



8th International Penguin Conference

Bristol, UK
2nd – 6th September 2013



Bristol Conservation
& Science Foundation



University of
BRISTOL



8th International Penguin Conference

2–6 September 2013, Bristol, UK

Welcome and Introduction

I am very pleased to welcome you to the 8th International Penguin Conference in my home town of Bristol; this is the first time that the penguin conference has been held in Europe and only the second time in the Northern hemisphere.

The International Penguin Conferences are going from strength to strength; this, the eighth meeting will see delegates from around 30 countries and who between them have worked on all seven continents coming together.

We have a very full and lively programme including more than 60 oral presentations and over 100 posters as well as specialist workshops and a programme of public and social events.

I would like to say a very big thank you to all our sponsors whose generous support has helped to provide 20 travel bursaries as well as supporting the public and social events.

I extend a warm welcome to all, in particular to those who are visiting the UK, or Bristol for the first time. I trust that you will find the time to explore the city of Bristol as well as some of the surrounding parts of the UK and that you enjoy both the social and scientific aspect of the meeting.

Peter Barham
Organising Committee Chair

International Organising Committee

Peter Barham (Chair, University of Bristol, UK)
Jonathan Banks (University of Waikato, NZ)
Dee Boersma (University of Washington, USA)
Popi Garcia-Borboroglu (Global Penguin Society)
Phil Trathan (British Antarctic Survey, UK)
Heather Urquhart (New England Aquarium, USA)
Lauren Waller (Cape Nature, South Africa)
Eric Woehler (University of Tasmania, Australia)

Local Organisers

Peter Barham (University of Bristol, Chair)
Barbara Barham (Secretary)
Tilo Burghardt (University of Bristol)
Martin Chávez-Hoffmeister (University of Bristol)
Christoph Schwitzer (Bristol Zoo Gardens)
Nigel Simpson (Bristol Zoo Gardens)



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Safety Matters

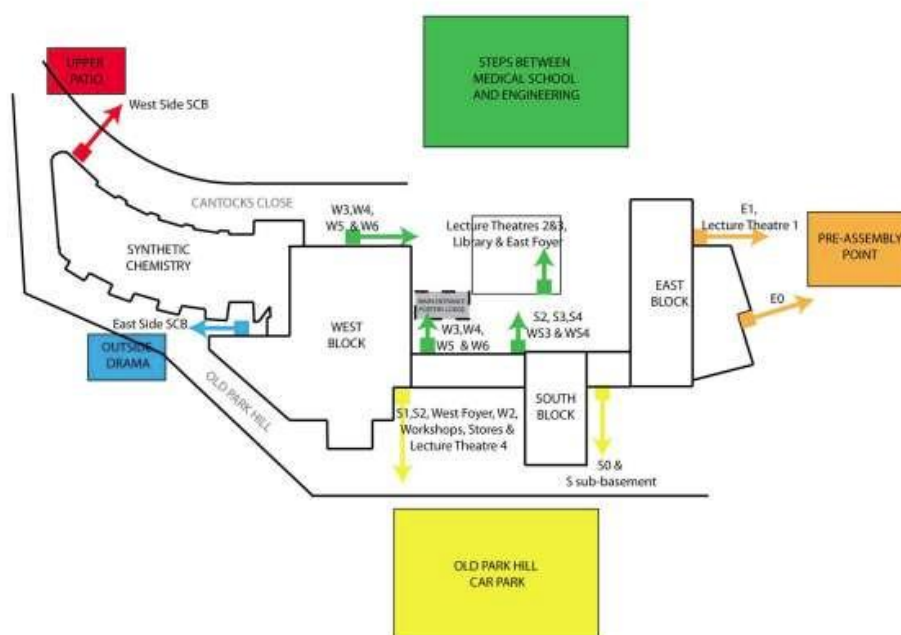
We want you to enjoy the conference in a safe and well managed environment. So please take a few minutes to read the safety notes below.

Building Evacuation

The main conference venue is the School of Chemistry; as you can imagine in the unlikely event of a accident occurring in the laboratories we will have to evacuate the building promptly. If the alarm sounds please follow the directions of the fire marshals and move quickly to the Assembly points which are safe distance from the building.

From the main foyer (where the posters are located) you should exit on to the Patio and thence to the Upper Patio and University Walk.

From the Lecture theatre the exit is via the front of the theatre i.e. the Lecturer's end, and out via the X-Ray Suite to the East side pre-Assembly point. You will be directed by a fire marshal from eh pre-Assembly point either to re-enter the building if it safe to do so, or to the main assembly point on the Upper Patio and University Walk.



Please note that on Tuesday morning at about 08:30 the fire alarms will be tested – please do not evacuate at that time unless the alarm sounds for longer than 30 seconds.

Other Safety Notes

Please do not enter any non-public areas of the Chemistry building – you should only use the lecture theatres and the two foyer areas and not enter any other parts of the building.

To avoid any trips or falls, please try to avoid spillages of food or drink in the building. Should any spills occur please report them immediately either to the Conference Desk or to the Porters so they can be cleaned up quickly.

Thank you for your cooperation.



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Monday, 2nd September

Lecture Theatre 1 School of Chemistry, University of Bristol

- 9:15 – 9:45 Registration
- 9:45 – 10:15 Coffee
- 10:15 – 10:30 Opening remarks (Archbishop Desmond Tutu and Bernard Stonehouse)
- 10:30 – 11:00 Thiebot, How to achieve hyperphagia before moult with millions of conspecifics? A case-study in a key marine predator, the macaroni penguin
- 11:00 – 11:20 Poisbleau et al., Do temperatures influence egg masses in rockhopper penguins?
- 11:20 – 11:40 Cerchiara and Boersma, Telomere Maintenance and Reproductive Attempts in Magellanic Penguins (*Spheniscus magellanicus*)
- 11:40 – 12:00 Koehn, The Importance of Morphological Traits and Heritability in Male Magellanic Penguins (*Spheniscus magellanicus*)
- 12:00 – 12:20 McInnes et al., The Power of Poo – Diet analysis of Adelie Penguins from faecal samples
- 12:20 – 14:00 Lunch**
- 14:00 – 14:20 Polito et al., Sympatrically breeding *Pygoscelis* penguins balance niche plasticity and segregation under variable prey conditions
- 14:20 – 14:40 Fretwell et al., A unique spectral signature for Guano
- 14:40 – 15:00 Catharine Horswill, The survival of macaroni penguins revealed using an automated gateway system
- 15:00 – 15:20 Emerson and Southwell, Ecological insights from long-term Adélie penguin monitoring at Mawson, eastern Antarctica: the interaction between penguins and their environment
- 15:20 – 15:40 Southwell and Emerson, Metapopulation-scale studies of Adélie penguins in east Antarctica: using spatial variation in the environment to understand the ecological relationships between penguins and their environment
- 15:40 – 16:20 Tea break**
- 16:20 – 16:40 Crawford et al., Winners and losers in South Africa's seabird assemblage – where was the African Penguin?
- 16:40 – 17:00 Kemper et al., What are the best indices to monitor trends in an aseasonally breeding, declining penguin population? The case of the African Penguin in Namibia
- 17:00 – 17:20 McGill et al., 15 Years and Counting: The Status of Humboldt Penguins in Peru based on Annual Censuses.
- 17:20 – 17:40 Ellenberg et al., Searching Fiordland crested penguins – how to minimise disturbance effects while maximising nest count reliability
- 17:40 – 18:00 Clucas et al., Population structure and demographic history of the *Pygoscelis* penguins on the Scotia Arc and Antarctic Peninsula
- 18:00 – 19:30 Wine reception – East Foyer School of Chemistry**



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Tuesday, 3rd September

Lecture Theatre 1 School of Chemistry, University of Bristol

09:00 – 09:30 Mattern et al., The Pros and Cons of being a benthic forager: how anthropogenic alterations of the seafloor affect Yellow-eyed penguins

09:30 – 09:50 Pelletier et al., Foraging strategies and oxidative stress – Consequences of growing chick on foraging effort of the Little penguin (*Eudyptula minor*)

09:50 – 10:10 Manco and Trathan, Contrast between incubation and brood in Chinstrap penguin (*Pygoscelis antarcticus*) foraging trips in the South Orkney Islands.

10:10 – 10:30 Ratcliffe et al., Segregation and association among three populations of Eudyptes penguins wintering in the SW Atlantic

10:30 – 11:20 Coffee

11:20 – 11:40 Raya Rey et al., New insights into the foraging behaviour and habitat of Rockhopper penguins breeding at Staten Island

11:40 – 12:00 Rosciano et al., Getting to know Magellanic penguins breeding in Staten Island: foraging behaviour and areas during chick rearing period

12:00 – 12:20 Geldenhuys et al., Foraging and breeding parameters at the only consistently increasing South African colony of African penguins

12:20 – 12:40 Robinson et al., Foraging behaviour of Endangered African penguins breeding at Robben Island and the influence of local prey availability

12:40 – 14:00 Lunch

14:00 – 14:20 Pichegru et al., Experimental fishing exclusions for penguins in South Africa – coasts of contrasts

14:20 – 14:40 Waluda et al., Long-term variability in Macaroni *Eudyptes chrysolophus* and Gentoo *Pygoscelis papua* penguin diets at Bird Island, South Georgia

14:40 – 15:00 Boersma, Increasing the Population of Galápagos Penguins

15:00 – 15:20 Moseley and Wanless, Translating research outcomes into fishery management change for African Penguin conservation

15:20 – 15:40 Waller et al., Developing a National Management Plan for the African Penguin in South Africa

15:40 – 16:20 Tea

16:20 – 18:00 Posters - **East Foyer School of Chemistry**



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Wednesday 4th September

Lecture Theatre 1 School of Chemistry, University of Bristol

09:00 – 09:30 Ksepka et al., Deep patterns in penguin evolution: insight from the fossil record

09:30 – 09:50 Ando and Fordyce, Waimanu penguins: Life of the earliest penguins

09:50 – 10:10 Acosta Hospitaleche and Griffin, Middle Cenozoic penguin remains from the Patagonian Cordillera

10:10 – 10:30 Chávez-Hoffmeister, The Peruvian Neogene penguins

10:30 – 11:20 Coffee

11:20 – 11:40 Jadwiszczak, Remarks on some intriguing skeletal features of the Paleogene Antarctic penguins

11:40 – 12:00 Guidard, Modularity and complete natural vertebral homeoses : evolution of the cervical system of penguins (Aves : Sphenisciformes)

12:00 – 12:20 Carravieri et al., Penguins as bioindicators of mercury contamination: geographic and historical trends within the southern Indian Ocean

12:20 – 12:40 Smith et al., Inter-individual differences in aggression in Magellanic penguins (*Spheniscus magellanicus*)

12:40 – 14:00 Lunch

14:00 – 14:20 Viblanc et al., Are both sexes sexy? Individual quality in monomorphic King penguins

14:20 – 14:40 Morten et al., The effect of body condition of abandoned African Penguin chicks (*Spheniscus demersus*) on their begging behaviour, survival and the release rates from hand-rearing.

14:40 – 15:00 Barham and Sherley, Does research harm African penguins?

15:00 – 15:40 Tea

15:40 – 19:30 Workshops (Lecture theatres 1, 2 and 3, School of Chemistry)

18:00 – 19:30 Public event (Great Hall Wills Memorial Building)



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Thursday, 5th September

Lecture Theatre 1 School of Chemistry, University of Bristol

09:00 – 09:30 Cornet et al., The adaptive capacities of Adélie penguins to face environmental variability: the role of heterogeneity within populations

09:30 – 09:50 Cimino et al., Physical factors as predictors: trends in the quality of Pygoscelis penguin chick-rearing habitat in the Southern Ocean

09:50 – 10:10 Scheffer et al., Foraging behaviour of King penguins breeding at Kerguelen in relation to environmental variability

10:10 – 10:30 Bost et al., Penguins and climatic variability: foraging responses of King penguins at Crozet and Kerguelen islands

10:30 – 11:20 Coffee

11:20 – 11:40 Dehnhard et al., Consequences of climate change for rockhopper penguins

11:40 – 12:00 Rebstock and Boersma, Climate change increases reproductive failure in Magellanic penguins

12:00 – 12:20 Tubbs et al., Heat tolerance of African penguins in the face of climate change

12:20 – 12:40 Van Eeden et al., African Penguin foraging ecology in relation to ocean physical processes

12:40 – 14:00 Lunch

14:00 – 14:20 Dann et al., Solar activity and the timing of breeding of Little Penguins

14:20 – 14:40 Ganendran et al., Effect of climate and oceanographic variables on survival of Little Penguins in south-eastern Australia

14:40 – 15:00 Agnew et al., Negative impacts of storm events on little penguins (*Eudyptula minor*)

15:00 – 15:20 Saraux et al., The effect of wind on little penguin foraging

15:20 – 15:40 Tea

15:40 – 18:00 Posters (East Foyer School of Chemistry)



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Friday, 6th September

Lecture Theatre 1 School of Chemistry, University of Bristol

- 09:00 – 09:30 Chiaradia and Saraux, Choosing the right response: which time scale variables to use on penguin research
- 09:30 – 09:50 Sherley et al., A different kettle of fish? The influence of local and regional prey availability on breeding performance of African penguins
- 09:50 – 10:10 Ludynia et al., The Dyer Island Penguin Pressure Model – an interdisciplinary tool for understanding population trends
- 10:10 – 10:30 Thierry et al., Linking weather conditions and hatching success in Adélie penguins using dummy eggs recording incubation parameters
- 10:30 – 11:20 Coffee**
- 11:20 – 11:40 Kowalczyk et al., The importance of resource abundance and alternative prey availability on the reproductive success of an opportunistic top predator
- 11:40 – 12:00 Lynch and LaRue, Emerging geospatial technologies for studying penguin biogeography
- 12:00 – 12:20 Hart et al., Seabird Autonomous Monitoring Systems (SAMS) and large-scale monitoring of penguins around the Southern Ocean
- 12:20 – 12:40 Trathan et al., Developing the tools to identify Ecologically or Biologically Significant Areas as precursors to the creation of marine protection and reserves of relevance to penguins
- 12:40 – 14:00 Lunch**
- 14:00 – 14:20 Collen et al., Towards monitoring global penguin population change
- 14:20 – 14:40 Puetz et al., Post-fledging dispersal of King Penguins in the South Atlantic
- 14:40 – 15:00 Bon and Bost, Determining the feeding success of king penguins along their foraging paths: a predictive model based on diving behaviour
- 15:00 – 15:20 Handley and Pistorius., Animal-borne camera loggers: Investigation for use in Gentoo penguin foraging ecology
- 15:20 – 15:40 Seddon and van Heezik, Twenty-five years of Otago University student research on Yellow-eyed penguins: what do we know; what don't we know?
- 15:40 – 15:50 Closing remarks
- 15:50 – 16:30 Tea**



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How to achieve hyperphagia before moult with millions of conspecifics? A case-study in a key marine predator, the macaroni penguin

Jean-Baptiste Thiebot^{1,2}, Yves Cherel¹, Philip N. Trathan³, Charles-André Bost¹

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³British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge CB3 0ET, UK

Moulting is the highest physiological stress in penguins' life-cycle, and is prepared by hyperphagia period at-sea. Though crucial to individuals' survival, the marine habitat used before moult was never monitored reliably in the keystone marine consumer macaroni penguin *Eudyptes chrysolophus*, so that it remained unclear how individuals mitigate potentially strong intra-specific competition at that time. We successfully surveyed pre-moult ecology at sea of 22 macaroni penguins from Crozet (46°S; 51°E) and Kerguelen (49°S; 70°E) islands in 2009 and 2011, respectively, using advanced geolocation technique and stable isotopes analysis. Such techniques were needed to overpass technical issues linked to the animals' prolonged period spent at sea (51 and 42 d away from the colony for penguins from Crozet and Kerguelen, respectively) coinciding with the fall equinox. Penguins distributed in population-specific oceanic areas marked by the same cold temperatures (close to 3.5°C) south the archipelagos. Distributed at c. 900 km from their respective colonies, macaroni penguins foraged at similar trophic level ($\delta^{15}\text{N}$ values: 8.1 and 8.3‰ for penguins from Crozet and Kerguelen, respectively) in these areas. Based on k-means analysis categorization method, individual variation in spatial distribution within each population was well explained by sex, and this analysis was supported by the fact that females systematically used colder waters than males. Finally, 20 other non-breeding individuals that moult earlier had higher trophic level ($\delta^{15}\text{N}$ values: 9.0‰) than the post-breeding birds. Hence, such divergent strategies developed among [1] localities, [2] individuals (sexes) and [3] breeding status during an intense feeding phase suggest limiting food resource with possible 'wasp-waist' control processes in this marine system. Our study also confirms the large foraging range and oceanic habitat of post-breeding eudyptid penguins, even with lesser time resource available compared to post-moult winter exodus. Further, this study brings new support to the fact that macaroni penguins do not prey upon Antarctic krill in the southern Indian Ocean. Now, our work may eventually be used to develop habitat modelling focused on the areas used during this crucial period, so as to make the tie between yearly profitability of the marine environment exploited there and individuals' recruitment during the following breeding season in this vulnerable species.

Do temperatures influence egg masses in rockhopper penguins?

Poisbleau, Maud¹, Dehnhard, Nina²; Demongin, Laurent¹, Quillfeldt, Petra^{2,3} and Eens, Marcel¹

¹ University of Antwerp, Biology - Ethology, Belgium

² Max Planck Institute for Ornithology, University of Konstanz, Germany

³ Justus-Liebig University Giessen, Animal Ecology & Systematics, Germany

Climate change may influence the breeding patterns of many species. For instance, the timing of reproduction in passerines is advanced when air temperatures experienced prior to breeding are high. Similarly, sea surface temperatures (SST) influence the timing of breeding in seabirds. Breeding success is also affected by these variations in temperatures, but the mechanisms involved, other than the ones implying food supply, remain unclear. For instance, only few studies have focussed on the effects of temperatures on different egg components.

We tested whether SST and air temperature influence different components of egg masses in a population of southern rockhopper penguins *Eudyptes chrysocome* breeding on New Island, Falkland Islands (Malvinas). In four breeding seasons, we weighed 878 eggs and collected 301 eggs for analyses. Egg formation in penguins starts already at sea before arrival in the colonies. We therefore used average SST from the areas the most likely utilized by females for the time period when they were still at sea prior to the arrival in the colony. For the time period between arrival and egg laying, we used average air temperatures recorded by an automatic weather station close to the breeding colony.

SST positively influenced yolk mass, with a larger extent for the first-laid egg (A-egg) compared to the second-laid egg (B-egg). On the contrary, SST negatively influenced albumen and total egg mass. These results imply a direct positive influence of warm temperatures (energy trade-off between self-maintenance and egg formation) on the yolk, which is partially formed at sea, especially for the A-egg. They also suggest an indirect negative influence of warm temperatures (via food availability and female body reserves) on the albumen, which is formed in the colony for both egg categories. After arrival in the colony, air temperatures positively influenced the different components of egg mass but again at a larger extent for A-eggs than for B-eggs. Shell mass was not significantly affected by either SST or air temperature.

Altogether, these results corroborate the idea that females face a trade-off between self-maintenance and reproduction during egg formation. In addition, the fact that B-eggs were less sensitive to temperature variations than A-eggs shows that the trade-off is asymmetrically directed towards A-eggs. This has important implications for crested penguins (*Eudyptes* sp.), species that rarely raise chicks from A-eggs and for which the degree of the initial size hierarchy between siblings largely determines the survival of twins.

Telomere Maintenance and Reproductive Attempts in Magellanic Penguins (*Spheniscus magellanicus*)

Jack A. Cerchiara; Dr. P. Dee Boersma

Department of Biology University of Washington Kincaid 24, Box 351800 Seattle, WA 98195-1800

For the majority of species, body mass is predictive of longevity, with larger individuals having longer lifespans. Many bird species live significantly longer than their size equivalent mammalian counterparts. Seabirds' physiological adaptations may allow them to survive longer than their mass-predicted lifespan. Magellanic penguins (*Spheniscus magellanicus*) exceed their mass-adjusted predicted lifespan by approximately 26%. In other long-lived seabirds, telomere length has been implicated in contributing to this longevity. Telomeres are tandem repeating, non-coding sequences that protect the coding regions of DNA during cell replication. In most species, these telomeres shorten as a result of aging and stress. To examine telomere lengths in relation to age, we collected blood samples from eighty (80) wild, known-age adult Magellanic penguins from September to December 2007 at Punta Tombo, Argentina. Recruitment and survival of cohorts is not equal so, samples of blood were collected from individuals of less than 6 years old, exactly 15 and 19 years old and from adults 24 or more years of age. We used Quantitative Polymerase Chain Reaction (qPCR) to determine telomere length. This technique compares the real-time measurement of the sample telomere length to that of a known length reference gene. We found that in wild Magellanic penguins, telomere lengths did not shorten after 5 years of age. In 2010, we resampled thirty-six (36) of the adults sampled in 2007 and telomere lengths showed no evidence of shortening, suggesting high telomere maintenance. In other species, reproduction poses a considerable stress and results in the release of the stress hormone corticosterone. Corticosterone can lead to the release of reactive oxygen species or 'free radicals', damaging DNA and shortening telomeres. We tested for the cost of reproduction by measuring if telomeres showed increased shortening with an increased number of reproductive attempts. When controlling for age and sex across all breeding adults aged 5 years or older, we found no significant relationship between the number of reproductive events and telomere length, suggesting that adult Magellanic penguins may not be compromising themselves or their longevity by the cost of reproduction. Continual investigation of the aging physiology of seabird species could yield significant clues to understanding the processes of aging in long-lived species and perhaps hold clues to mitigating the pathologies inherent in human aging.

The Importance of Morphological Traits and Heritability in Male Magellanic Penguins (*Spheniscus magellanicus*)

Laura E. Koehn, P. Dee Boersma

University of Washington Department of Biology

Heritability measures the genetic component of the resemblance between parents and their offspring. High heritability is of evolutionary importance because without inheritance from parents to offspring there is no potential for evolution to occur. We estimated heritability for four structural traits in Magellanic penguins (*Spheniscus magellanicus*): bill length, bill depth, flipper length, and foot length. Large male penguins are more likely to win fights at the beginning of the reproductive season, acquire mates, and have good quality nests. In this population, the functional sex ratio is skewed so there are more males than females. Therefore, we predicted that heritability estimates for morphological traits would be higher in male offspring because of the added importance of these traits for males in regards to sexual selection. We estimated heritability by comparing mid-parent size (the average of both parents sizes) and offspring size for each offspring gender separately using linear regressions. We then compared fathers and all offspring, mothers and all offspring, daughters with mothers, daughters with fathers, sons with mothers, and sons with fathers as well. Bill size (depth and length) was significantly heritable from mothers and fathers to sons, and foot length from fathers to sons. No traits were significantly heritable from parents to daughters and flipper length was not significantly heritable for any gender. Bill sizes and feet are all important for intrasexual competition amongst male penguins when fighting to obtain a mate or good quality nest. In contrast, females rarely fight and females always get a mate. Morphological traits appear less important for females than males in acquiring a breeding site and a mate. Our results suggest intense sexual selection leads to higher heritability for these traits in male offspring. Evolutionary change should occur for bill and foot size in males, as these are likely important to male fitness because of strong sexual selection and our results show these traits are heritable.

The Power of Poo – Diet analysis of Adelie Penguins from faecal samples

Julie McInnes, Louise Emmerson, Cassy Faux, Colin Southwell, Simon Jarman

Australian Antarctic Division

Penguin diet is difficult to study because direct observation of foraging is difficult and stomach sampling techniques are invasive, labour intensive to sort and soft bodied prey are often not identifiable. The recent development of Next Generation Sequencing (NGS) has provided a powerful tool in dietary analysis, by identifying prey DNA in predator faeces. This technique allows a large number of prey DNA sequences to be identified simultaneously and the proportion of each to be calculated. We have used this technique to investigate the inter- and intra- annual variation in Adélie Penguin diet at sites in east Antarctica. We investigated if there are dietary differences between what breeding adults consume, what they feed their chicks and what non-breeding adults digest during the incubation, chick guard and crèche stages of the breeding season. This work allows us to identify not only the variation in diet between these groups, but will also provide insights to develop a standard approach for penguin scat collection at breeding colonies in the future. We will also present preliminary results from our use of DNA in faecal samples to sex individuals and investigate parasite presence. There is more to poo than meets the nose, with NGS allowing us to collect large samples sizes with minimal disturbance and exciting results.

