In April of 2009 one of our Chinstrap penguins (*Pygoscelis antarctica*) developed an abscess due to an impacted preen gland. The determination was made to remove the preen gland and surrounding skin. The area was left to granulate to allow surgical closure later. After two unsuccessful attempts to close the wound due to non-resolving dermatitis we called Central Park Zoo which had lost two Chinstrap penguins and one Gentoo penguin from squamous cell carcinoma, which had presented in the same way. A biopsy of our penguin confirmed squamous cell carcinoma. Radiation therapy presented itself as an option due to a partnership with a local emergency veterinary treatment center. Seventeen radiation treatments were performed. Radiation sessions lasted about 45 minutes and the bird was anesthetized for each. The wound appeared to be healing. Two weeks after the final treatment, balance issues were observed. A CAT scan revealed a spinal column lesion damaging the vertebrae. The bird was euthanized February 2010 and we are awaiting the full necropsy results.

Factors affecting post-fledging return rate and timing in the king penguin (*Aptenodytes patagonicus*)

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Recently, the use of marine top-predators as sensitive indicators of environmental stress has become of strong interest for studies attempting to clarify the impacts of climate change on population dynamics. Recruitment into the breeding class is a crucial point in population dynamics and is critical for population turn-over and renewal. However, few studies have yet considered life-history traits relating to early life stages. Here, we present the first study of juvenile king penguin dynamics based on a 10-year automatic monitoring of undisturbed birds. We investigated the impact of different factors related either to environmental conditions or individual quality on post-fledging returns. Juvenile return rate (range 68-87%) was much higher than previously assumed for this species, and increased during warm years and with higher body condition at departure. Post-fledging returns exclusively occurred during one of the three summers following their departure. The longer the fledging trip, the earlier the return during summer time and the longer birds visited the colony afterwards. Although attendance in the colony was more than twice the time required for moulting purposes, no juvenile attempted breeding. Nonetheless, their presence in the colony could be an important part in the learning process of mating behavior and could have strong implications on other life-history traits such as recruitment age.

A collective effort to save the African penguin: the role of maintaining an accurate regional studbook

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The African penguin *Spheniscus demersus*, one of Southern Africa's flagship endemic species, is currently undergoing an alarmingly rapid population decline and has recently been uplisted to the 'Endangered' category in the 2010 IUCN Red List. This charismatic species is being harshly affected by commercial fisheries and shifts in prey populations. There is no sign of this declining trend reversing, and unless immediate conservation action is taken, the African penguin could face an uncertain future. The National Zoological Gardens of South Africa is currently responsible for maintaining the regional African penguin studbook. Studbooks have been recognized as essential tools in the coordinated and scientific management of endangered species. If we are able to formulate an effective captive breeding program, this will be an important contribution, on the behalf of captive holding institutions, to the conservation of the African penguin. Preliminary analysis of the current studbook data received, from 1980 to date, revealed that there are currently nine institutions in South Africa holding African penguins, with the total captive population amounting to 169 birds, 56 of which are considered as potential founders. Given the parameters established through the studbook, in order to be able to maintain a genetically stable population, a minimum population size of approximately 150 animals needs to be maintained. This is well within the current carrying capacity of the South African captive population. In order for our captive management program to be successful, we however need more complete studbook information from each of the holding institutions. In order to effectively manage this small population, captive institutions will have to permanently mark their birds; determine sex; note exact hatch, acquisition, transfer and death dates; and keep accurate parentage records.

Computer vision monitoring of African penguins (*Spheniscus demersus*): new data on the field capacity from Robben Island

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In light of the uncertainty surrounding flipper banding in some species, there is growing interest in alternative penguin identification methods that minimise disturbance but still allow for robust population monitoring. We have previously reported on the development of a prototype computer vision system that automatically identifies individual African penguins *Spheniscus demersus* using natural markings. Here we demonstrate the potential for fully-automated, non-invasive, monitoring in the field at Robben Island, South Africa.