Sympatrically breeding *Pygoscelis* penguins balance niche plasticity and segregation under variable prey conditions

**Michael J. Polito^{1,2}, Wayne Z. Trivelpiece³, William P. Patterson⁴,
Christian S. Reise³, Steven D. Emslie¹**

1) Woods Hole Oceanographic Institution, USA

2) University of North Carolina Wilmington, USA

3) NOAA, National Marine Fisheries Service, USA

4) University of Saskatchewan, Canada

We used stable isotope and stomach content analyses to examine niche plasticity and segregation in sympatrically breeding *Pygoscelis* penguins at two sites in the South Shetland Islands, Antarctica, during five breeding seasons that differed in the abundance and demography of their principal prey, Antarctic krill (*Euphausia superba*). There was a general and consistent pattern of niche partitioning between penguin species in all years, with lower trophic positions, greater krill consumption, and higher use of offshore foraging habitats by Adélie (*P. adeliae*) and Chinstrap penguins (*P. antarctica*) relative to sympatric Gentoo penguins (*P. papua*) at both sites. All three species generally increased their consumption of higher-trophic prey such as fish in years when large Antarctic krill was less abundant, although site-specific differences in diet, niche width and plasticity were evident in Gentoo penguins. However, in years when Adélie and Chinstrap penguins increased their consumption of high-trophic prey, it often led to partial niche overlap with sympatric Gentoo penguins. The small and relatively consistent niche widths observed in Adélie and Chinstrap penguins suggest that individuals within these populations generally respond to environmental conditions in a similar manner. In contrast, the higher degrees of individual niche variation, proclivity for foraging more on fish, and use of nearshore, benthic habitats may buffer Gentoo penguins from recent declines in Antarctic krill that have negatively affected other *Pygoscelis* penguin species.

A unique spectral signature for Guano

Peter Fretwell¹, Richard Phillips¹, Andrew Fleming¹ and Mike Brooke²

: ¹: British Antarctic Survey, Madingley Road, Cambridge. ²: Department of Zoology, Downing Street, University of Cambridge

Recent work on emperor penguin populations utilizing remote sensing has demonstrated the capacity of using freely available medium resolution remote sensing platforms to search over large areas to find colony locations. Once found higher resolution satellites or aerial photography can be used to count or estimate the populations at remote colony sites. These recent works have concentrated on emperor penguins that breed on sea ice, this makes their colonies relatively easy to find as the guano in medium resolution imagery is clearly identifiable in the visible wavelengths as a reddish brown stain against the homogeneous white background of the sea ice. Nothing else on the sea ice has this signal and therefore emperor penguin colonies can be simply identified. All other Antarctic seabird species breed on rock, and this makes their guano more difficult to differentiate from the surrounding environment in the visible wavelengths.

Early work on the spectral signature of Adélie penguin (*Pygoscelis adeliae*) guano by Schwaller indicates that in medium resolution Landsat imagery, guano may be differentiated from certain rock types by using the near and shortwave infra-red bands. Schwaller used bivariate plots of Landsat TM imagery to show that Adélie penguin colonies in the Ross Sea area could be differentiated from snow and the surrounding geology (basalt and tuffs). Our aim was to expand upon this study to test whether the detection of guano in freely available Landsat images could be used to potentially identify unknown breeding seabird sites. We used the spectral angle mapper in ENVI image processing software to identify similar spectral signatures to known Adélie penguin colonies in Marguerite Bay on the Antarctic Peninsula.

The results identified all known Adélie colonies, several known shag and petrel colonies and one known fossil Adélie colony. It also showed one very strong signal on the Faure Islands, an island group with no previously known bird colonies. Validation by VHR satellite imagery and aerial photography confirmed this signal to be a previously unknown Adélie colony. It is presently unclear whether this colony has been previously overlooked or if it has formed recently with changing ice conditions in the area.

The survival of macaroni penguins revealed using an automated gateway system

Catharine Horswill, Phil Trathan and Norman Ratcliffe

British Antarctic Survey

In order to simulate long-term population dynamics it is necessary to understand trends in population demography and the processes that drive them. For highly mobile species with unobservable life stages (e.g. deferred reproduction), such as penguins, it is difficult to directly measure survival rates throughout the life cycle. Most of the penguin literature thus focuses on one stage. Few studies have addressed how survival rates vary during different life stages; even fewer have related this to observed population trends. This study examines the survival rates of macaroni penguins at Bird Island, South Georgia, utilising 30 years of monitoring data which indicates this population to have halved between 1982 and 2001, but stabilised in recent years (decreases of 5% p.a. to 2001; <1% thereafter until the current date). To investigate the factors which control this population trend, we present a multi-state capture-mark-recapture (CMR) model for this period of stabilisation. The multi-state approach allows direct estimation of survival rates for birds during their fledging year, as well as years from then onwards. Furthermore, we have incorporated individual fledging weight in order to assess its influence on survival during the first year of life. We used micro-chip PIT tagging to mark individual birds, “recapturing” them with an automated PIT-reader gateway system fitted at the entrance to the colony. We show that whilst survival rates vary on an annual basis, they remain low during a birds fledging year (mean=0.35), increasing thereafter (mean=0.90). During a birds fledging year, survival rate is significantly influenced by weight at fledging, with larger individuals having a higher probability of survival. Using these survival estimates in a population model we explore how survival rates may have suddenly increased around 2001, leading to the observed change in the rate of population decline.

Ecological insights from long-term Adélie penguin monitoring at Mawson, eastern Antarctica: the interaction between penguins and their environment

Louise Emmerson and Colin Southwell

Australian Antarctic Division

The ice-free breeding Adélie penguins inhabit a diverse range of environments at which they breed and encounter dramatically variable marine environments both within and between breeding seasons at the same site as well as across their breeding range. It is well acknowledged that contrasting penguin responses at different sites are likely to be a result of the different marine environments that the penguins encounter. The importance of sea-ice for Adélie penguins is well established, with sea-ice influencing penguin populations through a variety of processes operating at different spatial and temporal scales. For example, in the Mawson region, the sea-ice adjacent to breeding sites breaks out relatively late and this has an effect on breeding phenology and reproductive success for this population. At other sites, open water immediately adjacent the colony allows easy access for foraging, and hence the impediment of fast-ice on reproductive success is often not apparent. In this talk, we will describe the highlights of ecological understanding we have garnered from studying Adélie penguins at Béchervaise Island over a 22 year period. The study is capturing the essence of temporal environmental variability and how penguins respond to this through demographic monitoring, an automated weighbridge, a tracking program, dietary studies and a mark-resight program. We describe the environmental variables which act as clear drivers, outline where no such relationship is apparent, and contrast these to other populations. We will also briefly discuss demographic insights from the long-term mark-resight program. There is clear evidence that reproductive success, phenology and survival is intimately linked with the sea-ice environment for this population. Furthermore, our results show a clear distinction in the response of penguins to different types of ice as well as the timing of the presence of sea-ice. These results are a product of efforts from annual monitoring since 1990 as part of Australia's contribution to the CCAMLR Ecosystem Monitoring Program.

Metapopulation-scale studies of Adélie penguins in east Antarctica: using spatial variation in the environment to understand the ecological relationships between penguins and their environment

Colin Southwell and Louise Emmerson

Australian Antarctic Division

Most insights into the ecological drivers of Antarctic penguin populations have been gained from long-term studies of local populations by using the natural temporal variation in environmental conditions to develop explanatory and predictive models. A complementary approach is to use spatial variation in environmental conditions to develop such models, but this approach has rarely been used because of the difficulty of undertaking ecological studies over large spatial scales in Antarctica. The Adélie penguin is an ideal species for this approach because it has a circumpolar distribution and inhabits a wide range of terrestrial and marine habitats for breeding and foraging. In this talk, we will describe how we have extended aspects of the long-term monitoring program of the local Adélie penguin population at Béchervaise Island near Mawson to metapopulation scales across east Antarctica. To do this, we have developed and applied where necessary new methods and technologies for broad-scale population assessment and monitoring at multiple sites across a 4000km length of the east Antarctic coastline. In this talk we will present results from our population surveys which have found many new breeding sites and revealed an expanding breeding distribution and population across east Antarctica in the last 30 years. Regional variation in these population responses are providing insights into the likely drivers of these changes. Through a newly-established network of remotely operating cameras, we are finding regional variations in breeding success and phenology within and between the major metapopulations across east Antarctica. We are also applying this broad-scale approach to foraging and diet studies. The results from these studies will add to and complement the insights into ecological drivers gained from the long-term monitoring at Béchervaise Island, and support Australia's contribution to the CCAMLR Ecosystem Monitoring Program and the development of a feedback management strategy for any future krill fishery in east Antarctica.

Winners and losers in South Africa's seabird assemblage – where was the African Penguin?

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Fifteen seabirds breed in southern Africa, of which seven are endemic as species and two as subspecies. Over recent decades, South African populations of seabirds showed divergent trends, ranging from increases through stability to sometimes severe decreases. Five of the seabirds feed predominantly on prey that are exploited by fisheries: African Penguin *Spheniscus demersus* (Endangered), Cape Gannet *Morus capensis* (Vulnerable), Cape Cormorant *Phalacrocorax capensis* (Vulnerable) and Swift (Crested) Tern *Thalasseus bergii bergii* (Least Concern) on anchovy *Engraulis encrasicolus* and sardine *Sardinops sagax*; Bank Cormorant *P. neglectus* (Endangered) on rock lobster *Jasus lalandii*. Recent shifts in the distributions of these prey items away from South Africa's north-west coast towards the south-east, thought attributable to environmental change, led to a mismatch in the distributions of the breeding localities and prey of the five seabirds off South Africa's west coast. Consequently, numbers of three seabirds halved: Cape and Bank Cormorants after the early 1990s and African Penguins since the turn of the century. By contrast, numbers of Cape Gannets increased modestly and those of Swift Terns almost four-fold since the early 1990s. The success of the gannet and tern in the face of change is attributable to an increase in South Africa's eastern colony of gannets, aided by high survival of adult birds and perhaps immigration of first breeders from decreasing western colonies, and a probable high production of Swift Terns. The gannet has an extensive foraging range and the tern is nomadic between breeding localities, which gives these two species greater ability than the other three to adapt to changes in the distributions of their prey. Additionally, the gannet is able to supplement its diet with fishery wastes. By contrast, a lesser mobility and adaptability of penguins and Cape and Bank Cormorants rendered them susceptible to reduced local availability of prey that was compounded by intense fishing in the west. The African Penguin and Cape Cormorant suffered high adult mortality in the last decade. Some seabirds that do not feed on commercially-exploited prey, including Crowned *P. coronatus* and White-breasted *P. lucidus* Cormorants, showed long-term stability but with range extensions to or increased proportions breeding in the south-east. Effective spatial management of fisheries and the establishment of suitable breeding localities near areas of fish abundance will prove crucial for the conservation of seabirds such as the African Penguin that have specialised diets, small foraging ranges and compete with fisheries for food.

What are the best indices to monitor trends in an aseasonally breeding, declining penguin population? The case of the African Penguin in Namibia

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Numbers of globally endangered African Penguins in Namibia have been rapidly declining over the last century. Conservation management measures that have been implemented to promote recovery include, amongst others, the recent proclamation of the Namibian Islands' Marine Protected Area which encompasses all penguin breeding localities in Namibia and some known foraging hotspots. In order to gauge the success of these conservation measures, accurate estimates of population size and other demographic parameters are needed for a meaningful interpretation of population trends. Factors related to life-history strategy, such as a lack of breeding synchrony, tend to complicate interpretation. The four main African Penguin breeding localities in Namibia, that together support roughly 96% of the Namibian penguin population, have been monitored extensively since the mid-1990s. We explore various datasets collected since then, including time-series of nest counts and counts of moulting birds, as well as re-sighting data of banded individuals, to assess which datasets (or combinations of datasets) provide the most useful indices to monitor population trends. We discuss the merits and shortcomings of each dataset and associated monitoring method, identify gaps in current data collection and suggest ways to improve dataset value.

15 Years and Counting: The Status of Humboldt Penguins in Peru based on Annual Censuses.

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Humboldt penguins (*Spheniscus humboldti*), once seen in the hundreds of thousands along the west coasts of Peru and Chile, are now considered “vulnerable” by IUCN and perhaps number about 40-50,000 individuals globally. During the Population and Habitat Viability Analysis (PHVA) workshop conducted in 1998, an international working group determined that a standardized census methodology should be used in both countries to refine the estimates of total population and to begin to document changes in numbers and patterns. During the past 15 years, standardized counts of Humboldt penguins have been undertaken 11 times in Peru. The standard protocols call for counting each site twice during the molting period in order to estimate complete numbers; however, that has been possible in only four times at all sites. However, Punta San Juan Reserve, the largest single Humboldt penguin site in Peru, has been counted twice each year. During the 15 years of these standardized censuses, the counts of penguins in Peru have varied from 2000 to more than 20,000. Given that the standardized methodology calls for censuses during the molt period and at approximately the same dates annually, variations could be due to variation in average date of molt, variations in locations used by the molting birds, or true variation in population numbers. Examination of these patterns certainly suggests that a count from any single year should not be considered a definitive indication of conservation status. During this 15-year period, seven new sites have been added to the census route based on information gathered that indicated consistent use by penguins. At the same time, three sites were eliminated from annual counting due to very small numbers and disproportionate time required to access those sites. At six sites, numbers have increased significantly during 15 years while other sites have remained more or less steady. This paper will discuss some of the challenges of maintaining absolutely consistent methodology and also the challenge of converting numbers from the actual counts to an estimate of the total population in Peru. Although there are difficulties in achieving perfectly standardized counts, overall the counts indicate strong positive growth of the population.

Searching Fiordland crested penguins – how to minimise disturbance effects while maximising nest count reliability

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Fiordland crested penguins nest in loose colonies in often inaccessible terrain along New Zealand's rugged Southwest. Since the early 1990s populations have been monitored, however, a recent review found data to be inconclusive and unreliable. Monitoring encompassed single nest counts by observers with varying degrees of experience, a method that may considerably underestimate true nest numbers with no means to determine potential search error. Double counts by two independent teams with similar experience and effort allow quantifying the number of nests missed during a single search and thus will provide a better estimate of actual nest numbers. A pilot study using double counts during the 2010 breeding season suggested that even a single nest count may have considerable impact on incubating Fiordland crested penguins, with up to 12% of the nests found abandoned during the second search. Hence, concern has been raised that the higher accuracy of double counts may come at the cost of higher nest failure rates.

In the course of Fiordland crested penguin nest searches during the breeding seasons 2011 and 2012, we recorded disturbance responses of nesting birds and nest habitat details. Additionally, small temperature loggers (iButtons) were deployed into a selection of nests to quantify how long the clutch was left unattended after disturbance by searchers, and to determine if nests remained active after the second search. iButtons were retrieved at the end of the season after the birds had left their breeding sites. Analysis of iButton temperature data revealed that while some nests likely failed due to human disturbance others simply failed on the search day long after the searchers had left the area.

Temporary absence from a clutch creates predation opportunities and exposes eggs to the elements which can affect embryo development. Both first and second searches caused the abandonment of almost a third of all nests. Temporarily abandoned nests were left unattended for up to 4.5 hours. Despite considerable predation opportunities created by the nest searches only very few nests have likely failed due to predation. However, with varying predator densities this may change in the future. We discuss important factors affecting the likelihood of nest abandonment and give management recommendations on how to reduce human disturbance effects during nest searches while maximising data accuracy for reliable analysis of population trends.

Population structure and demographic history of the *Pygoscelis* penguins on the Scotia Arc and Antarctic Peninsula

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The Scotia Arc is an area of the Southern Ocean showing increases in sea surface temperature and changes in the extent and timing of seasonal sea ice coverage. Understanding historic changes in population and current penguin population structure is key to interpreting population shifts in the region and therefore effective management of the Southern. Using 12-13 microsatellite loci developed for penguins, we characterise the current population structure of three sympatric species of penguin; the Gentoo (*Pygoscelis papua*), Adélie (*Pygoscelis adeliae*) and Chinstrap (*Pygoscelis antarcticus*) penguins. Historic signatures of demography were determined by sequencing the HVR-1 region of the mitochondrial genome. The two recognized sub-species of gentoo penguin, *Pygoscelis papua papua* and *Pygoscelis papua ellsworthii*, form two monophyletic lineages distributed either side of the Polar Front. Using a rate of molecular evolution calculated from Adélie penguin (*Pygoscelis adeliae*) subfossil remains puts the divergence at 26 kya, suggesting they were isolated in different refugia during the last glacial maximum (LGM). Strong population genetic structure was found in the Gentoo penguin from microsatellite and mitochondrial data, weaker population structure in the Chinstrap penguin and very weak structure in the Adélie penguin. The non-breeding migratory distribution of these latter species compared to resident gentoo penguins must allow greater gene flow between colonies. All species have undergone demographic expansions within the last 5,000 to 20,000 years. This suggests expansion southwards out of glacial refugia as suitable breeding sites became available.

The Pros and Cons of being a benthic forager: how anthropogenic alterations of the seafloor affect Yellow-eyed penguins

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The Yellow-eyed penguin in New Zealand is known to be a benthic forager. Being able to search for prey at the seafloor even at depths >100m is likely to provide Yellow-eyed penguins with a competitive advantage in a region renowned for its seabird diversity and abundance. However, unlike pelagic penguin species that may extend their foraging ranges to compensate for prey shortages, the specialisation on foraging at the seafloor limits the penguins to narrow shelf-regions and makes them susceptible to perturbations of their benthic habitat. Between 2003 and 2012, we studied the foraging behaviour of Yellow-eyed penguins to examine the Yellow-eyed penguins' level of specialisation on benthic foraging and assess the flexibility in terms of individual movement patterns and foraging ranges. We deployed GPS dive loggers which simultaneously recorded geographic location and diving behaviour on penguins from sites covering the species' core breeding range on the New Zealand mainland. At all sites, the penguins exhibited almost exclusively benthic foraging behaviour; non-benthic dives were primarily associated with travelling. However, movement patterns differed considerably and seem to be closely related to regional characteristics of the seafloor and state of the benthic ecosystem within their home ranges. At Oamaru, North Otago (45.1°S) penguins showed highly consistent foraging patterns where individual birds targeted spatially distinct locations of increased benthic biodiversity. On the Otago Peninsula (45.9°S) birds also exhibited consistent movement patterns, although not as pronounced. In years of reduced breeding success the birds ranged further and showed remarkable foraging patterns in which some of them followed straight line courses, in some instances backtracking along the same line several times. The most likely explanation is that the penguins foraged along dredge marks left in the seafloor by bottom fisheries, presumably feeding on benthic fish species attracted by exposed invertebrates. Finally, comparing penguins from two sites in the South (46.7°S) we found that birds from Stewart Island foraged within a spatially very limited area (~160km²) focussing their activities on a few distinct locations. Conspecifics from nearby Codfish Island utilised a much wider area (~995km²) and travelled further than penguins at any other site. Penguins from Stewart Island are exposed to commercial oyster fishing that is responsible for the systematic removal of benthic communities, thereby reducing viable penguin foraging habitat which also reflects in poor reproductive success. Our data highlights the Yellow-eyed penguins' dependence on intact benthic ecosystems in the proximity of their breeding sites and reveals a particular susceptibility to indirect anthropogenic influences affecting the seafloor.

Foraging strategies and oxidative stress – Consequences of growing chick on foraging strategies of the little penguin (*Eudyptula minor*)

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Learning the physiological mechanisms underlying the trade-off between reproductive investment and self-maintenance can assist understanding changes in costs associated with reproduction, a hot topic on life history studies of long-lived animals. Laboratory experiments or brood manipulation in the wild have shown that oxidative stress can be a good proxy of the cost of the parental investment. Oxidative stress is the imbalance between reactive oxygen species (ROS) production and the antioxidant defences, which could lead to deleterious oxidative damage, an important factor associated with ageing processes. In this study on the little penguin, an inshore seabird, we examined the consequences of the increasing need of growing chicks on the foraging strategies and the oxidative status of its parents. Using GPS and accelerometer loggers and blood analysis, we monitored the foraging behaviour of 18 breeding penguins, rearing chicks at different ages during the guard stage when parents usually make one-day foraging trips. Foraging behaviour changed in relation to chick age. As chicks get older, parents increased their diving effort (vertical distance travelled and number of dives), departed the colony later and travelled closer to the colony. These changes in foraging behaviour were associated with an increase in oxidative damage but without any changes in antioxidant defences, suggesting an augmentation in ROS leading to molecular damages and an increasing oxidative stress. Our study on a natural population showed that the chick age was related to increase in parental foraging effort, leading to increase in oxidative damages, given that ROS production was positively correlated with energy expenditure. We suggest that this deterioration in the oxidative status with the chicks' age could trigger a change in the breeding strategy, i.e. parents would switch from time-restricted one-day trips of guard to more-flexible longer trips at post-guard, when adults can invest in both parental care and self-maintenance.

Contrast between incubation and brood in Chinstrap penguin (*Pygoscelis antarcticus*) foraging trips in the South Orkney Islands.

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Understanding foraging behaviour for krill dependent species is a crucial issue for the CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources) Scientific Committee in order to determine sustainable krill fisheries targets using an ecological approach. In order to build a foraging model for Chinstrap penguin (*Pygoscelis antarcticus*) in the South Orkney Islands, sixty birds from Cape Geddes (north coast of Laurie island) were tagged through six rounds covering the end of incubation and the beginning of brood (between 21st of December 2011 and 20th of January 2012). The tagging devices captured the surface position via a GPS logger and the pressure via a time-depth recorder (TDR). Combining these two datasets allowed innovative three dimensional representation of the penguin's foraging trips and a complete data exploration by joining surface variables (speed, distance to the colony, sinuosity, etc...) with dive variables (dive time, depth, bottom time, etc...). The spatial representation and analysis of the bird's foraging trips revealed a strong contrast between incubating and brooding birds. The first showed few long foraging trips covering great distances (reaching more than 250 kilometres from the colony) with a higher surface speed. They did frequent short shallow dives (23 metres median maximum depth). During brood, the penguins undertook more frequent shorter trips (median distance to the colony of 15 kilometres) with slower surface speed. They did less frequent, longer and deeper dives (63 metres median maximum depth). The differences in spatial ranges and trip frequencies confirm previous studies and can be explained by the changes in nesting behaviour between incubating the eggs and feeding the chicks. During the first phase, each parent is accumulating reserve while the other is fasting. During the second phase, the chicks 'nutrient needs require both parents to forage for shorter trips in order to supply enough food and to minimise exposure to predators. The observed differences in depths can be explained either by an increase in competition due to a higher foraging density in the vicinity of the colony or by variations in the spatial distribution of the resource. The second hypothesis will be tested thank to synchronous krill acoustic surveys. In order to build a complete foraging model, other biotic and abiotic variables will be incorporated and additional colonies and species will be surveyed in the next phases of the project.

Segregation and association among three populations of *Eudyptes* penguins wintering in the SW Atlantic

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Competitive exclusion theory predicts that ecologically similar sympatric species, and conspecifics from neighbouring colonies, may reduce competition by partitioning resources spatially. We tested this hypothesis by examining winter distribution of three populations of *Eudyptes* penguins in the SW Atlantic.

We deployed geolocators on southern rockhopper penguins from the large Falkland colonies of Steeple Jason Island (SJI), Beauchêne Island (BCI) and macaroni penguins from Bird Island (MBI), South Georgia during the austral winter of 2010. We used R package “tripEstimation” to produce grid maps of time spent and weighted these by population size and daily prey consumption to produce maps of total biomass of prey eaten at a 0.2 degree resolution. We then calculated the 95% contour overlaps in the food consumption of each population and used GAMs to model habitat preference.

SJI birds exhibited low overlap with those from both BCI and MBI, whereas BCI and MBI birds showed a high degree of overlap which is contrary to what would be expected from the distances among the three colonies. SJI birds selected shallow, productive subtropical waters whereas BCI and MBI birds selected deeper, cooler and less productive waters. When controlling for distance from colony and habitat, BCI and MBI birds showed a strong positive association with one another whilst showing weak avoidance of those from SJI. Differences in habitat preference therefore appear to be most important in segregating SJI birds from the other two populations, whereas BCI and MBI share similar habitats and tend to further associate within these. It is possible that, where BCI and MBI birds co-occur in high densities, they avoid competition along other niche axes such as dive-depth or prey size.

The data also offered the opportunity to examine overlaps with the South Georgia krill fishery that operates only during winter. The percentages of the populations' winter food consumption taken from within the 95% contour of the fishery were 0.26% for BCI, 0.20% for MBI and 0.00% for SJI populations. Given the lack of spatial overlap, and the fact that most birds winter in locations and habitats where Antarctic krill will not be an important prey item, competition between the South Georgia krill fishery and crested penguins is likely to be negligible.

New insights into the foraging behaviour and habitat of rockhopper penguins breeding at Staten Island

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Understanding the foraging behaviour and foraging habitat of species is crucial to various applications in ecology and conservation. The aim of this study was to analyze the foraging habitat characteristics of female rockhopper penguins during brooding at Staten Island using GPS and time-depth data, and to ascertain if different foraging strategies persist in the population. Using MaxEnt modelling, we applied ecological niche models to establish the oceanographic variables influencing the utilized brooding habitat. The most important oceanographic parameters predicting the at-sea distribution of the birds studied were the proximity of the shelf break and the sub Antarctic front (= SAF). A cluster observation analysis revealed two different foraging strategies: The first one was determined by bathymetry, sea surface temperature and the SAF (= coastal strategy), whereas the most important variables for the second group were the SAF, the shelf break and chlorophyll values (= pelagic strategy). Dive characteristics differed slightly between the two groups. Bottom time, number of wiggles, mean and maximum dive depth were higher in pelagic compared with coastal penguins. Stable isotope analysis of whole blood samples showed contrasting values for $\delta^{13}\text{C}$ (-21.6 ± 0.5 , -22.5 ± 0.4 , for coastal and pelagic birds respectively) but no differences for $\delta^{15}\text{N}$ (9.9 ± 0.4 , 9.3 ± 0.4 , respectively). The carbon value for coastal birds was higher than expected. As whole blood sampling integrated both, brooding and the incubation trip of the females, a potential explanation might be that coastal birds used more than one foraging strategy at a time (pelagic and coastal), or used a pelagic strategy during incubation and a coastal strategy while brooding. Given the known distribution of females during incubation from previous studies, the second explanation appears more plausible. The combination of these two strategies in the population during brooding could be advantageous as birds were reducing spatial overlapping while feeding within the same trophic level. Finally, this study highlights the importance of the SAF for rockhopper penguins, an oceanographic feature susceptible to changes in location following global warming and subsequent implications for conservation measures.

Getting to know magellanic penguins breeding in Staten Island: foraging behaviour and areas during chick rearing period

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Studies of the foraging behaviour of seabirds are important to establish their role in marine food webs. In Penguins, foraging behaviour is known to vary with locality, sex and stage of breeding. For the first time, we studied the foraging behaviour of Magellanic Penguins (*Spheniscus magellanicus*) breeding on Staten Island, Argentina, to evaluate differences in the foraging behaviour between sexes and to characterize the core areas of their distribution at sea. Fifteen Magellanic Penguins (PM) (8 males, 7 females) from the colony at Bahía Franklin were equipped with GPS data loggers during the early chick rearing period in December 2011. Also, blood samples were taken for stable isotope analyses. Foraging trip duration was 22.4 ± 7.5 hs and all except one penguin performed overnight trips, where dive depths were around 9 m. No significant differences between sexes were found for either diving or feeding effort, except for diving depth and wiggle number per minute during the bottom phase, being higher in males compared with females. PM initially headed northwest and west towards their foraging areas, with a maximum distance from the colony of 35.4 ± 7.6 km, covering a trajectory of 110.6 ± 29.7 km. Foraging areas (95% kernel contour) occupied 629.8 km^2 for females and 738.7 km^2 for males, and females' area overlapped with males' by 74%, revealing no differences in the areas for both sexes. Core areas (50% kernel contour) were situated in rather shallow waters (bathymetry 94.5 ± 60.9 m females, 74.8 ± 51.1 m males) with a high primary production (chlorophyll a, $1.7 \pm 0.8 \text{ mg/m}^3$ females, $1.8 \pm 0.4 \text{ mg/m}^3$ males) and temperate sea surface temperatures ($8.1 \pm 0.2^\circ\text{C}$ females, $8.2 \pm 0.2^\circ\text{C}$ males). Stable isotopes analysis revealed no significant differences between sexes either for $\delta^{15}\text{N}$ ($15.8 \pm 0.3\text{‰}$ females, $15.6 \pm 0.2\text{‰}$ males) or $\delta^{13}\text{C}$ ($-18.3 \pm 1.5\text{‰}$ females, $-17.2 \pm 0.7\text{‰}$ males), thereby indicating no dietary differences or contrasting feeding areas between sexes during the study period. $\delta^{15}\text{N}$ values were higher than those for *Sprattus fueguensis*, the preferred prey of PM, and $\delta^{13}\text{C}$ values showed that PM foraged mostly inshore, which was confirmed by the GPS data that showed most positions along the Le Maire Straight near the coast of Tierra del Fuego. In comparison with the nearest PM colony in the Beagle Channel, PM breeding in Staten Island performed longer and overnight foraging trips and covered larger areas. Those differences may be due to the larger density of birds feeding in the area and thus intra- and/or interspecific competition since the Beagle Channel's colony holds around 3,000 pairs while in Staten Island more than 100,000 PM pairs and about 120,000 Rockhopper Penguin pairs forage in nearby waters.

Foraging and breeding parameters at the only consistently increasing South African colony of African penguins

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The decline in the African penguin population has been well documented, such that the species is now listed as Endangered. Population declines have been recorded at all of the South African colonies, with the exception of one. The land based colony at Stony Point is the only colony showing a measurable increase.

This colony is one of only two land based colonies in South Africa, the other being Boulders. The first nest was discovered in 1982, providing the first reliable evidence for successful mainland-based breeding of the African Penguin in South Africa. The population increased steadily to a total of 35 nests in 1986. After leopard predations decimated the colony between 1986 and 1990, a fence was erected around the colony and since then the colony increased to a total of 1800 breeding pairs in 2012.

We present life history parameters of African penguins at Stony Point, including foraging behaviour, numbers of adult and juvenile moults, chick condition and breeding success. Available banding data is used to get a better insight into movement patterns of African penguins utilising Stony Point. All these parameters are compared to other, declining, colonies of African penguins in South Africa to understand the reasons for the different population trajectories.

African penguins from Stony Point spend 12-15 hours at sea, foraging in a 20-25 km radius around the colony compared to birds from the closest colony (Dyer Island) which spends between 24-36 hours at sea feeding in a 50 km radius from the colony. Numbers of adult moults more than doubled from an estimated 2469 in 2009 to 5436 in 2012 and juvenile moults have increased from an estimated 998 to 1468. Comparisons between chick condition and breeding success will also be presented. All these parameters and the immigration of, especially juvenile, birds from other colonies indicate that Stony Point presents a favourable habitat for African penguins, presumably due to better food availability.

We hope that through understanding the increase of the African penguin population at Stony Point, we can contribute towards understanding the reasons for the current overall population decline as well as help to define future conservation measures required for the African penguin population as a whole.

Foraging behaviour of Endangered African penguins breeding at Robben Island and the influence of local prey availability

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With African Penguin (*Spheniscus demersus*) numbers showing continued declines since the species' re-classification to IUCN Endangered status in 2010, there is an urgent need to improve our understanding of their foraging behaviour in relation to spatial and temporal prey availability. At Robben Island, a colony off the west coast of South Africa, research on penguins has taken place since the colony's re-establishment in 1983. The number of breeding pairs there peaked at 7798 in 2004 but has decreased since then. The 2012 census estimated their numbers at 1669 breeding pairs. Foraging data have been collected at this colony first in 2003 and since 2008. A sample of breeding birds provisioning small chicks has been equipped with GPS-temperature depth data-logger devices for one foraging trip. These devices were programmed to record one GPS fix per minute as well as temperature and pressure every second, allowing for the calculation of trip duration, time at sea, number of dives, distance travelled from the nest and trip path-length. From 2011 to 2012, the deployments of these devices were timed to correspond with small scale hydro-acoustic surveys that estimated pelagic fish abundance and distribution within a 20 km radius around the island. Kernel analysis was used to determine the penguin's main foraging grounds from single and multiple GPS track data, and to identify local areas where pelagic fish were most dense from acoustic data. The degree of overlap between these was calculated to assess whether penguins forage in areas of highest fish density and whether the proximity to the island of high density prey areas affected the scale at which penguins forage. If links between breeding success and a relationship between foraging effort and prey availability can be demonstrated this will have implications for the conservation of the African Penguin.

Experimental fishing exclusions for penguins in South Africa – coasts of contrasts

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The number of endangered African penguins *Spheniscus demersus* in South Africa has decreased by >70% since 2004 which led the species to be downgraded from Vulnerable to Endangered by the IUCN in 2010. Today, the population is estimated at 19 000 pairs, the lowest number ever recorded. Possible reasons for this collapse include (1) a shift in the distribution and decrease in abundance of their small pelagic prey, (2) local competition with purse-seine fisheries, (3) heightened mortality due to starvation, predation, oiling and disease; and (4) the impacts of climate change on breeding penguins on land and on marine ecosystem dynamics in general. Numerous conservation efforts have been put into place to reverse this trend, including experimental fishing exclusions around their four largest colonies. A task team composed of stakeholders from a number of government departments, fisheries representatives and scientists conducting research on African Penguins, was set up in 2008 to assess the impacts of experimental purse-seine fishing exclusions around four African penguin colonies off the west and south coasts of South Africa, and to formulate recommendations to the government based on these outcomes.

Experimental closures have been alternated between colonies and information on foraging behaviour and breeding output has been collected over the years since 2008. Contrasting preliminary results between coasts and between years suggest the necessity of a combination of localized fishery management measures, together with national spatial management of the fisheries, such as reduction of fishing quotas over large areas, in order to increase food availability for penguins around their colonies. The continuous collapse of Africa's only breeding penguin species adds urgency to the wider implementation of such measures.

Long-term variability in macaroni *Eudyptes chrysolophus* and gentoo *Pygoscelis papua* penguin diets at Bird Island, South Georgia

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The diet and breeding performance of seabirds and seals at Bird Island, South Georgia, in the Southern Ocean, has been recorded annually for over two decades as part of a large marine ecosystem monitoring programme. Here we analyse variability in summer diets of macaroni penguins *Eudyptes chrysolophus* and gentoo penguins *Pygoscelis papua* during the crèche period (January and February) between 1989 and 2010.

The most common prey for both penguin species was Antarctic krill *Euphausia superba* which was present in 83 % and 85 % of macaroni and gentoo diets respectively. Macaroni penguin diets were dominated by *E. superba* in 17 out of 22 years, with fish (*Krefftichthys anderssoni*, *Champscephalus gunnari*, *Lepidonotothen larseni*, *Electrona antarctica*) and amphipods (*Themisto gaudichaudii*) the main prey in other years. Gentoo diets were dominated by *E. superba* in 10 out of 22 years. Fish were the main prey in 12 years with *C. gunnari* and *L. larseni* the most commonly recorded species. In this paper we examine relationships between breeding performance and diet variability for the two species and implications for ecosystems management.

The environment at South Georgia is extremely variable, and related to the major climate indices of the southern hemisphere, such as the El Niño-Southern Oscillation and the Southern Annular mode. We examine how variability in the diet of these species relates to the prevailing environmental state and the consequences that this has for both species.

Increasing the Population of Galápagos Penguins

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The population of Galápagos penguins, the rarest species of penguin in the world, has declined by as much as 75% since 1972 because of introduced predators and climate change. In 2010 the Galapagos National Park and the Penguin Project, with funding from the David and Lucile Packard Foundation, started a simple experiment to increase the population. We built shaded lava nests using plate lava found on site in predator-free areas in the Galápagos. We placed nests in clusters of 5 to 10 nests (100 nests) and built 20 single nests that were more isolated and up to 50 meters from another nest. If Galapagos penguins are nest-site limited, I expect that during La Niña events when ocean productivity is high many of the shaded nests will be used. Since the nests were built, they were checked 4 times. One was lost to the Japanese tsunami; two were crushed by sea lions. Surface water temperatures have been high since the nests were constructed suggesting low primary production. However, penguins have visited the constructed nests as evidenced by feathers and guano. So far, two pairs had eggs in constructed nests and one of these hatched a chick. One pair, the only pair using a natural nest during one of the visits, was not the same as the pair that had used the nest earlier that year, suggesting good nest sites are in demand. In July 2012 we found no breeding penguins and no juvenile penguins in the population suggesting no successful reproduction in at least the last 6 months. Several more years of checking nests is needed to determine 1) how much the lava nests are used, 2) whether Galapagos penguins prefer clustered nests and 3) whether lava nests can help rebuild the population. The effectiveness of lava nests in increasing the penguin population may take several more years to determine.

Translating research outcomes into fishery management change for African Penguin conservation

Christina Moseley and Ross Wanless

BirdLife South Africa

The African Penguin is listed as Endangered and is experiencing annual decreases of 10-30% at many colonies. They are specialists on low trophic level fish (sardine and anchovy) but the capacity of the Benguela Current ecosystem to support the penguins (as well as other seabirds, cetaceans and predatory fish) is thought to have decreased through overfishing of small pelagic fish in the 1960s and an increase in the Cape fur seal population. The South African small pelagic fishery (targeting the same resource as the penguins) is currently managed without considering the spatio-temporal distribution of the resources. This, despite the recent, significant shift in fish distributions from the west coast to the south coast.

BirdLife South Africa has taken a multi-pronged and collaborative approach to address this threat, constructing interventions which combine research and policy to change how the small pelagic fishery is managed. This approach has led to progress in two key, related objectives:

1. to ensure spatial management is implemented when determining the annual Total Allowable Catch
2. that management recognises that penguins operate at different spatial scales from the fishery

Research is geared specifically to explore relationships between fishing and penguins.

1. As part of a programme to investigate the effects of small scale spatial closures, research funded by BirdLife South Africa is demonstrating benefits of preventing fishing close to a breeding colony.
2. Preliminary mapping of overlaps between fishing effort and the foraging ranges of penguins undertaking their pre-moult exodus suggests that individuals achieving moulting condition soonest foraged in areas of low fishing effort.
3. Multiple models, using differing modelling paradigms, have shown that fish abundance is an important predictor of African penguin demographics

Results of the three research programmes are presented and discussed at a national management forum. Through this process we have gained insights into the language, approaches and ethos within fishery management processes, providing opportunities to introduce “Ecosystem Approach to Fisheries”-type objectives into the fishery’s management framework. Strong donor commitment has allowed multi-year policy engagement. This has led to good progress at translating research outcomes into changed management practices for this fishery.

Developing a National Management Plan for the African Penguin in South Africa

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The present population of the African Penguin (*Spheniscus demersus*) in South Africa is approximately 2.5% of its level 80 years ago. The species has a Red List status of Endangered because the breeding population has decreased by > 50% in the three most recent generations and the decrease is continuing.

There are a number of organisations both national and international, government and non-government that are involved in the conservation of the African Penguin, unfortunately not always in a coordinated manner. In South Africa, the National Environmental Management: Biodiversity Act (No. 10 of 2004) provides the framework for the management of protected species through the compiling of a Biodiversity Management Plan for Species.

In 2010, the process was initiated to develop a Biodiversity Management Plan for the African Penguin. This management plan aims to provide a coordinated national approach to African Penguin conservation in terms of management, monitoring and research. It has as its vision to “halt the decline of the African Penguin population in South Africa within two years of the implementation of the management plan and thereafter achieve a population growth which will result in a down listing of the species in terms of its status in the IUCN Red List of Threatened Species.”

The presentation will outline the process followed to develop this management plan. It will also describe why this plan was drafted, the aims, objectives, benefits and anticipated outcome of the management plan.

While the development of this management plan was driven by the South African government, it would not have been possible without a number of inputs from NGOs, and this will be highlighted in the presentation.

In addition, the manner in which stakeholders such as scientists, conservation managers and non-governmental organisations are contributing to the implementation of this plan is described. Challenges faced in developing and implementing the management plan are also highlighted.

Deep patterns in penguin evolution: Insight from the fossil record

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Penguins have a deep and rich fossil record, extending back more than 60 million years. Thousands of fossil specimens have been uncovered over the past 150 years since Thomas Henry Huxley published the first scientific account of a penguin fossil based on a single limb bone from New Zealand. The majority of known fossil species represent stem-lineage penguins, species that diverged before the most recent common ancestor of the living species appeared. These extinct species include unexpected morphotypes such as spear-billed penguins, slender long-flipped penguins and "giant" penguins that greatly exceeded the living Emperor Penguin in size. The presence of multiple fossil assemblages of eight or more contemporary species reveals that penguins exhibited both higher levels of morphological disparity and higher levels species diversity in the past that they do today, implying also different patterns of niche partitioning.

This presentation will review recent advances and present new data on the morphological modifications that occur along the transition from archaic basal penguins to the modern crown radiation. While the fossil record provides the largest volume of evidence on the evolution of the penguin skeleton, the discovery of new specimens combined with application of modern methods has also yielded insight into early modifications of the neuroanatomy, integument and thermoregulatory systems of penguins associated with underwater wing-propelled diving. The earliest reported penguins (*Waimanu manneringi* and *Waimanu tuatahi*) are already flightless, but exhibit a primitive arrangement of the flipper bones, which become more flattened, stiffened, and densely osteosclerotic in later species. While these species are restricted to New Zealand, penguins spread to South America, Antarctica and Australia within 20 million years. Osteological correlates identified in early fossils from indicate colonizing lineages had acquired one key thermoregulatory structure that may have aided their dispersal across long distances of open water: a plexus of blood vessels along the flipper serving as a counter-current heat exchanger. Over the next 40 million years, changes in the auditory system, semicircular canal system, feather microstructure and bone microstructure accompanied the radiations and extinctions of nearly 50 fossil species. New findings from specimens including a nearly complete juvenile skeleton of *Kairuku* sp. are now expanding our knowledge of the growth patterns of extinct giant penguins.

***Waimanu* penguins: Life of the earliest penguins**

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Waimanu (Sphenisciformes, Aves) is an archaic fossil penguin genus from Paleocene strata, showing features structurally intermediate between volant seabirds and more-crownward penguins, in addition to some archaic characters seen in Mesozoic birds. *Waimanu* includes two species from the marine shelf strata of Waipara Greensand, North Canterbury, New Zealand: the larger and older *W. manneringi* (Early Paleocene) and smaller *W. tuatahi* (Late Paleocene). These species are the oldest named penguins, and are known from 4 specimens that include cranium, mandible, cervical, thoracic, synsacral, and caudal vertebrae, furcula, scapula, coracoid, humerus, ulna, radius, carpometacarpus, os coxa, femur, tibiotarsus, tarsometatarsus, and phalanges. The cranium has a distinct nasal gland fossa as in later penguins consistent with a marine lifestyle. The straight, slender bill, less elongate but comparable to that of *Icadyptes* and *Platydyptes*, and unexceptional cervical vertebrae, rule out a specialized diet; there is no reason to propose a crustacean diet that shares important portion in modern penguins diet, or fish-spearing habits as *Anhinga* (darters) does. The nearly flat, amphicoelous thoracic vertebrae are comparable to that in Cretaceous basal birds such as *Ichthyornis* and contrast with the opisthocoelous condition in later penguins, and allow that condition in more-crownward penguins evolved independently from the opisthocoelous thoracic vertebrae of other marine birds. The *Waimanu* wing elements are dense (osteosclerotic, with limited cancellous bone) and moderately flattened, with a sigmoidal humerus with developed head and deep tricipital fossa, less flattened ulna with distinct olecranon, and narrow radius. Structures in the wing and shoulder girdle are consistent with wing-propelled propulsion in water, indicating a non-volant lifestyle. Some features such as even-width scapular blade are plesiomorphic similar to that in presumed ancestral volant birds. More-crownward penguins show more-derived flattening of all wing elements and modifications to support a less mobile elbow joint. Both species of *Waimanu* have a plesiomorphic elongate tarsometatarsus with a posterior-directed medial trochlea indicating different foot function from crown penguins; perhaps foot propulsion supplemented the wing propelled diving. The *Waimanu* morphology is consistent with an obligate marine habit, probably in a shallow shelf setting. Structural attributes that allowed more-pelagic habits, such as the thermoregulation-linked humeral sulcus arose later in penguin history, linked with expanding geographic range.

Middle Cenozoic penguin remains from the Patagonian Cordillera

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Well preserved penguin bones (right humerus MLP 96-XII-2-1, a fragment of distal end of right coracoid MLP 96-XII-2-2, and a slightly damaged end of a left femur MLP 96-XII-3) were found in Middle Cenozoic marine beds. The Cerro Plataforma outcrop is unique because it is one of the few localities with Cenozoic marine fossils in the region; the outcrops of the fossil-bearing formation lie at about 1400 m a.s.l. and 500 km from the modern Atlantic coast and only 50 km from the Pacific Ocean (42° 20' S, 71° 51' W). This is the highest site in topographic terms in which penguin fossils occur and indicates a remarkable uplift for the area, probably from the middle Miocene on. There is still a debate about if the bearing beds are of Pacific or Atlantic origin. Associated fossil invertebrates mostly reveal Pacific affinity, and the shark tooth is cosmopolitan. An accurate identification of the fossil penguin was attained by means of a detailed description supplemented with quantitative analyses. Through direct comparisons with other remains and using morphogeometric tools, the specimens from Cerro Plataforma fall within the morphological range of *Palaeospheniscus bergi*. It has been mentioned as a frequent element in the Gaiman Formation (early Miocene, Argentina). This appears to point towards Atlantic affinities for the fossil penguin fauna in western Chubut. However, any certainty on the Atlantic or Pacific affinity of the bearing-rocks based on the penguin remains is challenged by the fact that there is material referable to this genus in rocks exposed along both sides of the present Andes. *Palaeospheniscus* has been cited with some doubts in the Bahía Inglesa Formation (middle Miocene-Pliocene, Chile); and certainly in the Chilcatay Formation (middle Miocene, Peru). However, the finding of *Palaeospheniscus bergi* in Cerro Plataforma would involve the development of a common marine assemblage in both coasts during the Neogene.

The Peruvian Neogene penguins

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The Peruvian fossil record of penguins is one of the most remarkable for their extraordinary quality and their chronological extent, with a range from Middle Eocene to the present. The Neogene record is almost restricted to the Pisco Formation (Middle Miocene-Pliocene), with the exception of a single specimen reported from the Middle Miocene of Chilcatay Formation. Since 2002, three new species of fossil penguins have been described from the Pisco Formation, all belonging to the extant genus *Spheniscus*. The oldest species is *S. muizoni* from the locality of Cerro La Bruja (Middle Miocene). The next species *S. megaramphus* comes from the locality of Montemar Norte (Late Miocene), and the youngest species described is *S. urbinai* from the localities of El Jahuay, Aguada de Lomas, Montemar, Sacaco Sur and Sacaco (Late Miocene to Pliocene). Additionally, the existence of at least another three indeterminate species based on size criteria and stratigraphic distribution has been suggested. These species include associated skeletons in excellent condition, offering a unique opportunity for the realization of detailed anatomical and phylogenetic studies. New specimens and the detailed observation of the original specimens, allow us to identify the existence of characters that allow a better discrimination of these species. Despite the fact that the general anatomy of these specimens closely resembles the living species of *Spheniscus*, there are subtle postcranial characters that distinguish the fossil taxa. In the skull the differences are more obvious, especially at the level of the rostrum, with two distinctive morphologies: the “megaramphus-type” and the “urbinai-type”. This two extreme morphologies have been used as the main characters to discriminate *Spheniscus megaramphus* of *S. urbinai*, but from the observations made on the specimens it is possible to suggest that the “megaramphus-type” might represent more than one species.

Two distinctive morphotypes are identifying in the set of specimens originally assigned to *S. megaramphus*. Only the isolated skull MUSM 795 and the Hueco La Zorra specimen are equivalent in size and proportions to the holotype, while all the other specimens including the paratypes are consistently smaller. A direct comparison of the postcranial elements available for both morphs shows that the smaller set is close to the size range suggested for *Spheniscus* sp. 2 and *Spheniscus* sp. 3, whereas *S. megaramphus* is even bigger and more robust than *S. urbinai*. Nevertheless, the morphology of both groups is almost identical and the states of characters are exactly the same.

Remarks on some intriguing skeletal features of the Paleogene Antarctic penguins

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Antarctic fossil penguins (Aves: Sphenisciformes) are known from the Paleocene and Eocene of Seymour Island, Antarctic Peninsula. These early sphenisciforms have been grouped into more than ten species and at least seven genera (exact numbers still being debated). Three genera comprise birds larger than the recent Emperor Penguin (*Aptenodytes forsteri*). The oldest Antarctic penguin, *Crossvallia unienwillia*, comes from the late Paleocene of the Cross Valley Formation and, judging from dimensions of its limb bones, is the earliest known truly “giant” penguin. However, its most peculiar feature appears to be unique morphology of the proximal femur (the massive head with a medially located pit that accommodates a so-called round ligament) suggesting that *Crossvallia* could have had a unique (within Sphenisciformes) body standing posture and/or been devoid of the ability to waddle. The oldest locally abundant record of fossil penguins originates in the Eocene of the La Meseta Formation. Birds from this amazingly diverse assemblage are very interesting from the functional point of view. For example, large-sized penguins from two genera, *Anthropornis* and “*Palaeudyptes*”, utilized two different design strategies within the hind-limb skeleton to compensate for the considerable body mass. Additionally, the wing skeleton of *Anthropornis* is characterized by the oldest known largely modern-grade carpometacarpal morphology, resulting in an enhanced stiffness of the metacarpal joint, whereas (surprisingly) some degree of mobility was still present within the carpal joint. Evidently, Antarctica played an important role in the early evolution of Sphenisciformes.

Modularity and complete natural vertebral homeoses: evolution of the cervical system of penguins (Aves: Sphenisciformes)

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Penguins (Aves: Sphenisciformes) are pelagic, flightless seabirds. They are exclusively terrestrial as juveniles but mainly aquatic as adults. To improve hydrodynamics, penguins tuck in their necks while swimming. This mechanism is also used on land, associated with the posture of these birds. The study of neck structure and cervical vertebrae morphology of four extant species – King Penguin (*Aptenodytes patagonicus*), Gentoo Penguin (*Pygoscelis papua*), Macaroni Penguin (*Eudyptes chrysolophus*) and Humboldt Penguin (*Sphensicus humboldti*) – shows a highly specialised fitting in adults, which develops during ontogenesis. Distribution of cervical vertebrae can be defined by six modules (Mo), each with its biomechanical function. Despite a common general structure, the cervical vertebrae exhibit morphological differences depending on their positioning.