False individual identifications of detected penguins occurred in less than 0.01% of comparisons ($n = 73,600$) to known individuals. The monitoring capacity in the field was estimated to be above 13% of the birds that passed the camera ($n = 1453$), with a significant increase under favourable conditions. Theoretical and empirical development of this capacity suggests high levels of enrolment and recapture over time frames of a few months. Finally, we present results from captive birds that confirm the long-term stability of the adult plumage pattern.

In conclusion, the demonstrated sensitivity is comparable to computer-aided animal biometric monitoring systems in the literature, while a full deployment of the system would identify more penguins than is possible with complete exploitation of the current levels of flipper banding at Robben Island.

Predatory impact of feral cats (*Felis catus*) on the Galápagos penguin (*Spheniscus mendiculus*) at its main breeding site, Caleta Iguana, Isabela Island, Galápagos

Steinfurth Antje [Animal Demography Unit, Department of Zoology, University of Cape Town, Rondebosch, Cape Town, South Africa; Charles Darwin Foundation, Isla Santa Cruz, Galápagos, Ecuador], **Dan Forman** [Department of Pure and Applied Ecology, Institute of Environmental Sustainability, Swansea University, Singleton Park, Swansea, UK], **Victor Carrion** [Galápagos National Park/Parque Nacional Galápagos, Isla Santa Cruz, Galápagos, Ecuador], and **Felix Hernán Vargas** [Charles Darwin Foundation, Isla Santa Cruz, Galápagos, Ecuador; The Peregrine Fund, 5668 W. Flying Hawk Lane, Boise ID, USA]

Insular breeding seabirds are extremely vulnerable to introduced mammalian predators as they have not evolved behavioural, morphological or life-history responses against them. We undertook the first study on *in situ* predation of Galápagos penguins (*Spheniscus mendiculus*) by feral cats (*Felis catus*) at the penguin's main breeding site to investigate whether cats pose a threat to this species. We examined five cat digestive tracts and eight scats and identified the occurrence of prey remains. Feathers and the tarsal bones of adult Galápagos penguins were identified in a total of two digestive tracts and four scat samples. Additionally, seven adult penguin carcasses were recovered within one month, six of which showed distinctive signs of predation by cats. One observation of a feral cat feeding on a penguin carcass was also recorded. These data importantly demonstrate that Galápagos penguins are actively preyed by feral cats.

Prior Population Viability Analysis showed that high survivorship of adult birds is essential for the long-term persistence of the Galapagos penguin. After our study, the Galapagos National Park initiated a campaign aimed at controlling cat populations at Caleta Iguana and other important nesting sites on Isabela Island. Further work however is urgently needed to assess the wider impact of feral cat predation on Galápagos penguin populations.

How *ex-situ* and *in-situ* organizations can work together to raise the profile of African penguins

Strauss, Venessa, Margaret Roestorf [SANCCOB (Southern African Foundation for the Conservation of Coastal Birds)], and **Tom Leiden** [Leiden Conservation Foundation]

SANCCOB is an *in-situ* organization which works closely with the Association of Zoo and Aquarium's African penguin Species Survival Plan (SSP) and a host of *ex-situ* international organizations. SANCCOB's goal is to raise the profile of African penguins and to keep the US organizations informed about the many challenges this species faces in the wild.

US Zoological Institutions have access to millions of visitors annually and are a vital link in the dissemination of information about wild penguins. It's important that they are continually updated with fresh, relevant information and research about wild African penguins so that their visitors may feel a connection to a species that lives on a distant continent and one they may never see *in-situ*.

In the spirit of WAZA's conservation strategy, this poster session will showcase successes and suggest practical ways of working together.

Population dynamics of little penguins over 25 years

Sutherland, Duncan R. and **Peter Dann** [Phillip Island Nature Parks, PO Box 97, Cowes, Victoria, Australia]

Estimates of population size and changes through time are critical for setting conservation priorities. The distribution of little penguins *Eudyptula minor* on Phillip Island has contracted substantially over the last century and is now restricted almost entirely to the Summerland Peninsula. Trends in penguin numbers on the Peninsula have been assessed near the periphery of the colony and suggest two-fold fluctuations since 1977. Here we present data on population dynamics of little penguins from 1984 to 2009 from systematic burrow surveys conducted across the entire colony. We have developed a new and robust technique to model true breeding population size from burrow counts by applying a correction for burrow occupancy rates and population abundances estimated simultaneously at eight monitoring sites where marked penguins were checked at fortnightly intervals. Using 148 quadrants across the Peninsula counted twice during the breeding season we estimate that the number of breeding penguins on Phillip Island is currently about 28,700 (26,382 – 31,018). We explore the likely drivers of observed population changes by modelling population dynamics as a function of extrinsic factors and intrinsic demographic variables.