As the number of vertebrae is the same in all penguins (n=13), these characteristics are identified as apparent cases of complete natural homeotic transformations – therefore, the composition of some modules varies. Two types of complete cervical homeoses are identified between species, but the second type can also occur within some species when the post hatching development is considered (*A. Patagonicus* and *P. Papua*) – the first type is a complete fixed homeosis, with a transitional vertebra (Mo 4) as cervical V or cervical VI; the second type affects the first vertebra of the module 6 (complete inter/intraspecific homeosis).

A comparison with some fossil representatives makes it apparent that the two modular configurations characterising the anterior part of the neck – a consequence of the first homeosis – existed 36 My (*Idadyptes salasi*) and 25 My (*Paraptenodytes antarcticus*) ago, for one, and circa 10 My ago (*Madrynonis mirandus*), for the other. These comparisons also reveal a clear differentiation in vertebral features between the fossil species of the Oligocene–Miocene ages and the more recent and extant penguins. These observations make the proposal of a hypothesis in relation to the ontogenetic influence of *Hox* genes, and their regulators, based on the changes observed in the cervical segment of Sphenisciformes (posterior shift leading to anteriorisations).

The inclusion of this study about penguins in the evolutionary system also involves a thought on the current state and the future of evo-devo (evolutionary developmental biology), the scientific connectivity that allowed a more comprehensive and practical completeness in the contemporary conceptualisation of evolution.

Penguins as bioindicators of mercury contamination: geographic and historical trends within the southern Indian Ocean

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Mercury (Hg) is a highly-toxic non-essential metal known to bioaccumulate and biomagnify within food webs. Due to long-range atmospheric transport and deposition, anthropogenic Hg emissions reach the Southern Ocean, but little is known on Hg contamination of Antarctic and subantarctic marine organisms. Among top consumers, seabirds have been identified as effective bioindicators of Hg contamination in the marine environment. Furthermore, feathers are a key tissue for monitoring purposes, because they are the main route of Hg excretion in birds and can be easily collected. As penguins stay all year long within the Southern Ocean, our objective was to use them as bioindicators of Hg contamination in the Southern Ocean across a range of geographical and temporal scales. Firstly, we validated the use of a single or multiple feathers to quantify individual Hg contamination by analysing four feathers per bird in seven king penguins. As expected, intra-individual variation in feather Hg concentrations is negligible when compared to inter-individual variation, because penguins renew their whole plumage simultaneously. Secondly, using data from four subantarctic species breeding on the Kerguelen Islands, we demonstrated that penguins show low to moderate feather Hg concentrations when compared to other seabirds. Feather Hg concentrations were higher in adults than in chicks and lower in the oceanic crested and king penguins than in the coastal foraging gentoo penguin. Interestingly, the latter species shows particularly large inter-individual Hg variations that can be explained by individual foraging habitat and diet. Thirdly, latitudinal variation in Hg contamination was evaluated using seven species breeding at three different locations, from Antarctica (Adélie Land) to the subtropics (Amsterdam Island). Overall, the results suggest that Hg is more bioavailable in subantarctic than in Antarctic waters. For instance, feather Hg concentrations are higher in the subantarctic king penguin than in the Antarctic congeneric Emperor penguin, despite both species feeding mainly on fish. Finally, historical trends in Hg contamination were investigated by comparing actual feather concentrations with those of museum specimens dating back to the 1950s. No general trend was found across species, but we report a decrease in Hg concentrations in Adélie penguins, an increase in gentoo and macaroni penguins, and no temporal change in emperor and king penguins. In conclusion, our results highlight species-specific and spatial and temporal variations in feather Hg concentrations of penguins, emphasising their value as indicators of Hg bioavailability in the Southern Ocean.

Inter-individual differences in aggression in Magellanic penguins (*Spheniscus magellanicus*)

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Inter-individual differences in behavior, often termed personality or temperament, are documented in a broad range of taxa. These studies have generally focused on the establishment of consistent differences, evolutionary forces leading to maintenance, impact on breeding patterns, and more recently on the consequences of these differences on fitness. Aggression is one behavior that has received particular attention. We recorded aggression measurements on 676 Magellanic penguins (*Spheniscus magellanicus*) during the 2007 breeding season at Punta Tombo, Argentina. To assess aggression, we presented a foreign object at half a meter and 5cm in front of the bird and recorded all behaviors. For breeding birds, we measured aggression at return from migration, return from foraging trips, egg laying, chick hatching, and through the end of the chick guard phase. While individuals incubated eggs or brooded chicks, we measured aggression every six days. On non-breeding birds, we collected data at return from migration, return from foraging trips, and every six days while the individual was present in the colony. In 2008, we resampled 53 breeding birds at chick hatching. For analysis, we divided the behaviors into four categories and assigned each a point value. The four categories are: flight behaviors (-1), indifferent behaviors (0), aggressive warning behaviors (+1), and assaulting behaviors (+2). Preliminary results indicate that penguins do display inter-individual differences in aggression which are consistent yearly. Breeding and non-breeding males do not differ in aggression during settlement. Males are significantly more aggressive than females during settlement. Males and females become significantly more aggressive the closer the object is to the nest. Males are significantly more aggressive at egg laying than they are at settlement for the 5cm score but there is no difference for the half meter score. This raised level of aggression is maintained until the end of the guard phase. Aggression levels at settlement have no significant relationship with number of chicks fledged for either sex. Our study lends additional support to the presence of consistent, inter-individual differences in behavior in wild populations and represents one of the first assessments of the consequences of these inter-individual differences on fitness in penguins.

Are both sexes sexy? Individual quality in monomorphic king penguins

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King penguins (*Aptenodytes patagonicus*) are amongst the most colourful of penguin species. They display bright yellow to orange auricular feather patches, a yellow to rusty-brown breast feather patch, and yellow to orange bill spots, which are known to also reflect UV. Growing consensus is that, in such species where both parents are dependent on each other and required to cooperate to successfully raise their offspring, selection should favour mutual mate choice for high quality partners and, in turn, the evolution of mutual ornaments. However, because males and females often have differing physiological constraints, it is unclear what proximate physiological pathways guarantee the honesty of male and female ornaments and whether similar ornaments convey similar (or different) information on quality in both sexes. Here, we will report on links between colour ornaments and proxies of individual quality such as body condition, parasite loads, oxidative status, stress hormones, metabolic rate and individual temperaments. In agreement with previous studies, we found that beak coloration and auricular patch size are key signalling traits. Yet, we will see that their signalling values can differ between the sexes.

The effect of body condition of abandoned African Penguin chicks (*Spheniscus demersus*) on their begging behaviour, survival and the release rates from hand-rearing.

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Since the beginning of the 20th Century the population of African Penguins has declined by over 90%, resulting in the species being uplisted to Endangered in 2010. There are several preventative measures currently in place to slow down the decline of the African Penguin population. These include the African Penguin Chick Bolstering Project (APCBP), which is implemented by SANCCOB (South African Foundation for the Conservation of Coastal Birds). Every year chicks at all development stages are abandoned once their parents begin to moult. The APCBP removes the abandoned chicks; they are then hand-reared at SANCCOB and released to bolster the wild population.

During October 2012- February 2013 the body condition of abandoned African Penguin chicks at SANCCOB will be calculated morphologically using head length and weight measurements. The chicks' progress through the hand-rearing process will be monitored. The significance between the initial morphological body condition, the survival rate and the time until release will be analysed using univariate analyses of covariance (ANCOVA).

The intensity of begging calls (number and rate) advertises a chick's body condition in many bird species (including Cory's Shearwaters). Preliminary experiments will be used to test whether this is also the case for African Penguin chicks. A hand-held microphone will record chick begging calls and using Avisoft software the call parameters will be analysed. Significance between body condition, calling frequency and duration will be tested using ANCOVA. Regressions will be used to determine the relationship between acoustic parameters and morphological body condition. If there is a relationship between morphological body condition and begging call parameters then call analysis could provide another approach to assessing a chick's body condition.

Using previously collected data it will be tested whether the condition of naturally reared chicks measured between June-August in years of mass abandonment are significantly different than in years when few chicks were abandoned. The same data sets will also be used to compare the average condition of chicks between September-October in years of little and mass abandonment.

The results will initially assist SANCCOB with refining the guidelines that they provide to colony managers (provincial and national conservation authorities) on how and when to detect and remove abandoned African Penguin chicks from colonies in South Africa.

Does research harm African penguins?

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When working with any animal but especially with an endangered species it is very important to assure ourselves that the impact of research we do is not harmful (or at the very least to mitigate against any harm that may inevitably be caused). However, to do this we need to have ways to assess whether or not we are doing damage and if we are to further assess the magnitude of that damage and eventually to measure the effectiveness of any mitigation measures we put in place.

We have looked at a number of possible measures of the impact of disturbance caused by our research on African penguins (*Spheniscus demersus*) on Robben Island. We have tried to compare a number of possible indicators between birds that nest in areas of the colony that are regularly disturbed by researcher activity and those that remain relatively undisturbed; these include: nest density; times of departure to sea in the mornings and return in the evenings; overall numbers of chicks fledged; and the condition of chicks as they grow.

We find no measurable differences in any of these parameters except in the condition of chicks. Chick condition (total mass divided by bill length) is a good indicator of parental effort and success – a well fed chick has a higher condition index than a poorly fed one; and importantly it can be measured at nests in well-defined areas at nests with well understood types of disturbance.

Our results indicate that at nests in areas which are undisturbed apart from the single time the measurement of chick condition is made, the chicks are in good condition. However, chicks at those nests which are visited on a regular schedule are in general in a similar but slightly better condition. Chicks at nests within the general areas where the regularly visited nests are located, but which are subjected to irregular disturbance are generally in a poorer condition.

A possible explanation is that African penguins, once habituated to regular visits by researchers are not negatively affected by these visits; while birds that are subject to erratic visits and patterns of disturbance are adversely affected.

We believe that the condition of chicks may prove to be a particularly useful indicator of the effect of researcher (and other) disturbance.

The adaptive capacities of Adélie penguins to face environmental variability: the role of heterogeneity within populations

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Population dynamics are the result of several life history parameters (age-specific survival and breeding success, age at maturity, etc.), which can be themselves the result of phenotypic traits (behavioural, physiological and morphological). The alteration, direct or indirect, of one of these parameters by environmental constraints may have effects on population persistence. However, individual adjustments of some phenotypic traits in response to the environment could enable a population to track a rapidly changing environment very closely, without the immediate necessity of genetic adaptations. In the context of environmental change, it is therefore important to study the underlying mechanisms of these adjustments, and to do so at both the intra-individual level (flexibility) and the inter-individual level (heterogeneity), but also to assess the relative roles of these mechanisms. Based on 7 years of automated transponder-based monitoring, we evaluated the inter-annual variability of several phenotypic and life-history traits in a colony of unbanded Adélie penguins *Pygoscelis adeliae* of the Pointe Géologie Archipelago, Adélie Land, and investigated their dependence on environmental stochasticity (and its associated consequences on food availability). The inter-annual variability in the survival rates and the return of juvenile Adélie penguins (ca 1650 individuals marked as chicks) to their natal colony, but also the plasticity and flexibility in some traits, such as the annual arrival dates at the colony for reproduction or the laying dates (ca 180 individuals marked as adults) that lead to different breeding outcomes, will be presented. We also investigated how environmental conditions, and also individual characteristics (i.e. sex, body condition and structural size), might affect those parameters. Moreover, we will present the first study and results on personality traits (i.e. intensity of activity and degree of aggressiveness and boldness collected through visual focal observations and videos), and how they are correlated with individual fitness, but also to individual quality indices, according to morphological and physiological conditions. Whereas the effects of environmental conditions at sea on reproduction are relatively well studied, environmental constraints on land still remain poorly investigated. However, their effects can have a strong impact on individual fitness. Therefore, the relationship between the breeding habitat quality (local weather, protection, location within the colony, density, etc.) and phenotypic and life history traits was also investigated. Our study allows us to better understand how heterogeneity enables populations to cope with environmental constraints, which is crucial to gauge the adaptive potential of these penguin populations to face future ecosystem changes.

Physical factors as predictors: trends in the quality of *Pygoscelis* penguin chick-rearing habitat in the Southern Ocean

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Rapid climate change in Antarctica appears to be altering the distribution and abundance of *Pygoscelis* penguin breeding colonies. Adélie (*Pygoscelis adeliae*), Chinstrap (*P. antarctica*) and Gentoo penguins (*P. papua*) are undergoing general population declines in their northernmost range while there are reported increases in their southernmost range. These changes are coincident with decadal-scale trends in satellite-derived sea ice concentration (SIC) and sea surface temperature (SST) during the chick-rearing season (Dec-Feb). Although the habitat range of Adélie, Chinstrap and Gentoo penguins often overlap, they require different physical and biological parameters for successful life cycle events. Utilizing SIC, SST, and bathymetry, we identified separate chick-rearing niche spaces for these *Pygoscelis* penguin species and used a presence-only, maximum entropy approach (MaxEnt) to spatially and temporally model suitable chick-rearing habitats in the Southern Ocean. MaxEnt estimates a species distribution by utilizing environmental variables, taken from species observation data, and determines their contribution to species habitat selection. For these *Pygoscelis* penguin species, MaxEnt models predict significant changes in the location of suitable chick-rearing habitat from 1982 to 2010. In general, modeled chick-rearing habitat suitability at specific colonies agreed with the previously documented population trends over the same time period and location. These changes were the most pronounced along the West Antarctic Peninsula, which has been rapidly warming for at least the last half-century. This study argues that the main ecosystem drivers at many penguin colonies are the local physics (SST, SIC, and bathymetry) and climate change, which govern bottom-up forcing and are a proxy for prey availability.

Foraging behaviour of king penguins breeding at Kerguelen in relation to environmental variability

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Environmental variability is known to influence the distribution of mid-trophic level species which are prey for diving predators, including king penguins (*Aptenodytes patagonicus*), one of the key avian predators of the Southern Ocean. To locate and exploit locations that have enhanced prey availability, penguins are thought to dynamically alter their foraging behaviour in response to both their prey and the environmental conditions encountered.

In this study we examined the foraging behaviour of king penguins breeding at Kerguelen in relation to environmental variability. We used Argos and GPS tracking together with time-depth-temperature recording to follow the at-sea movements of king penguins. Combining observed penguin behaviour with oceanographic data at the surface and at depth, enabled us to explore how animals adjust their horizontal and vertical movements in response to their environment.

King penguins adjusted their horizontal and vertical foraging behaviour and habitat use in response to environmental variability. Penguin foraging areas were dominated by an influx of cold waters of southern origin which interacts with Polar Frontal waters; this meso-scale interaction appeared to be of key importance for foraging. We examined the penguin's behaviour during the breeding season 2009/10, which was characterized by exceptionally long foraging trips and low reproductive success. Extended foraging trips beyond the foraging range of other years as well as significantly altered dive characteristics and the manner in which penguins utilised the thermal structure of the water column in 2009/10 suggests that the local oceanography and associated prey field may have been altered in such a way that king penguins were not able to forage successfully in their usual foraging area. Southward shifts in key oceanographic features in the penguin's foraging area as well as the disruption of the thermal structure of the water column indicated significant changes in oceanography (and the associated prey distribution) following fluctuations in regional climatic drivers. The exceptionally high breeding failure indicates that king penguins were not able to successfully adapt to conditions encountered during 2009/10.

The capacity of king penguins to adapt to variability in oceanographic conditions and associated prey resources in their foraging area may be limited by environmental thresholds beyond which successful foraging and reproduction may be significantly impacted. The breeding season 2009/10 may therefore allow us to identify key environmental conditions and environmental thresholds for successful foraging and reproduction at Kerguelen, which will be important in the context of regional climate change.

Penguins and climatic variability: foraging responses of King penguins at Crozet and Kerguelen islands

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Understanding how the climate variability affect the foraging ecology of marine key predators at a short and long-term scale is a key issue in the studies on the oceanic food webs. We conducted a long-term project on the foraging areas and behaviour of king penguins in the South Indian ocean, at Crozet (since 1993) and Kerguelen islands (since 1998). These 2 areas are influenced by distinct oceanographic process. The aims of the project is i) to study how the change in penguins foraging parameters and success reflect the impact of oceanographic conditions on key food webs; ii).to investigate the role of the Polar Front variability as a driving key force for penguins populations; iii) to model the foraging habitat in different climatic scenarios. As deep divers and long-distance foragers, king penguins are good candidates for such study. In addition they rely on major marine resources (myctophids fish). They forage preferentially along large-scale physical features and use the three dimensions of the hydrographic features to find their prey. The penguins are fitted with Argos transmitters or GPS with Time-Temperature-Depth recorders. The general patterns of foraging in terms of surface and diving behaviour were studied in relation to oceanographic features in the horizontal and vertical dimension. The foraging habitat used was modelled from physical and biotic variables and their related gradient. We discuss the results of the change in penguins at-sea trajectories, diving behaviour, foraging success and effort in relation to the inter-year changes in the hydrographic structure. King penguins foraging distribution was mainly driven by SST during both incubation and brooding and consistently over years. The penguins spent a high proportion of their foraging time in cold waters typical of the Polar Frontal Zone. As a consequence of extra-tropical warm anomalies penguins foraging distances and feeding depths can considerably increase (up to 71% and 37% for Crozet birds, respectively). Ultimately, the Crozet population of this long-lived penguin species decreased by 34%. Such changes were related to simultaneous activity of subtropical dipole events occurring in both Indian and Atlantic oceans. At Kerguelen, major anomalies in king penguins foraging and reproductive success appear to be caused by the occurrence of a strong large-scale signal of environmental variability (Indian Ocean warming from remote El Nino impact) amplified with smaller-scale atmospheric anomalies (storm passage). We discuss the potential impact of the predicted warming of the water masses in the Polar Frontal Zone by the end of the century, according to the proximity of the colonies to the polar front. The southward shift of the polar front could represent a major challenge for flightless top-predators such as king penguins.

Consequences of climate change for rockhopper penguins

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Population numbers of southern rockhopper penguins (*Eudyptes chrysocome*) have declined dramatically throughout their distribution range in the 20th century. While the exact reasons for these declines remain unclear, global climate change has been suggested as a potential explanation. Even though local populations appear stable at the moment, it remains open how sensitively this species reacts to current and future climate change.

We used a gateway system to study annual survival rates as well as daily foraging success during the chick rearing period in a colony on New Island, Falkland Islands (Malvinas). We related these parameters to either sea surface temperatures (SST) or ambient wind patterns (speed and direction), environmental variables that are supposed to be affected by climate change.

Annual survival rates were quadratically related to SST, particularly during the pre- to postmoul period. Our data indicate that southern rockhopper survive best at slightly colder than average SST, while mortality rates increased towards both enhanced and decreased SST. Daily foraging success was highly variable among days and was significantly higher during days with typical southerly to westerly winds compared to atypical northerly to easterly winds. An increase in wind speed was favourable for foraging during typical wind directions but not during untypical ones. These results underline the importance of short-term wind conditions on foraging success of flightless seabirds. Furthermore, as climate change is predicted to cause a shift of the Southern Ocean West Wind Drift to more southerly latitudes, it appears likely that the number of days with northerly to easterly wind directions will markedly increase in the future.

In conclusion, our results emphasize the sensitivity of southern rockhopper penguins to both changes in sea surface temperatures and wind patterns. These are alarming news for the future of the rockhopper penguin species complex, especially when considering the predicted changes, and they underline the need to consider feasible conservation strategies in the longterm.

Climate change increases reproductive failure in magellanic penguins

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One way that climate change may affect wildlife populations is through intense rainstorms. Global warming is causing more frequent and intense storms, and climate models predict this trend will continue. We examined how rainstorms impacted survival of Magellanic penguin (*Spheniscus magellanicus*) chicks over 28 years at Punta Tombo, Argentina – site of the largest breeding colony of the species. Here, the number of days with more than 20 mm of rain has significantly increased since 1960. During the study period, 16 of 229 storms in 12 years killed 208 of 2459 chicks. One storm in 1991 caused 66% of the chicks to die. Chick age, age squared, rain, low temperature, and their interactions helped explain chick death, with age the factor that best predicted a chick's fate. Most chicks died when they were 5-19 days old, after which mortality decreased rapidly with no chick dying from a storm after it was 33 days of age. In a subset of data (1030 chicks) with nest characteristics, high-quality burrow nests mitigated storm mortality somewhat but nest orientation did not matter. Our model showed that a heavier rainstorm extended the age when each chick was vulnerable and increased its probability of death. Concomitantly, since 1983 the synchrony of egg laying in Magellanic penguins decreased, which also lengthened the time when the colony was vulnerable to chick death from storms. The increased frequency and intensity of storms due to climate change will increase the frequency of reproductive failure and will likely diminish recruitment in Magellanic penguins. The pattern of storm death we found in penguins is likely to apply to many other seabird species breeding in the region, including albatrosses and cormorants, and will likely reduce their populations as well.

Heat tolerance of African penguins in the face of climate change

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Penguins have evolved morphological and physiological mechanisms to reduce heat loss when swimming in cold water, but these adaptations can be disadvantageous for low-latitude *Spheniscus* penguins breeding in hot, terrestrial habitats. Historically, most African Penguins (*S. demersus*) bred in burrows dug in guano. However, guano scraping removed this habitat for penguins, forcing them to breed in surface nests, exposed to extreme weather events and predators. Penguins are sensitive to heat stress during extremely high temperatures. If these conditions persist, some birds leave their nests unattended to go into the sea to cool down, which is often fatal for broods in exposed surface nests (predated by gulls). Similarly, during extremely cold, wet conditions, many surface nests in poorly-drained areas flood, leading to chick and egg loss through hypothermia. Since climate change increases the frequency of extreme weather events, the situation is worsening for this endangered species. Previous studies and our pilot data indicate that these effects can be ameliorated to some extent by the use of artificial nests or nest-covers. But whether these structures can fully replace natural burrows and/or whether any type of burrow will provide sufficient protection in the face of climate change remains to be tested.

In this study, we will (1) establish the thermoneutral zone and upper critical temperature of adult African Penguins and their large chicks, (2) understand the behavioural responses of penguins to increased temperatures on their colonies according to their breeding status, (3) estimate inter-colony and nest type differences to temperature exposure, (4) determine how extreme weather events of different types (heat waves, storms) can affect African Penguin breeding success and (5) evaluate the effectiveness of mitigation solutions such as artificial nests. The results of this study will help to predict how African Penguin populations may be affected by future climate changes, as well as informing management actions to limit such impacts.

African Penguin foraging ecology in relation to ocean physical processes

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Like other seabirds, penguin life histories (e.g. long life spans and late maturation) have evolved as a means to cope with the heterogeneous ocean landscape and low prey availability, amongst other constraints. Sea birds have also evolved strategies to increase the probability of locating these scarce and patchy prey distributions. For instance, many seabirds, such as albatrosses and the larger penguins, are known to utilize temperature gradients to locate meso-scale (100-1000 km) ocean physical features such as eddies, fronts and upwelling zones where nutrients are advected to the euphotic zone from deeper cool bottom waters. This nutrient injection drives productivity, making these features predictable feeding grounds for top predators. However on a fine (> 1 km) to coarse scale (1-100 km) it is less well understood how these predators find patchy prey locations where physical cues such as temperature are more ephemeral. Breeding African Penguins *Spheniscus demersus* have short foraging ranges (10- 50 km), and forage in dynamic coastal environments making them an ideal model for understanding how short-range top predators locate their prey. By modeling the sea- surface thermal habitat preferences and the dive behaviour in relation to thermoclines of African Penguins, I assess how these short-range foragers use ocean physical processes to increase the probability of locating their small pelagic prey. African Penguins were capable of utilizing temperature as a potential cue to foraging in three-dimensions. Penguins commuted east and south of their colony, likely predicting the occurrence of cool nutrient rich waters from a periodic upwelling cell. Penguins used a correlated random search strategy during foraging, suggesting that they searched continuously for prey, and it is therefore likely that penguins are limited by the patchy distribution of prey rather than an abiotic heterogeneous marine environment. When diving, penguins utilized thermoclines that fronted cool waters (14.1 ± 2.2 °C) as a potential cue to prey. Penguins dived deeper, foraging below the thermocline when the thermocline depth increased, and also responded in their dive behaviour under different thermocline structures. For instance, when thermoclines were a diffuse barrier to nutrients birds dived deeper towards the benthos. African Penguins show flexibility in their foraging behaviour, adjusting their dive behaviour to subsurface thermal structures. Penguins demonstrated foraging optimization by using temperature cues and behavioral switching to maximize the probability of locating prey patches. African Penguin behaviour suggests their prey fishes occupy specific thermal habitats, which provides scope for further discussion and research.

Solar activity and the timing of breeding of Little Penguins

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Charles Elton, “the father of ecology”, first suggested in 1935 that population cycles of animals may be related to sunspot activity but ultimately this was not found to be the case.

In this study we have modelled the timing of breeding Little Penguins *Eudyptula minor* in terms of sun-spot activity using a 43-year demographic dataset of breeding penguins in south-eastern Australia. There are four 11-year cycles of mean egg-laying date and sunspot activity recognisable over the study period.

The mean laying date of first clutches was correlated with mean annual sunspot activity. Earlier egg-laying was associated with reduced sunspot activity.

The potential causal links between solar activity, climate and the timing of breeding of penguins are discussed together with the implications of predicted climate change until the end of the 21st century.

Effect of climate and oceanographic variables on survival of Little Penguins in south-eastern Australia.

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Climate and oceanographic influences can have significant effects on the productivity of marine ecosystems and on the energy budgets of higher marine vertebrates. It is therefore possible that such variables also affect the survival probability of these animals. Global and regional patterns of wind, sea temperature, ocean currents and rainfall are predicted to change over the next century with potential impacts on the viability of marine vertebrate species.

We conducted a statistical analysis of a 42-year life-history data set of Little Penguins *Eudyptula minor* from Phillip Island in south-eastern Australia, with a particular focus on the relationships between the survival probability and various climatic and oceanographic variables. The survival and recapture probabilities are modelled via a series of biologically-sensible age structures and covariate dependencies, with survival possibly dependent on climatic and oceanographic variables such as strong wind events, sea surface temperature and chlorophyll a (as a proxy for marine productivity). Using the life-history data, we formed likelihood contributions for each bird and used the maximum likelihood method to estimate the model parameters.

First-year survival is negatively associated with the number of days with strong westerly winds in the autumn immediately following fledging and positively associated with the number of strong westerly wind days in the winter before egg-laying. Annual adult survival is negatively associated with mean wind speed in autumn, when adults moult, and positively associated with mean wind speed in winter. In addition, first-year survival is positively associated with sea-surface temperature in the winter before egg-laying and adult survival is negatively associated with sea-surface temperature in the winter immediately following moult.

These climatic and oceanographic variables have a lagged effect on both first-year and adult survival. We discuss mechanisms which might lead to these effects.

Negative impacts of storm events on little penguins (*Eudyptula minor*)

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Significant storm events on the south-eastern coastline, South Island, New Zealand, are dominated by persistent onshore winds and large ocean swells. The resulting turbidity decreases water clarity in a region that encompasses the foraging area of a population of little penguins (*Eudyptula minor*) at Oamaru. Little penguins are near-shore foragers and rely on vision to catch their prey, which likely means they experience foraging difficulties during such events. Breeding and survival of the penguins at Oamaru has been monitored since 1993, with all breeding adults and fledglings being marked with flipper bands. A weekly check of all nests in the colony has been conducted to record the numbers of adult penguins, eggs and chicks present. More recently foraging research has taken place involving the attachment of GPS and time-depth recording devices. A tourism operation exists at the Oamaru penguin colony where visitors attend evening viewing to see the penguins as they arrive ashore; each night since 1993 the approximate number of penguins arriving ashore has been recorded. During the period 1993-2012 storms that occurred during the austral winter resulted in an immediate drop in the number of penguins arriving ashore and a subsequent delay in the onset of egg-laying. An increase in adult mortality occurred, particularly of females; 18-20% of breeding adult females alive at the beginning of the season disappeared during the winter and did not breed, assumed to have died at sea. Storms that occurred during summer also resulted in a decrease in the number of penguins arriving ashore which lead to the loss of chicks due to starvation. The attachment of time-depth recording devices established that the birds adjust their diving behaviour during storms, diving to shallower depths. The significance of the immediate effects of storm events on demographic parameters and the potential long-term effects will be discussed.

Effect of wind on little penguin foraging efficiency

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Most of the documented effects of environmental and climate variability on top-predator life-history traits and population dynamics result from indirect effects mediated through the food chain. In the actual context of climate change, evidence is growing that wind strength and direction could play a determinant role for seabirds that forage at sea. Here, we investigated the effect of wind on foraging, using both local coastal weather station data and satellite-derived ocean wind, over 10 years involving more than 200 breeding little penguins continuously monitored by an automated weighing system. We found that both wind strength and wind direction could affect foraging and provisioning parameters of little penguins. In particular stronger winds resulted in longer foraging trips both during incubation and post-guard. The body mass changes associated with these foraging trips as well as the size of the meal given to the chicks increased with stronger winds during chick-rearing. During the breeding season, winds mainly blow westwards. Both body mass changes and meal size also increased with South-West winds rather than North-West ones. Changes in the adult own body reserves (i.e. body mass changes minus meal size) did not appear to be affected by winds. Such results illustrate the complexity of interpreting mechanisms involving wind. An increase in wind strength should be associated with the absence of thermoclines thus reducing little penguin foraging efficiency and resulting in longer foraging trips. However, at the same time, wind direction and strength are likely to significantly affect the flow and concentration of nutrients in Bass Strait, resulting in changes of prey distribution.

Choosing the right response: which time scale variables to use on penguin research

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Understanding how penguins respond to changes in their ecosystems requires selecting parameters that are sensitive enough to detect these changes. With increasing quality of biological data collected using new automated techniques and growing number of satellite-based environmental variables available, penguin biologists should be looking beyond traditional breeding variables to use more subtle and sensitive biological variables in their studies. Here we have a critical discussion on different time scales of variables used on penguin research. Using new and published data, mostly on little penguins as a model, we will show how penguins respond differently to same stressor at different spatial-temporal scale. When analysing fine scale 10-year attendance data we found that success at incubation, guard, post guard stages and overall breeding success (chicks fledged per pair) are not dependent events. For instance, hatching and post-guard success were correlated with breeding success but not with guard success. Chick mortality was concentrated in specific weeks, following sharp decrease in chick body mass. Parental attendance measure in hours rather than days revealed that old penguins work longer hours than young and middle-aged parents. But middle-aged penguins forage more efficiently than other age groups. In relation to the marine environment, sea surface temperature (SST) has high biological significance, providing relevant information on physical processes driving prey distribution. We found that breeding success was positively affected by sea surface temperature (SST) averaged over the entire breeding period, in contrast to a negative relationship between weekly chick survival and weekly SST. While penguin biologists are benefitted from a new multitude of environmental and biological variables currently available, caution should be exercised to identify the appropriate time scale, targeting variables at relevant breeding stages when designing any investigation.

A different kettle of fish? The influence of local and regional prey availability on breeding performance of African penguins

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Environmental change may make it more difficult to detect functional relationships between seabirds and their prey by disrupting the links between food availability at different spatial scales. In South Africa, the population trends and breeding success of African penguins *Spheniscus demersus* have previously been linked to the overall abundance of their main prey, anchovy *Engraulis encrasicolus* and sardine *Sardinops sagax*. However, during the late-1990s and early 2000s, both fish species increased markedly in abundance until 2004, after which sardine biomass decreased to below average levels. In addition, adults of both stocks were principally located along the South Coast from 2001 to 2012 and were thus distant from seabird colonies on the West Coast. In contrast, anchovy recruits, the main prey of chick-rearing penguins on the West Coast, remained abundant and their distribution did not alter over the same period, highlighting the need to consider resource indices over alternative spatial scales.

From 2001 to 2012, the number of penguins breeding at Robben Island and the fledging period of chicks were significantly related to the biomass of sardine measured six months earlier, possibly linked through adult condition at the onset of breeding. From 2001 to 2010, breeding success and chick-fledging rates showed positive relationships with local food availability, indexed through the annual industrial catch of anchovy made within 56 km (30 nautical miles) of the colony. In addition, chick-fledging rates were depressed in two-chick broods during years when anchovy contributed <75% by mass to the diet of breeding birds over the same period. After 2010, industrial fishing was restricted around Robben Island and chick survival increased marginally.

Previously reported relationships between the overall abundance of forage fish and penguin breeding success were not supported, suggesting that local food availability may now be disconnected from overall biomass in this system. Taken together, these results underline the need for adequate local food availability during the reproductive cycle but highlight the importance of the interaction with regional prey abundance during the non-breeding season. Small-scale fishing closures around seabird colonies are being trialled in South Africa, but our results imply that they may be inadequate to provide benefits at a population level in the absence of other broad-scale measures to ensure food security for top predators. Improving our understanding of how the interactions between resources on different scales affect population demographics will be crucial to improving the poor conservation status of southern Africa's seabirds.

The Dyer Island Penguin Pressure Model – an interdisciplinary tool for understanding population trends

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The African penguin (*Spheniscus demersus*), endemic to Namibia and South Africa, is currently listed as “Endangered” due to dramatic declines of its global population. The number of breeding pairs at Dyer Island in the Western Cape of South Africa, formerly one of the largest colonies, has decreased from over 20,000 breeding pairs to less than 2,000 in the last three decades. A large number of factors have been identified as potential reasons for this population decline. Reduced prey availability around Dyer Island could be caused by intensive fishing but also by a shift in fish distributions along the South African coast. Other factors include disturbance, oiling, predation by seals and gulls as well as climatic effects such as heat stress and flooding.

Using a systems modelling approach, we try to understand how these factors affect the number of breeding pairs as well as the breeding success of African penguins on Dyer Island. We will present how we worked as an interdisciplinary group of experts, consisting of biologists, fisheries scientists, modellers, conservation managers, social anthropologists and NGOs to design the model, and how we incorporated existing data sets on the breeding and foraging ecology of African penguins into the modelling approach to facilitate understanding of the potential drivers of penguin population dynamics at Dyer Island, and of potential management interventions.

The model aims for a better understanding of the interacting processes and will be used as a tool to advise the fisheries management working groups applying an Ecosystem Approach to Fisheries as well as for the implementation of the African Penguin Biodiversity Management Plan. The model examines possible trends in African penguin population numbers under different climate change scenarios and assists in developing management strategies to increase African penguin breeding numbers and to improve their breeding and foraging habitats.

Linking weather conditions and hatching success in Adélie penguins using dummy eggs recording incubation parameters

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Incubation is a key stage of the avian reproductive cycle, interesting to study since it poses conflicting difficulties for adults in terms of physiology and behaviour. In particular, high rates of heat production require energy, but nest attendance usually prevents animals from foraging to replenish their energy stores. Incubation costs are especially high for species breeding in inhospitable environments such as Polar Regions, as eggs may lose heat more rapidly. Environmental perturbations, such as storms or unusual weather conditions, may induce nest desertion, and potentially slow embryonic development. Penguins, especially the species breeding under severe Antarctic environmental conditions, appear to be an interesting model to study the relationships between weather conditions, incubation behaviour, and hatching success. We used dummy eggs to record incubation temperatures and rotation rates of free-living Adélie penguins. We also monitored nests for laying and hatching dates, number of eggs and chicks. Internal egg temperature was positively correlated with air temperature. Maximum egg temperature, which can be used as a proxy of brood patch temperature, did not change with weather conditions. There was also a positive correlation between the number of days when it snowed and incubation duration, together with a decreased number of hatched eggs during a year with particularly snowy conditions. This study allows a better understanding of the weather conditions that are important for successful incubation in Adélie penguins, in the light of recent climate changes. Indeed, climate models predict overall increases in temperature and also in precipitation over the next decades in Antarctica. Such changes could affect incubation behaviour, decrease breeding success at hatching and/or delay the hatching date in polar seabirds, ultimately decrease individuals' fitness and potentially affect populations.

The importance of resource abundance and alternative prey availability on the reproductive success of an opportunistic top predator

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Diet related breeding failure in seabirds has been attributed to declines in key prey abundance, the quality of prey, and overall prey availability. However, assessing the impact of changes in diet is challenging in marine environments due to the difficulties associated with identifying exactly what aspects of diet are responsible for breeding failure in particular seabirds. In this study, stable isotopes in combination with published concurrent indices of actual resource availability were used to assess the links between prey availability, seabird diet and reproductive success in the little penguin (*Eudyptula minor*), a generalist, inshore top predator. This study found that - contrary to what was expected - the decline of anchovy, a key prey item for this colony, was not solely responsible for the sharp decrease in reproductive success observed in 2010/2011. Low anchovy levels in combination with the scarcity of alternative prey were the most probable cause for poor reproductive performance. Low dietary diversity and the consumption of low trophic value prey were observed during this period. The following year penguins had access to increased levels of anchovy as well as a variety of alternative prey. High dietary diversity and the consumption of high trophic value prey were observed in their pre-breeding and breeding diet and likely led to early breeding, and high reproductive success. Our findings show that the diets of little penguins reflect changes in the abundance and composition of pelagic fish in Port Phillip Bay and demonstrate that resource abundance and the availability of a variety of prey species are critical factors in enabling predators to adapt to changes in environmental conditions and fluctuations in prey.

Emerging geospatial technologies for studying penguin biogeography

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In the last few years, advances in mapping, GIS, camera optics, and satellite technology have driven a proliferation of new geospatial tools. These technological developments are poised to revolutionize penguin research by providing a cost effective means to census, map, and monitor penguin populations on spatial scales that range from individual nest sites to entire continents. In this talk, I will introduce several of these new technologies, with particular focus on the use of high-resolution commercial satellite imagery and 360° camera imagery (Google StreetView), and will present some early results demonstrating how the integration of these emerging technologies allows us to address key questions in penguin biogeography previously considered unanswerable. Several case studies will be presented, including the first site-wide assessment of chinstrap penguin population change at Baily Head, Deception Island; the first complete census of penguins breeding in the South Sandwich Islands; and the first high-resolution global census of Adélie penguins. Future progress in these areas will require a synthesis of biology, computer science, and high performance computing; open areas for development and challenges presented by this 'brave new world' will be discussed.

Seabird Autonomous Monitoring Systems (SAMS) and large-scale monitoring of penguins around the Southern Ocean

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The biology of the Southern Ocean is changing and we need a step-change in the amount of biological data collected to understand the relative threats of climate change, fisheries, human disturbance and disease to animals in the region. While remote and logistically hard to work in, much of the Southern Ocean is visited regularly by tourist and scientific vessels. Opportunistic visits have been used to great effect to monitor large numbers of sites in the Antarctic Site Inventory. Counts, coupled with autonomous data recorders can monitor an area far greater than before and for measuring parameters that have hitherto only been recorded at a few sites, and largely next to scientific bases. Autonomous recording stations have the potential to revolutionise data collection as they are able to collect many of the parameters of breeding that usually require long-term researcher presence in the field. We present a network approach to monitoring colonies around the Southern Ocean, demonstrating (1) a power analysis of the most important sites for data collection, (2) a trial of 32 time-lapse cameras and SAMS around the Scotia arc and (3) an automated analysis of the visual data collected. We present results as to the signature of the different breeding parameters in images and over-winter and (4) How to automate analysis of the data collected to integrate it into a monitoring network that can feed into monitoring and management of the Southern Ocean.

Developing the tools to identify ecologically or biologically significant areas as precursors to the creation of marine protection and reserves of relevance to penguins

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Penguins have been described as sentinels, providing indications of ecosystem status and health. We know the southern ocean is changing and that, not surprisingly, some penguin populations are also. In the Antarctic and Sub-Antarctic the pygoscelids and the aptenodyptids exemplify current winners and losers. For example, at some locations gentoos and kings are showing population increases and range expansion whilst chinstraps, Adélies and emperors are thought to be more vulnerable, at least in the Antarctic Peninsula region. Crested penguins are showing declines across most of their range, with very substantial and concerning declines in some macaroni populations.

That penguin numbers are changing is not in doubt, but the reasons for these changes are less well understood. Here, we review some of the threats to these species and potential conservation initiatives that may help secure their future. We describe details of the potential pressures that may arise from climate change and from fishing, threats variously of local, regional and global concern. Other threats such as disturbance and habitat destruction (coastal development) are unlikely to have major impacts in the Antarctic and Sub-Antarctic, though they are important elsewhere.

In order to protect these sentinels, various international groups have advocated the need to set aside parts of the ocean as protected areas. Here, we review how the designation of marine Important Bird Areas (using the BirdLife criteria and approaches) and Ecologically or Biologically Significant Areas (as defined by the Convention on Biological Diversity) may help, and lead to the designation of Marine Protected Areas. We explore how the designation of MPAs may be undertaken through Marine Spatial Planning (MSP), both within areas of national jurisdiction and on the High Seas, including the development of some critical tools necessary to achieve this.

Vital information needed to help protect penguins through MSP (and development of appropriate at-sea management, including networks of candidate IBAs/EBSAs), is increased understanding of their spatial and temporal use of key habitats. Tracking data has been an effective tool for illustrating this in the past, and will be essential for developing new quantitative assessments in relation to current situations and future changes. However, it needs combining with other information on the marine foodweb and biodiversity so these can be adequately represented in the overall MSP process. We provide examples (including using tracking-based data for pelagic seabirds) to show how this works and could be developed and implemented for penguins in the future.

Towards monitoring global penguin population change

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Monitoring wildlife in the Earth's most rapidly changing ecosystems provides insight into patterns of environmental change, from which to make informed conservation management decisions. Observed and predicted changes in climate, and the expansion of fisheries in Antarctic and sub-Antarctic regions are two causes of concern, which make monitoring of key species in this remote part of the world critical. No inclusive monitoring network yet exists for this region, one of the world's least comprehensively studied and most rapidly changing. We present an index of change in penguin population status across oceanic regions of the southern hemisphere, aggregating data from a wide number of individual monitoring programmes to present an index of regional change in population status. We employ generalised additive modelling and geographically weighted regressions to perform a temporal and spatial analysis of penguin population trends from Antarctica. We show using data from 14 penguin species show an overall average decline in abundance over the last 37 years. Our results also reveal contrasting fortunes for western and eastern penguin populations, which broadly mirror continental scale warming and cooling patterns. Our results suggest growing threats will continue to have unequal impacts on species, requiring regionally tailored management, and supporting the need for further research to evaluate species specific responses to climate change and other threats. Expanded monitoring is required to ensure the best possible evidence base from which to protect penguins in a changing environment. We evaluate how the current limited monitoring network influences our findings, and use this as a means to suggest how monitoring might be most usefully expanded.

Post-fledging dispersal of King Penguins in the South Atlantic

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In December 2007 ten king penguin fledglings were equipped with ARGOS satellite transmitters at both the Falkland Islands and South Georgia to monitor their behaviour after entering the water and foraging at sea for the first time. Both breeding sites differ with respect to climate and location in relation to the Antarctic Polar Front (APF). The Falkland Islands are part of the larger Patagonian Shelf and are located to the north of the APF, whereas South Georgia is surrounded by only a relatively small shelf and located to the south of the APF. Accordingly, the respective climates differ greatly, with the Falkland Islands being cold-temperate and South Georgia sub-polar to polar. No significant differences were found in the birds' behaviour with regard to their origin. Birds from both sites foraged predominately within the Antarctic Polar Frontal Zone. However, three penguins from the Falkland Islands migrated first to the eastern coast of Tierra del Fuego before travelling further south. All other differences observed were minor and assumed to be of individual nature. Eight king penguins could be tracked for periods greater than 120 days; seven of these birds (three from the Falkland Islands and four from South Georgia) migrated into the Pacific, only one bird from the Falkland Islands moved into the Indian Ocean. Accordingly, migratory parameters calculated as well as association with SST, SSH and primary productivity did not reveal any significant differences or preferred migration strategies. The mean transmission period was 106 ± 64 days (range 4 – 261), during which time the birds travelled a total distance of more than 92,000 km (range 404 – 11,712). The mean daily distance covered was 45 ± 24 km (range 0 – 174), the farthest distance travelled from the colony was over 4,800 km. The results obtained indicate that inexperienced king penguins prefer the same foraging areas as adults, who forage in the vicinity of the Antarctic Polar Frontal Zone irrespective of their breeding site and its location in relation to the APF. Some individuals also foraged in mesoscale eddies or proceeded to the marginal ice zone. Human activities in the preferred foraging and migrating areas are rare, especially in winter. However, global warming could result in substantial oceanographic changes in the Southern Ocean, thereby threatening both king penguin adults and juveniles.

Determining the feeding success of king penguins along their foraging paths: a predictive model based on diving behaviour

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In the open ocean, the distribution of prey is highly patchy and varies in spatial and temporal scales. Optimal foraging models predict predators in such complex environments should forage so as to maximize net energy gain. Marine predators such penguins should for instance maximize time spent in a favourable patch. These models have been rarely tested on marine predators due to the difficulty to get information on their feeding success. Nevertheless, recent progress in bio-logging technology allows to get efficient devices which measure feeding events along foraging paths of free-ranging penguins by using GPS or Argos PTT together with a Time-Depth Recorder and an internal feeding recorder. However, the use of feeding recorders is highly constraining and do not allow to monitor a reasonable sample of instrumented individuals.

As a consequence, the 1st objective of this study was to develop a predictive model of the feeding success during a dive and a diving bout of foraging penguins. First, we combined different diving behaviour (i.e. number of wiggles at the bottom, characteristics of the ascent and descent phases: number of steps, transit rates, post-dive duration and maximal depth) in a statistical procedure. We used foraging data obtained from a deep diver and long distance forager, the king penguin *Aptenodytes patagonicus*, at the Crozet archipelago. The model has confirmed the importance of wiggles and transit rates respectively at the dive scale and the dive frequency, wiggles and maximal depth respectively, at the bout scale. Next, this model was used to predict feeding success on a total of 11 trips performed by breeding king penguins during the incubation and brooding period. Overall the salient result can be summarized as following: i- king penguins adopted an area restricted search (ARS) at different scales (3-79km) ii - the majority of feeding events were localized at the Polar Front, where the main prey of king penguin are aggregated in high concentration and iii – the penguins did not always adopt an area restricted search in response to the success feeding. To conclude, this study permits to build a reliable and efficient method which could greatly improve our knowledge on at-sea feeding behavior of penguins. More, this study highlights the need to take account of environmental conditions and the body condition in the understanding of foraging strategies. Finally it pointed out the need to include such proxies of feeding behavior when designing at-sea Important Bird Areas.

Animal-borne camera loggers: Investigation for use in Gentoo penguin foraging ecology

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Miniaturised devices for studying marine vertebrate ecology have been employed for many years. Many of these devices rely on underlying assumptions when making inferences (e.g. prey capture rate, feeding events) from the data. Direct observations, through the use of animal-borne camera loggers, have been limited to larger animals. The aim of this study was to test the effectiveness of miniaturised video cameras, in studying Gentoo penguin (*Pygoscelis papua*) foraging ecology at the Falkland Islands. Specifically, this study trialled video cameras for potential use in future studies, at sites with concurrent dietary investigations using stomach content analysis. We investigated potential duration of cameras, image quality and the possibility of (i) detecting prey capture events (ii) identifying intra/interspecific interactions (iii) identifying potential prey. Cameras were deployed at two sites across the Falklands (Cow Bay, n=6; Bull Roads, n=2). Cameras were attached to the back of the bird anteriorly to the ridge of the thoracic vertebrae. Cameras recorded for 30mins to 3hours. Image quality was clear, and prey capture events, intra/interspecific interactions and potential prey items were identified. These results indicate that, video cameras for the use of studying Gentoo penguin foraging ecology are a viable option. Factors such as light intensity and ocean turbidity may hinder the use of cameras; however, with improvements in technology these concerns may be overcome. It is clear that camera deployments could lead to a better understanding of the trophic ecology and behaviour of penguins.

Twenty-five years of Otago University student research on Yellow-eyed penguins: what do we know; what don't we know?

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Intensive monitoring of yellow-eyed penguins (hoiho) on South Island, NZ began in 1980s. Currently there are ~30 hoiho breeding sites on the Otago coast that are monitored annually, contributing to a database of >4000 breeding observations over the past 28 years. Between 1988-2012 29 student theses have been produced, comprising 10 PhDs, 9 MSc, and 10 others (e.g. BSc Hons). Otago University supervised student projects have constituted the primary source of research outputs on hoiho, considering a range of topics, including taxonomy, breeding ecology, diet, population size and trends, and threats and conservation. Consequently we now have a reasonable understanding of the breeding biology and terrestrial-focussed aspects of hoiho ecology and conservation, but only a limited understanding of marine-based issues.

I will review 25 years of student research, using this research history to explore future research areas. Early work considered implications of breeding habitat loss, including threats from introduced predators, but also applied new techniques for diet sampling to infer patterns of foraging and chick provisioning under environmental variability. Research on the impact and management of terrestrial predators lead to robust management policy with the result that key mainland sites are now virtually without predator impacts. Some research was in response to threats, including disease and increasing human disturbance, as yellow-eyed penguins became a tourist attraction. Other research served to explicitly test management approaches, such as removal of eggs, or the use of vegetation buffers to discourage predators – both discontinued as a result of student research findings. New tools enabled work on foraging ecology, through the deployment of GPS tracking devices and time-depth recorders, expanding our understanding of at-sea behaviour, albeit restricted to the breeding season. Application of genetic analyses uncovered the recent mainland occupation by hoiho following the extinction of a hitherto unknown sister species, and confirmed the separation of mainland and sub-Antarctic populations. The most recent research has utilised the database of breeding records to explore the impacts of environmental variation on breeding productivity over decadal scales, to identify the correlates of lifetime reproductive success, and to assess the possible impacts of all this research.

Future work should apply innovations enabling long-term tracking of penguins at sea to quantify environmental interactions outside the period when breeding birds are predictably present ashore. Deployment of ultra-lightweight GPS devices with extended life and capacity for remote download will make it possible for the first time to track non-breeding birds, including fledglings.