Phylogenetic analysis of penguin species based on sequence variation in the MHC genes.

Tsuda, Tomi T. [Penguin Fund Tokai Univ. Sch. Med], **Eri F. Kikkawa** and **Hidetoshi Inoko Tokai** [Univ. Sch. Med.]

We are interested in identification of genetic variations and investigation of evolutionary relationship among all the species of penguins. The MHC (major histocompatibility complex) region of vertebrates is a highly polymorphic genomic area with an important role in the regulation of the immune system and in the recognition of nonself from self. We determined nucleotide sequence compassing exon 2, intron 2, and exon 3 of the Mhc class II DRB-like gene in penguins, and constructed a phylogenetic tree using these sequences. In this paper we will present the benefit of the Mhc genes, which provide excellent markers for studies on ecology and evolution because of their extensive polymorphism.

Gender determination of Magellanic penguins (*Spheniscus magellanicus*) from morphometrics: a brief review

Vanstreels, Ralph Eric Thijl [Laboratório de Patologia Comparada de Animais Selvagens, Departamento de Patologia, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Brazil] **Andrea Corrado Adornes** and **Paula Lima Canabarro** [Centro de Recuperação de Animais Marinhos (CRAM), Museu Oceanográfico, Universidade Federal do Rio Grande], **Valeria Ruoppolo** [Emergency Relief Team, International Fund for Animal Welfare], **Rodolfo Pinho da Silva Filho** [Centro de Recuperação de Animais Marinhos (CRAM), Museu Oceanográfico, Universidade Federal do Rio Grande; Emergency Relief Team, International Fund for Animal Welfare], and **José Luiz Catão-Dias** [Laboratório de Patologia Comparada de Animais Selvagens, Departamento de Patologia, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Brazil]

Magellanic penguins (*Spheniscus magellanicus*) exhibit temporal sexual dimorphism related to the breeding season, however during winter the difference is not always sufficiently evident. A few studies using discriminant function analyses have been published to determine the gender of an individual based on its morphology, according to their age groups: fledglings and juveniles (Scolaro 1987, Colonial Waterbirds 10:50-54), juveniles and adults (Bertellotti et al 2002, Waterbirds 25:479-484), adults (Scolaro et al 1983; The Auk 100:221-224). The body measurements used for this purpose varied among methods and included: Bill Depth (BD), Bill Length (BL), Total Flipper Length (TFL), Elbow-to-tip Flipper Length (EFL), Tibio-tarsus Length (TL) and Middle Toe Length (MTL). These methods were developed with wild specimens, and care should be taken when evaluating captive specimens as their bills tend to wear less than in the wild, biasing the results. Gender determination is generally less accurate in juveniles (accuracy 78-96% depending on discriminant function used) than in fledglings (93%) or adults (93-97%), but may still be acceptable depending on the research goals. While other methods may be more accurate, gender determination from morphometric data still offers reasonably reliable results and is generally an accessible, inexpensive and non-invasive method for determining the gender of Magellanic penguins.

Female-biased sex ratio of Magellanic penguins (*Spheniscus magellanicus*) stranded along the southern Brazilian coast

Vanstreels, Ralph Eric Thijl [Laboratório de Patologia Comparada de Animais Selvagens, Departamento de Patologia, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Brazil] **Andrea Corrado Adornes** and **Paula Lima Canabarro** [Centro de Recuperação de Animais Marinhos (CRAM), Museu Oceanográfico, Universidade Federal do Rio Grande], **Valeria Ruoppolo** [Emergency Relief Team, International Fund for Animal Welfare], **Rodolfo Pinho da Silva Filho** [Centro de Recuperação de Animais Marinhos (CRAM), Museu Oceanográfico, Universidade Federal do Rio Grande; Emergency Relief Team, International Fund for Animal Welfare], and **José Luiz Catão-Dias** [Laboratório de Patologia Comparada de Animais Selvagens, Departamento de Patologia, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Brazil]

Magellanic penguins (*Spheniscus magellanicus*) breed in Argentina, Chile and the Falkland Islands and seasonally migrate northwards in winter, when some animals become stranded along Brazilian beaches. Data was obtained from 408 penguins (375 juveniles, 33 adults) found stranded dead or alive along the Southern coast of Rio Grande do Sul State, Brazil, and admitted at the Centro de Recuperação de Animais Marinhos (32°S 52°W) from 2002 to 2009. Gender was determined at necropsy (n=382) or by PCR for the Chromo-helicase-DNA-binding gene (n=26). Overall sex ratio was uneven (36% male: 64% female), a pattern observed in both juveniles (35% male: 65% female) and adults (42% male: 58% female). The bias towards females was present at least to some extent in all studied years. The reasons for this female-biased sex ratio are unclear, but may be associated to differences in diving or migratory behavior, or gender-biased tendency to suffer from excessive parasitism, injuries from fishing nets, to have poorer feeding success, or other factors involved in stranding. Further research is recommended to confirm if sex ratio bias is also found in Magellanic penguins stranded in other regions; research on the migration and diving behavior of this species should attempt to compare gender differences that could identify biological reasons to explain such pattern.

Gender determination of Magellanic penguins (*Spheniscus magellanicus*) from morphometrics: accuracy of published discriminant functions for stranded animals in southern Brazil

Vanstreels, Ralph Eric Thijl [Laboratório de Patologia Comparada de Animais Selvagens, Departamento de Patologia, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Brazil] **Andrea Corrado Adornes** and **Paula Lima Canabarro** [Centro de Recuperação de Animais Marinhos (CRAM), Museu Oceanográfico, Universidade Federal do Rio Grande], **Valeria Ruoppolo** [Emergency Relief Team, International Fund for Animal Welfare], **Rodolfo Pinho da Silva Filho** [Centro de Recuperação de Animais Marinhos (CRAM), Museu Oceanográfico, Universidade Federal do Rio Grande; Emergency Relief Team, International Fund for Animal Welfare], and **José Luiz Catão-Dias** [Laboratório de Patologia Comparada de Animais Selvagens, Departamento de Patologia, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Brazil]

To evaluate the accuracy of published discriminant functions for morphometric gender determination in Magellanic penguins (*Spheniscus magellanicus*), we used data from 408 penguins found dead on the beach or undergoing rehabilitation at Centro de Recuperação de Animais Marinhos (32°S 52°W, Rio Grande - RS, Brazil) from 2002 to 2009, whose gender had been determined (147 males, 261 females) either at necropsy (n=382) or by PCR for the Chromo-helicase-DNA-binding gene (n=26). For juveniles (n=375), Sclaro 1987 (Colonial Waterbirds 10:50-54) accurately determined the gender of 77% of the animals (males=38%, females =97%), and Bertellotti et al 2002 (Waterbirds, 25:479-484) achieved an accuracy of 81% (males=59%, females=93%). For adults (n=33), Sclaro et al 1983 (The Auk 100:221-224) accurately determined the gender of 79% of the animals (males=50%, females=100%), and Bertellotti et al 2002 achieved an accuracy of 82% (males=57%, females=100%). The discriminant functions performed poorly in identifying males, with at least 41-43% of the males being mistakenly classified as females. Gender determination with 81-82% accuracy may be useful for husbandry or veterinary purposes, considering these methods offer immediate results and are relatively non-invasive, with low costs and equipment requirements. However, the accuracy may be insufficient for more rigorous applications and research purposes, in which other methods for gender determination are advised.