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Poster Abstracts

Comparative brain anatomy of fossil and living *Pygoscelis*

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Anatomical descriptions of penguin brains are scarce in the literature, and fossil brains are even rarer. Brain anatomy of fossil birds can be studied using cranial endocasts that closely reflect the brain anatomy and blood vessels, since the brain is almost completely filling the endocranial cavity. Here, we use CT scans of three specimens, including the holotype of *Pygoscelis calderensis* (SGO-PV 792, SGO-PV 791 and SGO-PV 790) and the three extant species, *P. adeliae*, *P. antarctica*, and *P. papua* to obtain virtual reconstructions and describe the endocranial anatomy. In all species, the olfactory tract is slender and long and anteroventrally projected, although the fossil *Pygoscelis calderensis* shows olfactory tracts relatively longer than the extant species. The olfactory bulbs are oval-shaped and slightly divergent from the midline in *P. calderensis* and *Pygoscelis antarctica*, whereas the bulbs are markedly divergent in *Pygoscelis papua* and *P. adeliae*. Each cerebral hemisphere is markedly expanded laterally occluding the optic lobe in dorsal view, as in most living birds. *P. calderensis* have more pointy lateral margins than the extant species, which have rounded lateral margins. In all species, there is an evident eminentia sagittalis dorsally, which is oval shaped and separated from the rest of the hemispherium by a conspicuous vallecule. The cerebellum and the auricular cerebelli are large, and the pituitary body is small and exhibits an oval shape. Cranial nerve VI has a short passage that runs from the floor of the medulla oblongata to enter the pituitary fossa. The internal carotid arteries also enter the pituitary body through separate foramina. The passages for the arteries diverge from the midline in a wide angle in ventral view of the endocast. The medulla oblongata is elongate and its ventral surface presents a rostro-caudally oriented mark that we interpret as a blood vessel. The inner ear in the living forms has the general avian morphology, with large and slender semicircular canals and a long and slender lagena. The semicircular canals are oval-shaped. The anterior semicircular canal is larger and taller than the posterior semicircular canal. The large and slender canals are related with high manoeuvrability in *Archaeopteryx* and comparatively acrobatic flight in extant birds. The lagena is simple, long and tubular-shaped.

Use and consumption of Humboldt penguin (*Spheniscus humboldti*) at Pampas Gramalote archaeological site, Peru

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The Pampas Gramalote archaeological site is located in the city of Huanchaco, La Libertad Department in Northern Peru. The site (between 1550 and 1250 B.C.) corresponds to the Initial Period and produced, among other, marine bird remains including Humboldt penguin bones that are the base of present contribution. The stratigraphic and chronological information points to three different phases in which the occupation took place. The material discovered in the site is arranged into three different Units (Unit I, II and IV). In these, a total of 193 Humboldt penguin remains were recovered. In Unit I a total of 30 specimens were found, 70% (N=21) concentrated in Phase I, 27% (N= 8) in Phase II and 3% (N= 1) in Phase III. The element found with higher frequency in Phases I and II was the humerus, in Phase I thoracic vertebrae represented 29% (n= 6) of elements; in Phase II the femur and radius comprised 25 % (n= 2) of the elements. In Unit II a total of 95 Humboldt penguin remains were found, with 46% (N= 43) corresponding to Phase I, 48% (N= 45) to Phase II and 6% (N= 6) to Phase III. During Phase I, the most abundant elements were the pedal phalanges with 23% (n= 10). In Phase II the highest percentage corresponded to the humerus with 16% (n= 7). In Phase III the synsacrum was the element with highest frequency (33%, n= 2). In Unit IV only two phases were recognized. Humboldt penguin remains totaled 68. In Phase II remains were 37, from which 19% (n= 7) corresponded to thoracic vertebrae. In Phase III, 30 elements were found, with the humerus and carpometacarpus representing in each case 17% (n= 5) of the penguin remains. A chronological analysis of the material shows an increase in the consumption of Humboldt penguins during Phase II (1450 – 1350 B.C.). During Phase II, 90 elements were found, which corresponded to 47% of the remains found in the site. The present material also shows the presence of juvenile birds. This suggests the possible capture of birds in the islands nearby Huanchaco, such as the Macabi and Guañape islands. The use of Humboldt penguin for consumption is still a common practice by traditional fishermen today, as the meat is used fresh or salted-dried. More information will be acquired as new specimens will be discovered in the study site.

Mortality of Humboldt penguin (*Spheniscus humboldti*) during the years 2011-2012, in the Paracas National Reserve, Peru

Altamirano-Sierra, A. and Reyes, J.

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The Paracas National Reserve is located in the Ica Department in South-Central Peru. In this marine reserve there are colonies of Humboldt penguin breeding in islands and coves along the coast. The status of national reserve allows the development of several economic activities, among them fisheries. During the period 2011-2012 a project was developed to establishing the number of penguins that died in areas where the artesanal fishery activities and Humboldt penguin habitat overlap. During 12 months a total of 34 field trips (two trips per month) were performed. The following localities were inspected for penguin carcasses strandings: Canastones beach, Chucho, Rancherio, La Raya, El Ancla and the Lagunillas Port. Biometric and biological information were taken whenever possible. A total of 325 dead penguin carcasses were found for the whole study period. The localities that recorded the highest percentage of stranding were the Chucho beach with 40% (N= 131), Rancherio with 18% (N= 58), El Ancla with 17% (N= 56) and the Canastones beach with 10% (N= 32). The months with higher number of stranding penguins were September with 224 (69%), October with 52 (16%), May with 8 (2%) and August with 17 (5%) . Biometric data for sex determination could only be taken on 114 penguins; of these, 73 were males, 39 were females and 2 were undetermined. The present data registered the highest mortality for Humboldt penguin in the Paracas National Reserve, as previous opportunistic observations reported much lower numbers. The total number of Humboldt penguins found during the study is approximately similar to the actual penguin colony found in the Tres Puertas cove. A factor that contributes to this mortality is the illegal use of dynamite during fishing activities in the area, but entanglements in fishing gears cannot be ruled out.

Mortality of Humboldt penguins (*Spheniscus humboldti*) during the years 1998-2007, at the Pisco-Paracas area, Peru

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The Humboldt penguin (*Spheniscus humboldti*) is the only spheniscid species that breeds in the coast of Peru. The species has suffered substantial population decline due to several factors (*i.e.* oceanographic anomalies and anthropogenic pressures). During the period 1998 -2007, while carrying out diverse field work in the Pisco-Paracas area, in South-central Peru, opportunistic observations were made on the carcasses of stranded Humboldt penguins. Observations and data recording were done around the marine port of San Andrés (in Pisco), and the ports of Lagunillas, Rancherio, Laguna Grande, Chucho beach, La Raya beach and El Ancla beach in the Paracas National Reserve.

During 34 field trips performed to the study area for the reported period, a total of 400 dead Humboldt penguins were found. The years with higher number of penguins were 2007 and 2001 with 115 and 83 carcasses found, respectively. The highest percentage of Humboldt penguin stranding was recorded at Chucho beach (33 %) and Rancherio beach (30.5%).

Humboldt penguin colonies at Independencia Bay are concentrated in the Tres Puertas cove and also at La Vieja and Santa Rosa islands. The high percentage of penguins carcasses stranded found at Chucho and Rancherio beach are from the colonies at the mentioned localities. The artisanal gillnet fishery operating at Independencia Bay is probably the cause of high mortality of penguins recorded at the Chucho and Rancherio beaches. Other threat that may contribute to the mortality of Humboldt penguins in the area is the use of dynamite, an illegal fishing method known to occur at Chucho beach.

Environmental dynamics and toxokinetics of mercury in wild *Spheniscus* and *Pygoscelys* penguin colonies in Chile and Antarctica

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Mercury is a non-essential metal that bioaccumulates and biomagnifies through food chains. Seabirds, due to their longevity and high trophic level, accumulate high concentrations of mercury in their tissues; therefore, they have been widely used as bioindicators of pollution in different environments and locations. Penguins are seabirds that are distributed exclusively in the southern hemisphere including the coasts of South America, Africa, New Zealand, Australia, sub-antarctic islands and Antarctica. We studied the toxokinetics of mercury in two species of penguins that live in different latitudes with various degrees of anthropogenic pollution: Humboldt penguin (*Spheniscus humboldti*), endemic to the Humboldt Current in the Eastern South Pacific and Chinstrap penguin (*Pygoscelys antarctica*), whose distribution is restricted to Antarctic and sub-Antarctic areas. Additionally we evaluate the relationship between the environmental loads, food sources and metal levels in animals. In the case of Humboldt penguins, samples were collected in three different reproductive colonies in northern and central Chile (Pan de Azúcar Island 26°S, Isla Grande de Atacama 27°S and Pupuya Island 33°S). We obtained blood and feathers samples adult penguins (n=53), fish (*Engraulis ringens*, *Odontesthes bonariensis* and *Sardinops sagax*), water, soil and marine sediments in triplicate from each colony. For Chinstrap penguins we collected samples from three localities in the Antarctic territory (Narevsky, O'Higgins and Shirreff 63°S) and we obtained blood (n=108), feathers (n=11) and feces samples (n=75) from adult individuals. All the analyses were made through atomic absorption spectrophotometry (EAA). Preliminary results in northern Chile (n=39) indicate that Pan de Azúcar penguins (a place with larger anthropogenic pollution) have higher concentration of mercury in blood than Isla Grande de Atacama penguins ($0.8518 \pm 0.09 \mu\text{g/g}^1$ and $0.4490 \pm 0.08 \mu\text{g/g}^1$ respectively) suggesting that in this species blood reflects contamination levels present in foraging areas during the breeding season. Additionally we did not observe significant differences between males ($0.6464 \pm 0.09 \mu\text{g/g}^1$) and females with eggs ($0.6889 \pm 0.12 \mu\text{g/g}^1$), suggesting that maternal transference is not an important route of excretion and probably molt is the major route of elimination of mercury in this species. Currently we continue analyzing biological and environmental matrices in the rest of the locations sampled, both on the coast of Chile and Antarctica. Acknowledgment: FONDECYT No11110060, INACH T_27-10, SeaWorld & Busch Garden Conservation Fund, CONICYT.

Hemoparasite (*Plasmodium spp.*) in *Spheniscus magellanicus*, a case report

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Juveniles' Magellanic penguins, *Spheniscus magellanicus*, follow sea currents in search of food, frequently in Brazilian coastal areas, where they can be seen stranded and quite weak. It is believed that when they reach the coast of Brazil they have low resistance to infection causing a great negative impact which may be exposed to the parasites for the first time. Malaria, a blood protozoan (*Plasmodium spp.*) is responsible for high mortality in captive penguins, becoming an event with relevant epidemiological implications. The present study aimed to report a case of this protozoan in a Magellanic penguin smear. The animal, AVE 1337, was held in the CRETA (Instituto Argonauta para a Conservação Costeira e Marinha) located at Ubatuba city, state of São Paulo (Brazil), since 11.17.2011, when he was found on the Picinguaba beach, Ubatuba- SP. After a complete rehabilitation, he was held in an open enclosure surrounded by galvanized wire mesh laminated, with tiled floors and a saltwater pool. In March 7, 2012, the animal showed inappetence, prostration, food regurgitation, group isolation and intensely pale mucous membranes. These signals had been reported a few days before (March 5, 2012) in another penguin, in the same enclosure, which died within hours of showing these symptoms. A hematological study was held with 1.5 ml blood collection, however, the animal died. The blood was placed in heparin and a blood smear were prepared and stained with Panotico fast. Blood smears were evaluated under an optical microscope in immersion objective (x1000) in which erythrocytes inclusions have been found compatible with *Plasmodium sp.*, being considered a high parasitaemia. The detection of the parasite morphology remains the routine method in rehabilitation centers and although it shows low sensitivity, in this case, it was concluded that this method can be satisfactory in the acute phases where the parasitemia is high. However, in many cases, when the diagnosis is reached, the tissue damage may be severe, preventing therapeutic protocol. It is extremely important to direct further studies towards the avian malaria understanding, since the maintenance of life quality and the pathogens spread control should be priorities for guidelines in meetings about reintroduction, as well as the penguins contact with another birds or wandering residents in captivity distributed by South America, since the agent can be shared between different species of birds without pathogenic potential.

Assessment of Polycyclic Aromatic Hydrocarbons (PAHs) metabolites in Magellanic penguins (*Spheniscus magellanicus*) from the Southeastern Brazilian Coast

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Penguins are vulnerable to marine pollution because they remain long time in contact with water which can be contaminated. Since they do not fly, they have less ability to escape of the presence of contaminants. Migratory routes of Magellanic penguins (*Spheniscus magellanicus*) often coincide with regions of intense maritime traffic. In areas with activities of boats, penguins covered by oil can be found. The goal of the present study was to evaluate the Polycyclic Aromatic Hydrocarbons (PAHs) metabolites in *S. magellanicus* bile from the Southeastern coast of Brazil. The samples were collected during 2006 to 2010 in the north of São Paulo (n=91) and south of Rio de Janeiro (n=18) States (Brazil). The metabolites were analyzed with a high performance liquid chromatography with fluorescence detectors (HPLC/F) and quantified as Naphthalene (NAP), Phenanthrene (PHE) and Benzo[a]pyrene (BaP) equivalents. The concentrations of those metabolites ranged, respectively, from 1.84 to 530 ng g⁻¹ of bile; <LQM to 15.2 ng g⁻¹ of bile; and <LQM to 2.05 ng g⁻¹ of bile. The majority of the samples have presented lower levels than those found in fishes bile sampled on contaminated areas of the Brazilian coast. Although the metabolic rate in birds is higher than in fishes, the time of uptake and the amount of PAHs ingestion should be either considered. The presence of PAHs metabolites showed that those compounds are bioavailable in the marine environment along penguins' migration pathway.

First hemogram during *Spheniscus magellanicus* rehabilitation program

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The presence of Magellanic penguins (*Spheniscus magellanicus*) on Brazilian southern and southeastern beaches is a natural phenomenon that normally occurs in the winter months. Several hypotheses have arisen to increase the appearance of penguins in the Brazilian region and, based on them, it is believed that during migration these birds can suffer numerous stress situations such as abrupt climatic changes, starvation, parasites infestation which the specie does not created a natural defense, physical harm, human activity, pollution, predation or disease. Due to these various conditions, many of these animals arrived dehydrated, hypothermic, with trauma lesions and covered in oil until they are sent to rehabilitation centers. Hemograms were made with 56 Magellanic penguin, that had arrived at Creta (Marine animals' rehabilitation center) located at Ubatuba, state of São Paulo (Brazil), in 2012, during June to September. Most of Them (81%) did not survive. The blood was collect as soon as the animals arrive in the center. The samples were placed in heparin and analyzed within 24 hours. The hematological numbers are: RBC ($10^6/\mu\text{L}$) 1.4 (0.2 - 3.12), PCV % 30.2 (8 - 53), Hb (g/dL) 10.2 (2.6 - 25), MCV 253.6 (90 - 475), WBC ($10^3/\mu\text{L}$) 6.6 (0.5 - 25), Heterophils 76 (34 - 93), Monocytes 11 (0 - 46), Lymphocytes 9.2 (0 - 28), Eosinophils 3 (0 - 20), Basophils 0 (0 - 2). The weight ranged from 1.02 to 4.08Kg (mean 2.29kg). The temperature ranged from 33.2 to 41.5°C (mean 37.6°C). The clinical history was generally characterized by animals that remained in sternal recumbency, pale mucous membranes, dark brown/green liquid feces and with evident sternal bone. The hematological findings such as anemia and leukopenia confirmed the suspicion that most animals were weakened by lack of food and the great migration effort. There were no cases of hemoparasites. Studies on hematology in Magellan penguins Contribute to a better understanding for the penguin rehabilitation program in the South America.

Persistent organic pollutants in juvenile Magellanic penguins (*Spheniscus magellanicus*) in Chile: preliminary results

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Persistent organic pollutants (POPs) remain in the environment for a long time and are spread to long distances. The Magellanic penguin, *Spheniscus magellanicus*, is the most abundant of the penguins that live in temperate regions of the western South Atlantic. Its breeding season runs from October to March, when it feeds off the coast of Argentina and southern Chile. They are considered sentinels of the marine environment, due its wide distribution in the region of western South Atlantic and eastern Pacific Ocean. In the present study, persistent organic pollutants (POPs) were determined in 04 livers from Magellanic penguins, *Spheniscus magellanicus*, found on Concepción and Punta Arenas, Chile, during 2011. The following concentrations of POPs (wet weight) were found: Σ PCBs: < L.Q.M. to 352 ng g⁻¹; Σ DDTs: 2.3 to 99.7 ng g⁻¹; and Σ HCHs: 4.0 to 18.5 ng g⁻¹, HCB 2.0 to 10.5 ng g⁻¹. Among the PCBs, there was a predominance of hexachlorobiphenyls (138 and 153) and heptachlorobiphenyls (187). Among the organochlorine pesticides, DDT predominated, mainly in the *p,p'*-DDE form. The maximum concentrations of POPs found in the specimens of *S. magellanicus* reached levels very similar to those found in Brazilian region. Although preliminary results indicated the presence of POPs in *S. magellanicus*, further studies are needed to elucidate mechanisms and potential impacts.

An Isolated Case of Beak Injury in a Female African Penguin (*Spheniscus demersus*) at The Scientific Center, State of Kuwait

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The Scientific Center

Penguin exhibits are becoming increasingly popular in zoos and bird parks, and the Scientific Center Kuwait is amongst the zoos that keep penguins. Sustaining the bird's survivability in captivity was challenging, a challenge we had encountered when Lulu, one of the female penguins got beak injury from unknown reason. There is a lack of documented information regarding beak injuries on penguins especially in captivity though bill aberrations have been reported on wild Emperor Penguins (*Aptenodytes forsteri*). Beak abnormalities are mainly caused by diet, disease, parasites and exposure to pollutants. This poster presents an isolated case of beak injury in an African Penguin (*Spheniscus demersus*) as well as the medical and non medical response taken by the center's staff. Lulu was noticed to have lost interest in any activity, isolated herself from the group and lost weight. Thus Lulu was subcutaneously injected with 0.25cc Ivermectin and performed oral treatment of 10mg/kg Itraconazole (Sporanox) twice a day, for one week. Thereafter, the dose was reduced to 10mg/kg once a day for another week. Hematological test to rule out aspergillosis was not performed due to lack of diagnostic laboratory in Kuwait. However, fecal samples and bacterial culture were performed which only resulted to a few ova and normal flora of common microorganisms. A month after, changes in beak appearance started to manifest. Lulu's maxillary damage was so severe that the beak turned into a grotesquely disfigured beak lesion, which further caused substantial unnatural overgrowth of tissue, forming a ball-like tissue mass. Tissue culture and biopsy were performed to rule out tumor or another disease, which might have caused the beak's condition. Result showed negative. For a month, Lulu was orally administered with 3.75mg Meloxicam (Mobic) a nonsteroidal anti-inflammatory drug with analgesic and fever reducer effects. At the same time, she was force-fed once daily with 300 g of sardines with multivitamins (Mazuri Brand), and cleansed the exposed tissue with 0.75% providine iodine and fucidin ointment. Lulu was isolated from the group and abstained from swimming. She was returned back to the exhibit after some time when her beak gradually improved and she managed to grab and hold the fish without help. Treatment, recovery and rehabilitation took almost a year. The beak injury of Lulu is still a perplexing issue. Until now the query on the cause of the beak injury remains unanswered. Proper documentation of the case will provide baseline information to have a better understanding and knowledge on beak injury care and management.

It is a neighbourly thing: at-sea associations in foraging in little penguins

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Benefits of colonial breeding in birds include reduction in thermoregulation costs, defense from predation, assessment/selection of mates at the time of mate choice, sharing of parental care or transfer of information about foraging sites/opportunities. Seabirds are ubiquitous colonial breeders and it has been suggested that benefits for foraging decisions can be obtained from group hunting and/or identifying profitable areas (Information Centre Hypothesis). Local enhancement or social facilitation, where conspecifics provide information about the position of food, is widespread among a variety of bird species. Prey distribution, patch size, and the presence of conspecifics are important factors influencing a predator's feeding tactics, including the decision to feed individually or socially. However little is known about synchronizing activities with other group members in marine birds as they spend most of their lives at-sea where it is difficult to obtain information about their foraging behaviour. In this study we report on little penguins travelling and diving in close proximity during the breeding season. These individuals also belonged to nests close together in the same area. Further research is necessary to evaluate if this is cooperative hunting behaviour or if individuals are able to locate food by following knowledgeable conspecifics to food sources.

Unusual high frequency of Aspergillosis on wild Magellanic Penguin (*Spheniscus magellanicus*) in southern Chile

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Aspergillosis is a common disease of captive penguins at zoos and rehabilitation centers. Necropsies show that Aspergillosis is the main cause of death for captive Magellanic penguins (*Spheniscus magellanicus*) but the frequency of Aspergillosis on wild penguins is unknown.

From December 2010 to March 2011 and October 2011 to February 2012, we determined the cause of death of Magellanic penguins on Magdalena Island (52°55'S; 70°34'W) located in the Magellan Strait, Chile. We found that 14% of the penguins (8 chicks and 1 adult) had macroscopic lesions indicative of Aspergillosis (N=65, 44 chicks and 21 adults). For diagnosis we used exudative or caseous secretion in the trachea, air sacs thickened and/or with caseous secretion and multiple granulomatous nodules in lungs. These 9 penguins presented two or more of these lesions. Histopathological examination in the air sacs and lungs using haematoxylin-eosin stain results were consistent with Aspergillosis. Eight of the 65 dead penguins had lung granulomas and five of the 9 penguins with the macroscopic lesions have fungal structures. Out of the 9 penguins that had Aspergillosis, 8 were in poor body condition, as evidenced by their light weight, small pectoral muscle bulk and lack of subcutaneous fat. The Aspergillosis infection may benefit from nutritional deficiency and a depressed immune system. Two chicks of these 9 penguins had multiple proliferative cutaneous nodular lesions too and we suspected they had Avian Pox Virus. We confirmed the diagnosis with a histopathological examination from skin sample showing intracitoplasmic inclusion bodies and globous and degeneration of keratinocytes. This disease affects individuals with depressed immune systems and there are no previous reports of wild penguins affected by both diseases simultaneously. Aspergillosis frequency at Magdalena Island is higher than the 3,3% to 4,1% reported for dead Blue Penguin (*Eudyptula minor*) in the wild. At Magdalena Island penguins nest in very deep humid burrows that may facilitate the development of fungal infections when penguins have nutritional deficiencies and the immune response is vulnerable.

Mercury levels in feathers of Magellanic penguins

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The ocean plays an important role in the global cycle of mercury (Hg). As top predators, seabirds integrate exposure to contaminants over large geographic areas. To interpret what accumulated Hg levels mean, requires understanding life history, diet, foraging habitat, and the concentration in other biomarkers or abiotic substrates. Hg causes a wide range of effects on reproduction, including low egg weight, thinner shell, malformations of the embryo, decreased growth, and decreased chick survival. Feathers are useful to determine mercury (Hg) contamination. We evaluated the mercury concentration in feathers of 79 Magellanic penguins (*Spheniscus magellanicus*) age 1.5 years to 25 years at Punta Tombo, Argentina before and during their molt. Mercury ranged between <1.4 and 367 ng/g dry weight, with three extreme high values (8,996 ng/g, 3,011 ng/g and 1,340 ng/g) all in young adults. Juveniles at the molt were about 1.5 years of age and had significantly lower Hg levels (52 ng/g, n=37) than those of young adults (2 to 4 years old, 77.2 ng/g, n=18). Juveniles had also lower Hg levels than older breeding adults (14 to older than 25 years of age, 194 ng/g, n=21). Males and females had similar mercury loads, although in adult males the range was significantly greater than in adult females. In general, pelagic seabirds can have higher levels of mercury than shorebirds, if they feed on mesopelagic preys, because of the greater bioavailability of organic Hg. Magellanic penguins feed on pelagic prey and in Argentina their diet is mainly piscivorous and on the Brazilian coast mainly cephalopods. Anchovy and hake in the Argentine Sea yielded detectable Hg levels while cephalopods easily incorporate Hg which is transferred to their predators. Differences in diet may explain the variation in Hg concentrations among similar aged penguins. Higher variability in Hg concentrations for adult males compared to females could be a result of physiological differences. Female egg laying, for example, may allow excretion of Hg, so that males would have more Hg than females. Compared with other penguin species, Hg concentrations in Magellanic penguins were low. We found mercury levels for Magellanic penguins older than 4 years of age in the Southwest Atlantic averaged 206 ± 98 ng/g, and this value is useful as a baseline for biomonitoring and / or ecotoxicological studies.

Strong winds kill Magellanic penguins in Magdalena Island, Chile

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One of the predictions of climate variability is the increase in the frequency and intensity of wind and rain storms in particular regions. The rain storms can be an important cause of egg and chick mortality. During December of 2010 to March of 2011 we determined the cause of death for penguins on Magdalena Island (52°55'S; 70°34'O), located in the Magellan Strait, Chile. The main causes of chick death were starvation, predation, disease and storms but what was surprising was that most adults died from wind storms that buried them alive. Most adult mortality on land was from winds buried adults in their nest. We found 38 dead penguins in their nesting burrow. Of the penguins found dead, 76% were adults (45% males, 26% females, 0,5% unknown) and 24% were chicks. In six nests (N=28), both the adult and the chick were dead (21%). In another nest the adult was dead and it was incubating an egg and another adult was with a dying chick. From October 2011 to February of 2012 we checked a 4 ha plot when winds were more than 80km/h. The winds killed 5 adult penguins and killed another adult incubating 2 eggs. The strong winds in the areas without vegetation caused erosion and rapidly filled burrows with dirt and sand so penguins could not escape and died. Strong winds during the breeding season represent an important source of adult penguins mortality on Magdalena Island. An increase in wind strength in this currently windy region is likely another negative effect of climate variability in the survival of penguins.

Environmental determinants of genetic structure in Magellanic Penguin breeding colonies of the Atlantic and Pacific Oceans

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The characterization of demographically independent and genetically differentiated penguin populations is essential to preserve genetic resources and identify potential units of conservation. Using mtDNA Cytochrome Oxidase I (COI) and nuclear Major Histocompatibility Complex (MHC) class II genetic markers, we assessed levels of genetic diversity and genetic structuring of Magellanic penguin (*Spheniscus magellanicus*) colonies located at the northern range of the species' distribution in the Atlantic and Pacific Oceans. Genetic analysis of 128 individuals from 7 breeding colonies revealed 30 COI haplotypes and 56 MHC Class II alleles. Analyses of Molecular Variance revealed that 23% and 22% of the observed variation in mtDNA and MHC markers, respectively, can be explained by differences among colonies between ocean basins ($P < 0.001$). In contrast, no significant differences were detected among colonies within ocean basins, even between colonies that were separated by more than 1000 km. Breeding colonies at the edge of the northern distribution range in the Atlantic and Pacific oceans showed a considerable number of unique COI haplotypes (10-12) and MHC alleles (14-24), likely the result of long term demographic isolation driven by the separation of the ocean basins. The COI typing of the Punta Arenas breeding colony, at the southern tip of the continent, revealed no significant differences with all three colonies from the northern Pacific range, suggesting that this colony is part of the Pacific population system. The MHC typing of Punta Arenas, however, showed genetic similarity to breeding colonies from the Atlantic Ocean basin, suggesting that these colonies may be exposed to similar pathogen pressures. Our results suggest that the regional genetic structuring of Magellanic Penguin populations is driven by oceanographic differences between ocean basins and distinct pathogen pressures.

Penguin feathers as a predictive tool for assessing mercury concentrations in marine food webs throughout the Southern Hemisphere

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The wide geographic distribution of penguins throughout the Southern Hemisphere provides an opportunity to expand our understanding of large-scale patterns of mercury in marine food webs using a single taxonomic group. As highly specialized marine predators nesting in large, readily accessible colonies, penguins may serve as model species for studying mercury contamination in marine ecosystems. The goal of this study was to document mercury exposure in penguins in four distinct marine ecosystems: the Southern, south Pacific, southeastern Atlantic, and southwestern Atlantic Oceans. We tested the hypothesis that risk of exposure to mercury in Antarctic penguins, foraging in an ostensibly remote food web, would be lower than in species found at lower latitudes in closer proximity to anthropogenic sources of mercury pollution. Adult body feathers were collected from eight species of penguins (*Pygoscelis adeliae*, *P. papua*, *P. antarctica*, *Aptenodytes patagonicus*, *Eudyptes chrysocome*, *Spheniscus magellanicus*, *S. demersus*, and *Eudyptula minor*) between 2009 and 2012; all feathers were individually analyzed for total mercury. Significant differences were detected among species ($F_{6,149}=281.5$, $p<0.001$); the three species of *Pygoscelis* penguins had the lowest mercury concentrations while *E. chrysocome* had the highest. With the exception of *E. chrysocome*, mercury concentrations in all species fell below reported adverse effects levels. Ultimately our hypothesis was not completely supported as species such as *S. demersus* and *E. minor*, which forage near areas with dense human populations, had lower mercury concentrations than species living in considerably more remote regions. Trophic position, foraging habitat (epipelagic vs. mesopelagic), and proximity of the nesting colonies and feeding grounds to possible anthropogenic and natural sources of mercury are currently being investigated in an effort to explain the disparities in mercury concentrations among species and geographic regions.

Effects of nest site quality on Humboldt penguins' breeding success

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Guano extraction has always been considered a major threat to populations of Humboldt penguins (*Spheniscus humboldti*) in Peru. Guano mining leaves penguins without the main substrate they use to excavate their burrows, which is their main historical nest type and the one that is thought to lead to better success rates than other nest types. This project attempts to measure the effect of nest and environmental characteristics on breeding success in this species' main breeding habitats and nest types including guano deposits, crevices and sea caves (most available and very common breeding site), and artificial nests present inside a natural reserve. During this period a regulated guano harvest took place and its impacts on the penguin population were also measured.

Guano harvest protocols that work: Protecting Peru's largest colony of Humboldt penguins *in situ*

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Humboldt penguins have undergone extreme population size fluctuations and have an overall decreasing population trend making them currently listed as Vulnerable by IUCN. Although legally protected on the coasts of Peru and Chile, they have faced severe population declines since the 19th century and marked reductions after strong El Niño events. Punta San Juan (PSJ) is the largest breeding site for this species in Peru and an important breeding colony amongst its range. On Peruvian islands and peninsulas penguins nest along side of guano birds (cormorants, pelicans and boobies that produce guano). Guano has been a valued resource in Peru since late 1800s, and guano harvests have been taking place since then in close proximity to penguin nesting sites, becoming an important threat to local populations. Since 2001, guano harvests at PSJ are closely coordinated with the government officials in charge of extraction and include observers *in situ* in aims to protect the largest colony of Humboldt penguins in Peru and extend recommendations on harvests elsewhere. In 2012, 5,000 tons of guano were extracted from PSJ during the months of August-October, when penguins were preparing for their second breeding peak. To protect penguins from negative impacts of the harvest –which includes >100 men shoveling and bagging guano– protocols included a *penguin blind* which consisted of a 80 x 6 foot fabric shield placed between the extraction area and penguin colonies, coupled with a daily monitoring system to collect information and mitigate impacts (disturbance events) of harvest activities. Data pooled by volunteers show that 25% (n=13) of all disturbance events (n=52) affected penguins. 59% of disturbance events recorded affected >50% of the colony and were caused by guano workers (40%), followed by the guano truck (40%), volunteers (10%) and natural causes (10%). 24% of all events impacted >50% of the colony and were caused by guano workers (25%), natural causes (25%) and overflying airplanes (25%). Finally, 18% of all disturbance events impacted 50% of the colony and were caused by guano workers (67%), and volunteer observers (33%). In sum, although the most common cause of disturbance events were guano workers, the number of these events (n=7) is low. Also, we recommend the use of fixed structures (*i.e.* blinds) as a form to mitigate the impact of guano workers at other sites along the coast of Peru where future guano harvests will take place.

Penguin Plunge: a shift in design and management of penguins in Calgary Zoo

Dr Malu Celli & Dr Jake Veasey

Calgary Zoological Society

In early 2012 Calgary Zoo opened Penguin Plunge, part of a \$24 million complex. The facility was designed to house 80 birds of 4 different species (Humboldts, Rockhoppers, Gentoos and Kings) and originally modelled after a North American facility that offers a close visitor/bird interaction. Partway through construction, our animal care team came under new management and pushed the limits of the design and fixed budget to significantly increase in the footprint of the indoor and outdoor enclosures and pools and change the form and function of these spaces.

Our aim to achieve best practice in penguin care, with an emphasis on a more holistic ethological approach as opposed to a reactive medical management, has also been reflected in the daily husbandry practices and philosophy behind the management of feeding, substrate, training, rearing, enrichment, etc.

One year on, we would like to discuss the remaining constraints of the original design as well as the success of the revised design, the impact it had on zoo visitation and the events that marked the first year of Penguin Plunge. This would be a great opportunity to share practices and discuss perceived differences in penguin management across zoos in different parts of the world.

Working unsociable hours: the effect of fine time scale nightly colony attendance on the reproductive success of little penguins (*Eudyptula minor*)

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A central theme of life history theory is that allocating resources to one trait reduces the amount of resources that can be allocated to another. Therefore when resources are limited, organisms must prioritise their allocation of resources resulting in trade-offs between certain fitness-related traits. An important trade-off for central-place foraging seabirds, involves making either single or multiple day foraging trips, with longer trips beneficial for adults and shorter trips beneficial for their offspring. Few studies, if any, have investigated whether this trade-off also operates at a smaller scale i.e. within each day. Here we determined whether the fine scale colony attendance, measured in hours, of little penguins (*Eudyptula minor*) affects their reproductive output using continuous data from an automated monitoring system over nine years. During the post-guard stage of breeding, little penguins exhibited a trade-off between colony attendance and reproductive output at the scale of hours within each day. Penguins allocating less time attending the colony had higher reproductive success, most likely due to maximised foraging time. The duration of colony attendance explained the variability in chick linear growth rate and overall breeding success but did not significantly affect chick peak mass. Age played a crucial role; older penguins spent the least time attending their colony. Allocating less time attending the colony may be detrimental to adult condition and survival, therefore this risky strategy may suit older penguins with a reduced potential for future reproduction.

Changes in the foraging effort of individual Little penguins whose diving activities were monitored throughout the breeding season

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The diving activity of seabirds is usually monitored by equipping birds during one or a few consecutive trips at sea to limit the disturbance but also due to battery life and/or memory limitations of small data loggers. The assumption is then made that the data collected are representative of the whole breeding stage and that the effort of each individual is consistent through time. The aim of our study was to measure continuous diving effort throughout most of the breeding season to test if these assumptions were correct. We monitored the foraging activity of 10 individual male Little Penguins during four successive deployments of small time-depth recorders starting at the incubation stage up to the post guard stage. In addition we collected blood samples every 3 weeks to have information on their diet as inferred by the stable isotope ratios of Nitrogen and Carbon. We found that the diving effort of Little penguins decreased towards the end of incubation, reaching a minimum value around chick hatching, and then increased substantially during chick rearing to values higher than initially recorded at incubation. Birds modulated their diving effort by changing the number of dives performed each day and by changing the time spent at the bottom of the dive where most of their prey are encountered. Penguins also showed individual differences in their diving behaviour or in their diet, suggesting that they may have different foraging strategies. The unexpected u-shape trend of diving effort over time could be explained by penguins recovering from long fasting periods in incubation and by an increase in chick demand during chick rearing. The continuous recording of diving activities revealed that diving behaviour changes within stage, suggesting that assumptions on one foraging trip only may not be representative of the entire breeding stage.

First attendance and breeding of young Little penguins

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We examined the pattern of attendance of first time young Little penguins come ashore. Using an automated monitoring system over 10 years, we were interested at which age young penguins are first detected in the colony, b) if they have the same pattern of attendance of adults c) whether they breed in the year of first arrival or they learn the ropes and then breed a year after and d) does chicks' early stage of life quality (before fledging) determines their arrival as young adults. This paper will reveal some interesting facts of very early life of Little penguins.

(Please note this is an honours thesis in progress so the abstract still preliminary. We shall send final version by mid-April when this study concludes). Thanks for your patience!

Mate Choice in Mixed-clade Colonies of Little Blue Penguins

J. Alan Clark, Jonathan C. Banks, Abbie Mason, Rebecca Gamboa, Philippa Agnew, Megan Henriquez, Melissa Meadows, Joseph R. Waas

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The Little Blue Penguin (*Eudyptula minor*) can be divided into two deeply divergent clades: the Australia and southeast New Zealand clade and the New Zealand only clade. Individuals of both clades can be found in colonies on the east and southeast coast of New Zealand's South Island. Given the deep genetic divergence within this species, we wished to explore mate choice in mixed-clade colonies to determine whether mating between clade members was random or whether individuals showed patterns of assortative or disassortative mating. However, clade membership in Little Blue Penguins is cryptic and can be determined only through molecular methods. In addition, Little Blue Penguins cannot be definitively sexed through visual inspection or morphological measurements. Consequently, genetic methods are required to explore mate choice in this species. To acquire DNA without collecting blood, we focused on extracting the small amount of DNA often found on feathers. We removed 2-3 feathers from from 100 pairs associating together just prior to the breeding season at two mixed-clade colonies in Oamaru, New Zealand. We developed a reliable method to extract DNA from feathers using a modified, commercially available DNA extraction kit. To sex individuals, we applied several primers previously used on other penguin species. To determine clade membership, we developed an economical alternative method to sequencing using restriction fragment length polymorphism. Because genetic testing is not always feasible, we also collected and analyzed morphometric data to compare to our genetic data. In addition to measuring bill depth, bill length, foot length, head length, and flipper length, we also assessed flipper color patterns and feather color. We used these data to evaluate mate choice. While our sample of mixed-clade pairs was small, we found no evidence of assortative or disassortative mating between clade members. The methods we developed to extract feather-based DNA, sex individuals, and assign clade membership should be of value to future research on Little Blue Penguins.

Captive Management of Little Blue Penguins during the Rena Oil Spill 2011, New Zealand

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In 2011 New Zealand suffered its worst environmental disaster to date. On October 5 the C/V Rena ran aground on the Astrolabe Reef, Tauranga and consequently split over 350 tonnes of heavy fuel oil. Coastal wildlife was significantly impacted by the spill and an oiled wildlife response was mounted, involving the capture, washing and rehabilitation of oiled birds. The little blue penguin, *Eudyptula minor*, is found commonly around the coast of New Zealand and Southern Australia. It was the most commonly affected species found alive during the Rena oil spill incident with 383 individuals admitted with varying degrees of oiling.

The care and management of these birds was fluid and evolving throughout the spill response.

Previous experience with little blue penguins in captivity shows that pododermatitis and aspergilosis were the two most likely problems to occur. Where possible, prevention is preferable to treatment.

Itraconazole was used prophylactically at 5mg/kg once a day, given orally to all penguins throughout the spill. There were no confirmed cases of aspergilosis seen in penguins throughout the spill, although other species died with this disease. Different materials were used to prevent pododermatitis in the various housing stages, some more effective than others; however the best preventative measure was enforcing longer swim times as this reduced or prevented pododermatitis.

As the little blue penguin is a social species, large groups could be housed together in specially built outdoor aviaries. This was only possible when the penguins had gained their waterproofing.

The peak egg laying time for the little blue penguin is September to November with chicks taking 8 weeks to fledge. The spill coincided with egg laying and chick-raising and hard decisions were made regarding the practicality and probability of successfully hand-raising and releasing chicks during this time. Previous experience suggested that hand raising little blue penguin chicks has minimal success in producing individuals fit for wild release due to imprinting. Therefore, a collective decision was made to euthanize any chicks brought into the Oiled Wildlife Facility. Of the 383 live oiled penguins rescued during the spill, 365 were later released (95%). The penguins were micro-chipped, along with a control group, and post release monitoring will be carried out to investigate the breeding and survival success rates over the following 16 months.

Foraging ecology of southern rockhopper penguins breeding at Steeple Jason and Beauchêne Islands, Falklands

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Steeple Jason and Beauchêne are the largest breeding sites for the southern rockhopper penguin (*Eudyptes c. chrysocome*) at the Falkland Islands. Combined, they account for 71 % of the southern rockhopper penguin breeding pairs at the Falkland Islands or approximately 26 % of the global population. Steeple Jason is located to the far northwest of the archipelago, some 400 km from the nearest region of continental shelf-break. Conversely, Beauchêne is the most southerly Falkland landmass and adjacent to the continental shelf-break. The distance between Steeple Jason and Beauchêne and differences in their proximity to the continental shelf-break, suggests that the foraging behaviour and diet of rockhopper penguins will differ at these two important breeding sites.

To test this hypothesis, we concomitantly deployed GPS TDlogs on breeding southern rockhopper penguins at Steeple Jason and Beauchêne and investigated components of diet.

During the incubation period adult males from Steeple Jason exclusively foraged on the Patagonian Shelf. Conversely, adult males from Beauchêne foraged to the south, including the region of the Burdwood Bank, with the majority of time spent off the continental shelf. During early-chick rearing, adult females foraged on average 30 – 40 km from the colony. Females from Beauchêne spent more time on foraging trips and had longer and deeper dives than Steeple Jason females. Diet composition at Beauchêne Island during the brood period was dominated by crustacean, whereas diet at Steeple Jason had higher proportions of fish.

This study provides new data and ultimately may recommend developing separate management units specific to each site.

Recent census reveals an increasing trend in the number of southern rockhopper penguins (*eudyptes c. Chrysocome*) breeding at the Falkland Islands

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The Falkland Islands currently support one of the highest numbers of Southern Rockhopper Penguins (*Eudyptes c. chrysocome*). A recent archipelago-wide census in 2005 revealed that Southern Rockhopper Penguins had declined by 90,000 breeding pairs in the five year period between 2000 and 2005. To assess whether the number of Southern Rockhopper Penguins breeding at the Falkland Islands have continued to decline, we conducted an archipelago-wide census in 2010.

We report a conservative estimate of 319,000 \pm SD 25,000 breeding pairs at the Falkland Islands in 2010. This represents a 51 % increase when compared with the number counted in 2005. To evaluate whether demographic rates between 2005 and 2010 could account for the increase in breeding pairs, we ran a simple stochastic population model. The population model predicted a 53 % increase in the number of breeding pairs over a five year period (322,712 \pm SD 26,096). The increase in the number of breeding pairs was therefore probably attributed to improved vital rates in the period between the 2005 and 2010 archipelago-wide censuses.

Based on the 2010 Falkland Islands estimate, the global population of the subspecies *E. c. chrysocome* is now closer to 870,000 breeding pairs of which the Falkland Islands accounts for approximately 36 %, the second largest proportion of breeding pairs after Chile. We conclude that despite fluctuations, the number of Southern Rockhopper Penguin breeding pairs at the Falkland Islands has increased over the last 15 years.

Persistent organic pollutants (POPs) and polycyclic aromatic hydrocarbons (PAHs) in three species of penguins (*Pygoscelis antarctica*, *Pygoscelis adeliae* and *Pygoscelis papua*) from Admiralty Bay, King George Island, Antarctica

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Although Antarctica is a remote and inhospitable region, it is not free from the input of anthropic compounds, such as persistent organic pollutants (POPs) that include organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs). Organochlorine pesticides and PCBs are persistent and toxic compounds that can be distributed worldwide via ocean currents and atmospheric transport, and can be bioaccumulated and biomagnified in the food web. PAHs have different sources to marine environments including atmospheric deposition, river runoff, domestic and industrial outfalls and the direct spillage of petroleum and derivatives. This study aims to verify the occurrence of POPs and PAHs in 14 fat samples of three species of penguins: *Pygoscelis adelia* (n=7), *Pygoscelis antarctica* (n=5) and *Pygoscelis papua* (n=2), from Admiralty Bay, King George Island, Antarctica. The POPs and PAHs were Soxhlet extracted with organic solvents and the extract was purified with silica and alumina chromatographic column. The lipids were further removed by high-performance liquid chromatography (HPLC). PCBs and PAHs were quantitatively analyzed by a gas chromatograph with mass spectrometer (GC/MS) and OCPs were identified and quantified by a gas chromatograph equipped with electron capture detector (GC-ECD). The fat samples of penguins *P. Adelia*, *P. antarctica* and *P. papua* presented the following concentrations range in ng g⁻¹ wet weight, respectively: 84.0 to 202.60.1 to 258 and 198 to 239 for PAHs and <1.36 to 32.3, <1.36 to 2.34 and 1.78 to 10.2 for PCBs. The pesticide concentrations ranged respectively from 24.0 to 49.1, 10.30 to 132 and <0.19 to 62.1 for hexachlorocyclohexane (HCHs), <0.30 to 26.3, <0.30 to 34.3 and <0.30 to 9.34 for hexachlorobenzene (HCB) and 6.00 to 53.9, 15.9 to 67.4 and <0.22 to 60.5 for cyclodienes. The concentrations of the majority of the compounds were similar among the three species of penguins that are more restricted to the Antarctic region and feed primarily on krill and fish. Transport, oil storage, and use of fossil fuel are the major sources of PAHs to the Antarctic environment. Predominance of alkylated PAHs related to parent compounds is considered as evidence of petroleum derivative contribution. Although the amounts of POPs are lower than other birds that have migratory habits or different feeding, their detection is an evidence of global dispersion of those compounds.

Predicting the onset of breeding and moulting in Little Penguins from ocean temperatures

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Ocean temperature has been shown to be related to various demographic parameters, including the timing and success of breeding, in a number of seabird species. However, the influence of sea temperatures on the timing of moult of seabirds is rarely considered and yet it is a critical stage in the annual cycle of some seabirds, particularly penguins. Here we consider the influence of ocean temperatures on the timing of both breeding and moult and the interactions between them. Using a 40-year life-history dataset of Little Penguins in south-eastern Australia, we examined the timing of breeding (mean laying date) and the timing of moult (mean moulting date) with seasonal sea-surface temperatures (SSTs) in north-central Bass Strait.

Mean laying dates and mean moulting dates (both the moult before breeding and after) were not correlated. Egg-laying date was correlated with SST in the first three months of the year prior to breeding. SST explained 53% of the variance in mean laying date. This model predicted an early egg-laying date, higher average chick mass at fledging and a higher number of chicks produced per breeding pair when autumn SSTs in Bass Strait are warmer. Mean moulting dates were associated with ocean temperatures in spring prior to moult (February –April). When ocean temperatures were warmer in the spring before moult, mean moulting date was earlier.

As Bass Strait warms, both breeding and moult will be earlier.

GENETIC VARIABILITY OF HUMBOLDT AND MAGELLANIC PENGUINS POPULATIONS AT SOUTH AMERICAN

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The South American have 3 penguins species, *Spheniscus magellanicus*, *Spheniscus humboldti* and *Eudyptes chrysocpmes*. The two species more abundant are *Spheniscus magellanicus* and *Spheniscus humboldti*. The Humboldt penguins are considerate extremely endangered and included in CITES I, another way the Magellanic penguin are abundant species despite of some colonies showed reduced in its population size. There is great discussion about global warming and its effects on fauna and flora around the world. The penguins depend on relatively stable oceanographic and climate environments; they are considered as sentinels of the ocean due to their sensitivity to environmental changes. This work searches to recuperate the evolutionary history of the Magellanic penguin (*Spheniscus magellanicus*) and the Humboldt penguin (*Spheniscus Humboldt*) at South American continent, using a DNA approach to determine the potential relationship between their genetic variability and climate change. The D-loop region from mitochondrial (mt) DNA was sequenced and 18 loci of microsatellites were genotype in 375 individual from individual Magellanic penguins and 290 individual Humboldt penguins. As a result both penguin species showed high genetic diversity, suggesting a large population size. In addition, this study allowed estimated the migration of individuals among colonies, revealed high migration rates and low population structure, that is extremely important to conservation of this species in South American. The skyline plot analysis revealed population expansion based on mitochondrial DNA dating from approximately 750,000 to 500,000 years ago, a neutrality test revealed recent expansion. So, we concluded that both species (Magellanic and Humboldt) showed great population size in the past, that are supported its diversity until the current days. These species showed high capacity of dispersion, being important to maintain the genetic diversity of penguins population.

African Penguin Promises – Promoting Public Conservation Action

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The African Penguin (*Spheniscus demersus*) was added to the endangered species list in 2009. uShaka Sea World, in Durban, South Africa, exhibit a thriving colony of African Penguins. The Penguin's charisma charms people and in keeping with our park philosophy, we use this to encourage conservation action by our visitors.

Many awareness campaigns rely on fear tactics and 'bad news stories' to generate interest. However, conservation education research has shown that this approach can result in people feeling overwhelmed and powerless, resulting in no significant long term environmental behaviour change. For people to contribute to a sustainable future for our planet, a positive change in behaviour is required. In conjunction with the Animal Keepers Association of Africa, staff at uShaka Sea World spearheaded the creation of the "Penguin Promises" campaign. This campaign encourages people to make a promise to change an element of their behaviour in order to have a positive impact on the environment. Seven facilities in South Africa and one in France are now using this campaign to encourage behaviour change in their visitors - and we encourage more facilities to join us.

'Penguin Promises' is actively promoted in our interpretation in different areas of our facility. The campaign has an on-site component, whereby visitors make a promise to change their behaviour via a postcard, as well as a social media component. The digital component includes a dedicated website, linked to Facebook and Twitter. The project provides an opportunity to assess the role of social media in generating conservation action. Appropriate research is being done by uShaka Sea World to analyse the impact of this medium.

This campaign has been operating since 2010 and since then, many awareness campaigns for Penguin Promises have been initiated. This paper will provide feedback on how Penguin Promises is used to promote behaviour change at uShaka Sea World, and in the wider community, and will detail what has been achieved to date. "Penguin Promises" will continue into the future and longer term research objectives, conservation goals and awareness campaigns will be discussed.

Evaluating the use of corticosterone and DNA integrity as health biomarkers in an isolated, captive colony of African penguins (*Spheniscus demersus*)

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Animals very often do not adapt well to captivity and suffer from a decrease in reproductive effort. When animals suffer from continuous stressful conditions, they may exhibit high baseline corticosterone levels, which in turn affect reproductive effort and longevity.