Holding the fast: energetic and behavioral adjustments in courting and incubating male king penguins

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Breeding parents must balance their own energy requirements with those of their offspring. Trading-off becomes challenging when resource availability is absent (i.e. prolonged fasting), as observed in seabirds that forage at sea but breed on land. Successful reproduction then depends on the efficient management of energy stores ashore. In king penguins, males undergo fasting periods of up to one month while courting and incubating. Metabolic adaptation of this bird to prolonged fasting has been well studied under captive and non-breeding conditions. However, nothing is known on how birds freely breeding in a social context actually adjust energy expenditure. We monitored heart rate (HR), a proxy to energy expenditure, body temperature, and physical activity (actimeter) throughout courtship and first incubation shift in male king penguins breeding on Possession Island (Crozet Archipelago). We determined that HR decreases constantly throughout courtship but increases again upon egg-laying. Changes in HR were paralleled by a constant decrease in activity, whereas body temperature remained unchanged. We suggest that decreased physical activity but no significant hypothermia may be used to sustain the long courtship-incubation fast. An increase in HR upon laying may relate to increased social stress or “emotional” investment paralleling increased reproductive value of the egg.

An investigation into the potential effects of Sulfadiazine + Pyrimethamine on the reproduction of African (*Spheniscus demersus*) and Humboldt penguins (*Spheniscus humboldti*)

Garrett, Travis, Stephanie Hinkle, Felicia Knightly, Kristin Mobley, and Willis, Mary Jo [Denver Zoo 2300 Steele St., Denver CO, USA]

Avian malaria (*Plasmodium* sp.), transmitted by mosquitoes and biting insects, is a significant concern for captive managed penguins. A compounded form of Sulfadiazine + Pyrimethamine (SP) is a critical component of some zoos' preventative protocol against malaria in various penguin species. The Denver Zoo began utilizing a regimen of SP in 2001 for this purpose. During the 2004 mosquito season blood samples were routinely obtained from two penguin flocks being treated with SP. Birds included in the study were 6 male (one under six months of age) and 3 female African penguins (*Spheniscus demersus*) and 3 male and 6 female Humboldt penguins (*Spheniscus humboldti*). Blood samples were drawn prior to starting the birds on SP for the 2004 season, at a 3-4 month interval during administration, and post treatment.

Evaluations of complete blood counts and serum chemistries were performed in an attempt to identify any adverse effects on the birds. As pyrimethamine is known to inhibit folic acid absorption in mammals, its effect on reproduction in penguins warrants investigation. 98 serum samples were analyzed by Texas A&M University, Department of Small Animal Clinical Sciences to evaluate folate levels.

The investigation is not complete as folate test results are in the process of being matched with the penguins' behaviors at the time blood samples were taken. This is in an effort to take into account whether the birds were exhibiting any breeding behaviors at the time of sampling. An opportunity to obtain blood samples from wild Humboldt penguins arose in 2008. 47 blood samples were obtained for testing from Humboldt penguins in Punta San Juan, Peru as a part of a comprehensive health study performed by the St. Louis Zoo. These samples will serve as a comparison to birds that have not been previously treated with the drug. Testing of these samples was recently completed by Texas A&M University, and data is currently being analyzed. We hope to conclude that there are no negative effects of SP on the folate levels of either species.

Not young but forever middle-age: there is a better age to forage in little penguins (*Eudyptula minor*)

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Age-related changes in breeding performance are likely to be mediated through changes in parental foraging performance. We investigated the relation between foraging performance and age in female little penguins at Phillip Island, Australia, during the guard phase of the breeding season in 2005. Foraging parameters were recorded with accelerometers for birds grouped into three age-classes: young (<5y), middle-age (5y ≥ age <11y) and old birds (≥11y). Age-related differences in diving performance suggested that middle age penguins were in better physical condition. Further, middle age and old birds showed a similar hunting strategy by pursuing prey upwards after reaching the maximum depth of the dive, probably taking advantage of higher upthrust, indicating higher foraging experience compared to young birds. We suggest middle age penguins forage better than young or old ones when optimal physical condition and foraging experience act simultaneously. Behaviour of a population is usually assumed to be the sum of individual behaviour regardless of age classes. The age composition in a population would probably influence population response to environmental changes, especially relevant in years of low resource availability. This is an important factor to be considered in population conservation and management by focusing on middle age individuals.

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