The African penguin (*Spheniscus demersus*) colony at uShaka Marine World, South Africa provide us with the opportunity to study members of this endangered species in an isolated environment, where factors such as consistent food availability and the absence of natural enemies provide them with a relatively stable environment. Blood and faecal samples were obtained from most penguins in the colony for analysis of serum and faecal corticosterone, as well as DNA integrity of blood cells. Our results suggest that collecting faecal samples between 10:00 and 14:00 is most reliable and sampling can be conducted on consecutive days, since the birds are habituated to cleaning staff and trainers visiting their enclosure. In our study DNA integrity was significantly affected by age, which corresponds to the free-radical theory of aging. Interestingly, penguins hatched in the wild and rehabilitated at the aquarium had significantly higher serum corticosterone levels, years after being introduced to the captive colony. Faecal and serum corticosterone levels, as well as DNA damage were only slightly (but not significantly) higher in breeding compared to non-breeding penguins, although breeding females had higher faecal corticosterone levels when compared to non-breeding females. In the absence of many of the perceived stressors in captivity, none of the factors we considered seemed to negatively affect the colony as a whole, although life history may cause some birds to be more susceptible to stress than others. The birds with the highest corticosterone levels were either breeding birds or birds that exhibited nervous behaviour overall.

This pilot study enabled us to evaluate the feasibility of using serum and faecal corticosterone levels and DNA integrity as short and medium-term biomarkers of stress in this colony as a whole, but most importantly, in individual birds.

Trends in the diet of two *Eudyptes* penguins at South Africa's Prince Edward islands over 20 years

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Two species of crested (*Eudyptes*) penguins breed at South Africa's Prince Edward Islands (Marion Island and Prince Edward Island) in the south-west Indian Ocean: Macaroni *Eudyptes chrysolophus* and Southern Rockhopper *E. chrysocome* Penguins. Their diet during the chick-rearing stage of breeding is monitored annually at Marion Island, using methods recommended by the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR). The paper will report the prey species eaten by both penguin species at Marion Island based on information collected from 1994 to 2012, a period of almost 20 years. The paper will also document trends in the relative contributions of different prey species to the diets of both penguin species. Additionally it will document trends in the mass of chicks of the two species at fledging and discuss the possible influence of diet on that mass. For both penguin species, the euphausiids *Euphausia vallentini* and *Thysanoessa vicina* contributed most of the mass of the diet during chick rearing, but myctophid fish, notably *Krefftichthys andersoni*, were important prey on occasions. Cephalopods were found mostly in rockhopper penguin diet samples.

PURIFICATION OF IgG AND IgM ANTIBODIES FROM PLASMA OF MAGELLANIC PENGUINS (*SPHENISCUS MAGELLANICUS*)

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Introduction and Objective: The Magellanic penguin, *Spheniscus magellanicus*, has a global population of approximately 1.3 million with pairs breeding in coastal Argentina, Chile and Malvinas Islands. A significant fraction of these animals, when visit the Brazilian continental shelf, is compromised by infectious diseases, as avian malaria. The immune system is crucial to control these infections by cellular and humoral components, as the antibodies that mediate distinct functions. According to these, the aim of this work was to determine an efficient method to isolate IgG and IgM antibodies from serum of healthy penguins, which will be used as future tools to improve immunologic test for diagnosis. We also determined the isoelectric point (pI) and glycosylation pattern of these immunoglobulins. **Material and Methods:** Plasma from 40 healthy penguins provided by the Santos Municipal Aquarium-SP was firstly delipidated and precipitated with caprylic acid followed ammonium sulfate at 40% saturation. The proteins precipitated were further purified using size exclusion chromatography (Sephadex G-200). The samples were analyzed by SDS-PAGE (7.5 and 12.5%) under non-reducing or reducing conditions, 2D-PAGE and ELISA using anti-chicken IgY antibody. The glycosylation pattern was determined by the affinity with distinct lectins.

Results and Conclusions: Gel filtration chromatography of penguin serum resulted in three peaks (P1, P2 and P3). The electrophoretic profile showed distinct bands above 220 (P1), around 180 (P2) and several under 60 kDa (P3). 2D-PAGE analysis revealed that IgG (P2) has heavy (H) and light (L) chains with 67 and 26 kDa, respectively. Their pI varied from 6.4 to 8.3 for H chain and 5.4 to 7.6 for L chain. The putative IgM (P1) presented a H chain with 86 kDa and the L chain with 26 to 28 kDa, with pI varying from 5.0 to 6.2 (H) and 5.8 to 7.4 (L). In addition, it was verified by ELISA a strong recognition of IgG (P2) but low binding of IgM (P1) by anti-chicken IgY antibody. The lectin affinity assays showed that the IgG and the putative IgM have complex type N-linked oligosaccharide chains. These results suggest that the double precipitations with caprylic acid and ammonium sulphate followed size exclusion chromatography were efficient to isolate putative IgM and IgG antibodies from penguin serum. The identity of the IgM and IgG will be confirmed by mass spectrometry.

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Trace Metals in blood of Little Penguins (*Eudyptula minor*)

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Our study aimed to establish a baseline of trace metal burdens of a high trophic feeder in the urban environment of Port Phillip Bay, Melbourne, Australia, which recently underwent major dredge activities. For comparison, a second population of the same species in a less industrial setting with partial foraging range overlap was sampled. Thirdly, an offshore colony, further away from potential anthropogenic pollution was selected as a reference population.

Little penguins (*Eudyptula minor*) colonising the urban environment of Melbourne's St Kilda breakwater are exclusively feeding in Port Phillip Bay. Phillip Island's little penguins also utilise Port Phillip Bay in winter but feed within 50km of the colony, in less polluted waters of Bass Strait during the breeding season. The reference colony at Notch Island is situated in Bass Strait, about 19 km off the East coast of Wilsons Promontory, Victoria, Australia, and resident little penguins have been found to forage exclusively in Bass Strait.

We sampled blood of free-ranging little penguins at St Kilda (n=125), Phillip Island (n=65) and Notch Island (n=10) in three distinct sampling periods (breeding, moult and non-breeding) over 2 consecutive years. Of the total 190 samples, 127 samples exceed 1 ml in blood volume and are analysed in duplicates and triplicates of 0.5 ml sub-samples for the following trace metals: As, Cd, Cr, Cu, Hg, Pb, Se, B, Al, Zn, Ca, Fe and Sn. Preliminary results indicate correlations of trace metal concentrations in blood with location, sampling period, sex and body weight for some metals, in particular mercury.

This research is the first comprehensive long-term study of the toxicology of little penguins using non-destructive methods, i.e. collection of blood for analysis. As trace metal concentrations in blood represent current exposure, this study helps assess toxicants within their foraging zone and proves the effectiveness of using the little penguin as a bioindicator species in a changing environment.

Isolated permeabilized fiber bundles as a new tool to investigate muscle bioenergetics in penguins

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Investigating bioenergetics in penguin skeletal muscle is of primary interest to unravel many aspects of their adaptation to harsh climatic environments. However classical biochemical methods are limited because of the usually high amount of biological material required. In this study, we have developed an alternative method based on permeabilized fiber bundles to investigate the maturation of energetic processes underlying the rapid growth of Adélie penguin chicks reared during the short Antarctic summer. Our results were compared to previous data obtained with a classical approach using isolated muscle mitochondria.

Pectoralis muscle biopsies of 30-50 mg were surgically obtained in chicks of different ages during the first month after hatching and in adults. Fiber bundles containing intact mitochondrial networks were rapidly prepared and permeabilized with saponin. Their respiration was then measured using carbohydrate or lipid-derived substrates with an Oroboros® oxymeter. The functional integrity of permeabilized fiber bundles was assessed by the absence of respiratory stimulation by cytochrome c addition. Two fusion proteins involved in mitochondrial network assembly, Mitofusin 2 (Mfn2) and Optic Atrophy 1 (OPA1), were also detected by western blots.

Whatever the substrate, muscle fiber respiration markedly increased during chick growth (+198%; $p < 0.05$) and further rose in adults (+40%; $p < 0.05$). Respiration of isolated mitochondria also varied with age and energizing substrates. Calculation of muscle respiration based on mitochondrial respiration and muscle mitochondrial content gave figures close to permeabilized fiber bundles and indicated similar changes with age. Interestingly, muscle fiber respiratory activity was positively related with Mfn2 and OPA1 relative abundance ($r^2 = 0.89$ and 0.79 ; $p < 0.01$).

On a methodological point of view, present data show that permeabilized fiber bundles represent a powerful alternative method to investigate the maturation of energetic processes in penguin muscles. More straightforward and requiring much less biological material than classical isolated mitochondria, this method provides valuable functional results. On a biological point of view, present results highlight the marked changes in muscle bioenergetics that may enable penguins to face both thermal emancipation and growth in childhood and marine life in adulthood. Further, the concurrent rise in mitochondrial fusion protein abundance suggests that remodelling of mitochondrial networks may be a key event in penguin muscle bioenergetics. This highlights the necessity to use technical approaches that preserve cellular mitochondrial network integrity.

This research project was funded by IPEV, CNRS and Lyon University.

Blood parameters of Chinstrap penguins in Antarctic Peninsula: differences between localities with and without the ticks *Ixodes uriae*.

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The changes of blood levels are one of the main indicators of the damage caused by the parasites in the animals. This study determines if the ticks *Ixodes uriae* interfere the haematological levels and blood biochemistry in Antarctic penguins.

We collected 300 Chinstrap penguin, *Pygoscelis antarctica* in Kopaitic island near the Base Bernardo O'Higgins, Narebsky island near the Base Escudero and Shireff cape in Livingston island. We did blood smears of every penguin with the aim to see hemoparasites and complete blood to determined: globular volume VG, Plasmic Total Protein TPP, Total Leucocytes Recuent TLR. We measure the enzyme Aspartate Amino Transferase AST, Alanin Amino Transaminase AAT and Alcalin Fosfatase AF. We did an active search in the different nest localities for the ticks and in the captured penguins. The stadistical indicators, arithmetic average, standard deviation, minimum, maximum, confidence interval of the parameters were determined using the program Reference Values Advisor. The t student probes were used for detecting differences in the parameters.

We did not find hemoparasites. The presence of ticks were more abundant in Shirreff than in Narebsky, but we did not find ticks in Kopaitic island. We found the following statistical differences: in VG was higher in Kopaitic than in Shirreff but we did not find differences between Kopaitic and Narebsky. In PPT we found differences between Kopaitic and Narebsky, but not between Koapitic and Shireff. RTL did not show differences between the three localities. Biochemical parameters between penguins from environments with and without ticks did not differ. We discuss the present results.

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Alopecia in Adélie penguins (*Pygoscelis adeliae*) on Ross Island, Antarctica

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A feather-loss condition mostly affecting adult Adélie penguins was recognized for the first time in the austral summer of 2011-12 at three colonies on Ross Island, Antarctica. Approximately 1 in 1000 birds was affected. This syndrome was again observed during the 2012-13 season though fewer birds (approximately 1 in 2000) were showing signs of feather loss. However, two chicks were also observed with this condition in 2012-13. No signs of feather loss were observed on the only other avian resident at these colonies, the South polar skua (*Catharacta maccormicki*).

Location of the alopecia varied; some birds had small to large bald patches on their backs, whereas others had alopecia on the head and/or neck, or on the legs. It is not known if this condition progresses to larger featherless areas, or if it affects survival of the birds.

No obvious causative infectious agents, such as lice or mites, were observed at the time of handling. Results will be presented from samples collected for serological analysis, blood smear screening, specific PCR (polymerase chain reaction) testing for beak and feather disease virus, and general metagenomic screening for putative causative agents.

Multi-year serological studies of Adelie penguins (*Pygoscelis adeliae*) on Ross Island, Antarctica 2010-2013

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Not only are there relatively few serological studies of Antarctic penguin species, the majority of studies of this type, however, have taken place in the Australian sector of Antarctica. This information is therefore under-represented for most of the other sectors of the Treaty area. Results of testing for antibodies to Influenza A, infectious bursal disease, Newcastle disease, and West Nile disease in Adélie penguins of Ross Island will be presented. Sera were collected during two sequential summer seasons at two different colonies, Cape Bird and Cape Crozier. A third year of samples was collected the following year at the three sub-colonies of Cape Bird. The overall total number of samples tested was 425.

These results will be discussed in light of the geographic location of these colonies, results of past studies on Ross Island and other locations within the Antarctic Treaty area. Considerations for future research will also be suggested.

Craniomandibular anatomy and functional morphology studies on fossil penguins from the Miocene of Patagonia (Argentina)

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Fossil penguins (Aves, Spheniscidae) are widely recorded in South America, especially from Eocene to present times. Their large taxonomic and morphological diversity was probably related with different feeding habits and diets.

In Patagonia (Argentina) there are currently three Miocene specimens that include preservation of part of the skull and mandibles. In this contribution, *Paraptenodytes antarcticus* (cast MLP from AMNH 3338), *Madrynornis mirandus* (MEF-PV 100), and MLG 3400 cf. *Spheniscus*, are studied. Reconstruction, morphogeometric analysis, detailed morphological description, and data from extant penguin muscles were used in order to determine their possible diets preferences.

A morphogeometric analysis was made using mandibular articular regions of 88 modern and fossil species of penguins, including: *Pygoscelis adeliae*, *P. antarctica*, *P. papua*, *Spheniscus magellanicus* and *Aptenodytes patagonicus*, remains from the Eocene of Antarctica and the Patagonian *Madrynornis* and *Paraptenodytes*. The MLG 3400 could not be included due to lack of preservation of mandible.

For each mandible, five landmarks, and eleven semilandmarks were established and shape changes were assessed through analysis of deformations. A relative warps analysis was made including the uniform deformation components. The interpretation of the results was made following previous published results of the authors, defining three morphotypes: crustacivorous penguins, piscivorous forms, and generalist feeders. The analysis placed *Madrynornis* close to the piscivorous *Spheniscus*, although the general morphology of the skull suggests a closer relationship with *Pygoscelis* in terms of functional mechanics. *Paraptenodytes* resulted close to *Aptenodytes* in the analysis performed.

Taking these results into account, dissections of *Spheniscus magellanicus*, were performed in order to identified muscle origins and insertions as well as articular surfaces, which have proven to be reliable tools to enunciate hypotheses about trophic habits and dietary preferences.

It was concluded that *Paraptenodytes antarcticus* and MLG 3400 cf. *Spheniscus* would have been piscivorous forms, although with different strategies for prey capture, according to the analysed anatomy. On the other hand, *Madrynornis*, resulted as a generalist penguins regarding its diet.

Tracking African penguins (*Spheniscus demersus*) outside of the breeding season: Regional effects and fishing pressure during the pre-moult period

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1) Percy Fitzpatrick Institute of African Ornithology, 2) Bird life South Africa

African penguins (*Spheniscus demersus*) have experienced a 60% population decline in the past 30 years due to an eastward shift in their main food source, anchovy (*Engraulis encrasicolus*) and sardine (*Sardinops sagax*). This shift is exacerbated by pressure from the small-pelagic fishery targeting these species. A lack of knowledge regarding foraging areas when not breeding has been identified as a deficiency in management planning for African penguins. Satellite transmitters were deployed on 10 adults during the pre-moult foraging period from colonies on the west coast (Dassen Island) and south coast (Bird Island, Algoa Bay) of South Africa. Kernel density analyses were produced using nightly locations to create foraging range maps, which were compared to catches made by the small-pelagic fishery during the monitoring period (September-December 2012). Birds from the two colonies differed in their foraging strategies. Dassen Island birds spent more than six times the number of nights further than the foraging range used during the breeding season (40 km from their colony) than Bird Island penguins. Birds from Dassen Island typically made long, looping trips more than 300 km away from the colony, and travelled further and at higher daily rates to foraging areas than individuals from Bird Island, feeding outside areas where fishing activity was highest. Kernel density analysis revealed the foraging range of Dassen Island penguins between Cape Columbine and the central Agulhas Bank. Individuals from Bird Island continued to central place forage, typically staying within 35 km of the colony. Penguins from Dassen Island that remained on the west coast had to compete with higher levels of fishing pressure than penguins from Bird Island, with more than 70% of the fleet-wide, 2012 purse-seine catch occurring within the area where Dassen Island penguins spent 50% of their time. These colony-specific differences suggest that management plans for African penguins need to be regionally targeted and incorporate larger foraging ranges during the pre-moult period for birds from western colonies. The larger foraging ranges and effort demonstrated by birds from the west coast suggest that a combination of the low fish abundance and higher commercial fishing pressure may force pre-moulting birds to seek food sources farther from the colony, putting them at higher risk of not surviving the annual moult. This project requires more years of data to ensure these foraging patterns are representative, and to more accurately provide management suggestions directed to alleviate stress on African penguins for long-term protection of this endangered seabird.

Monitoring erect crested and rockhopper penguins on the Antipodes Islands

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Many crested penguin populations around the world are in decline. On Campbell Island the rockhopper penguin (*Eudyptes chrysocome*) has declined 94% since the 1940s. The Antipodes Islands supports approximately 65% of the world's population of erect-crested penguins (*Eudyptes sclateri*), and a population of rockhopper penguins. To date, census methods have differed, resulting in incomparable results; however, from scant data available it appears that colonies of both erect-crested and rockhopper penguins have declined on the Antipodes Islands. The main objective of the 2011 expedition to the Antipodes Island was to standardise survey methods and obtain accurate baseline survey data of the population size for the rockhopper and erect-crested penguins on the island. Several methods were used to enable comparison with previous data. The colonies are often of mixed assemblages of erect crested and rockhopper penguins, each nesting in slightly different habitat. Therefore it was necessary to conduct ground counts to get accurate census data for these species. Approximately 86% of the total estimated nests on the island were ground counted. Due to difficulty of access, the remainder were counted using binoculars from vantage points on the island or from a boat. A total Antipodes Island census of breeding penguins was obtained from this data. All penguin colonies were mapped in 1978 and 1989, and the 2011 expedition also repeated this survey to investigate the persistence of colonies over time.

The prevalence and intensity of infection with parasite eggs found in the guano of African penguins, (*Spheniscus demersus*), of the nematode, *Cyathostoma phenisci*, and that of a novel schistosome species

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The rehabilitation of African penguins at the three centres along the South African coastline - SANCCOB (South African Foundation for the Conservation of Coastal Birds) in the Western Cape, SAMREC (South African Marine Rehabilitation and Education Centre) and PEC (Penguins Eastern Cape) both in the Eastern Cape – provide samples for the ongoing research of the presence and identification of endoparasites in African penguin guano.

The presence of the *Cyathostoma* species was first noted in 2007 and later identified as such by Dr E Harris (Dept. of Life Sciences, Natural History Museum, London.) Further morphological and molecular studies by G Kanarek identified the tracheal nematode as *Cyathostoma phenisci*, last reported in 1937 in a Humboldt penguin, (*Spheniscus humboldti*), imported from Tocopilla, Chile and died 24 hours later in Amsterdam Zoo.

Eggs first isolated in 2009 were identified as a novel species of the family Schistosomatidae by J Aldhoun in 2012.

Further molecular studies are underway.

Occurrence of Influenza virus in penguins – a brief review

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Influenza A virus (IAV) has been isolated from at least 105 species of birds representing a span of 26 bird families. The virus is most frequently found in bird species associated with aquatic environments, such as Anseriformes (including ducks, geese and swans) and Charadriiformes (particularly shorebirds and gulls). Penguins (Sphenisciformes), however, despite being undoubtedly associated with aquatic environments and oftentimes living within close proximity to other avian species known to carry these viruses with high prevalence, seem to present an exception. The virus has never been isolated or detected through RT-PCR in any penguins, neither wild nor captive. Antibodies against IAV antigens, however, have been found in a few occasions: in 1981, antibodies against IAV subtype H7 were detected in Adélie penguins (*Pygoscelis adeliae*) at Casey, East Antarctica; in 1996, antibodies against IAV (subtype not specified) were detected in Gentoo penguins (*P. papua*) at Bird Island, South Georgia Islands; in 2001, antibodies against the IAV subtypes H1, H3, H7 and H9 were detected in Adélie penguins at Hope Bay, Antarctic Peninsula; in 2002, antibodies against the IAV subtype H3 were detected in Chinstrap (*P. antarctica*) and Gentoo penguins at King George Island, South Shetland Islands, and antibodies against IAV subtype H7 were detected in Chinstrap penguins at the same location. IAV can be classified into two groups on the basis of their ability to cause disease in chicken: the most violent viruses are termed Highly Pathogenic Avian Influenza (subtypes H5 and H7), whereas Low Pathogenic Avian Influenza (other subtypes) are less severe and tend to be more frequent in birds. The finding of seropositive penguins suggests that, despite the lack of success in isolating the virus, penguins have been exposed to the pathogen presumably through the contact with other birds known to carry the infection, such as Arctic terns (*Sterna paradisaea*), Kelp gulls (*Larus dominicanus*), Southern giant petrels (*Macronectes giganteus*), among others. Because relatively few studies have attempted to detect IAV through direct diagnostic methods such as viral isolation or RT-PCR, it is not yet clear whether penguins may or not carry and/or spread the virus.

Penguins in the news: An evaluation of penguin-related articles in Brazilian newspapers

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The media plays a strong role in determining how the general public perceives animals and nature. Penguins are highly charismatic, and are commonly present in the general media, through films, animations, marketing, etc. Their appearance in newspapers, however, is much more limited and may or may not be faithful to their biology and conservation. While there are no penguins that breed in Brazil, large numbers of Magellanic penguins (*Spheniscus magellanicus*) visit the country's territorial waters during winter, and hundreds to thousands of these birds become washed ashore along its coast every year. The aim of this study was to revise the articles published on national and regional newspapers in Brazil, to examine the message conveyed and whether it reflected the scientific and conservation approach to these species. Two national newspapers (Estado de São Paulo, Folha de São Paulo) and two southern state newspapers (Diário Catarinense, Zero Hora de Porto Alegre) were examined using the in-built search engines of the newspaper websites to conduct searches for the keywords "pinguim", "pingüim", "pinguins" and "pingüins". Printed and online-only articles published from 2000 to 2012 were examined, and only articles mentioning actual penguins were included in the analysis (metaphorical references to penguins were common but were excluded). Each article was examined and the following info was recorded: date of publication, which penguin species was involved, what is the main topic of the article, country, context (captive, wild, rehabilitation, etc.), institutions and interviewees involved, whether penguins were the primary or secondary focus of the article, which topics of penguin biology are mentioned, which topics of conservation are mentioned, whether the article was neutral or had an explicitly or implicitly positive or negative attitude towards penguins, whether any relevant misinformation or errors occurred, and whether humour or anthropomorphism was present when referring to penguins. The results will be discussed in light of the scientific records and information on the presence of penguins in Brazil, and the implications for environmental education and public perceptions of penguins are discussed.

The first fossil penguin from the Neogene of Antarctica

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The only post-Eocene Antarctic fossil penguin (Aves: Sphenisciformes) is known from the late Miocene (*ca.* 10.2 Ma) of East Antarctica. Its remains were recovered from the glaciomarine succession of the Fisher Bench Formation (Fisher Massif, Prince Charles Mountains). No other extinct sphenisciforms were found that far south (beyond the Antarctic Circle). The hosting sediments were deposited in a marine environment during an open-sea incursion in the above-mentioned area. The penguin from the Fisher Massif is represented by two well-preserved wing bones, humerus and radius, assignable to the extant genus *Spheniscus*, a taxon so far known solely from the southern Africa and South America. Both bones are clearly larger than their counterparts in present-day species from this genus, comparable to those in *Pygoscelis papua*. The earliest unambiguous record of *Spheniscus* (and also crown-group penguins) dates to the latest middle/earliest late Miocene of Peru and the origin of recent species probably dates to the Plio-Pleistocene. Having regard to the above background, the specimen discussed here is unique and constitutes a valuable contribution to the study of penguin distribution and evolution during the Neogene.

Differential advantages of colonial breeding in the gentoo penguin *Pygoscelis papua*

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To investigate the differential advantages of colonial breeding in the gentoo penguin, we estimated the effects of colony size and nest location on nest safety from the environmental factors at Narebski Point designated as an Antarctic Specially Protected Area (No. 171), Barton Peninsula, King George Island, the Antarctic in 2011/12 and 2012/13 breeding seasons. The predation by brown *Catharacta antarctica lonnbergi* and south polar skua *C. maccormicki* was main factors affecting egg and chick survival in both breeding seasons. The inclement weather such as blizzard reduced chick survival in 2012/13. There was a positive correlation between subcolony size and breeding success. And also, central nests in the subcolony had higher breeding success than peripheral nests. It suggested that predator prefer to easily obtainable prey because they can avoid the intense mobbing of breeders. Nest and ground temperature were significantly higher in the central part than in peripheral and outer parts of the colony. In the cold season (2012/13) hatching success of peripheral nests was lower than that of central. However there was no significant difference between central and peripheral nests in the relatively mild season (2011/12). Although colonial breeding seems to be advantageous to reduce the predation and heat reserving during the incubation periods in the cold environment, just some breeders who occupied good nesting site received this benefits.

Intra-seasonal variations in foraging habitat and behaviour of Adélie penguins in the Prydz Bay

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Adélie penguins (*Pygoscelis adeliae*) are one of the most abundant Antarctic predators with a circumpolar distribution of breeding sites. Their habitat is limited to south of the Antarctic Circumpolar Current (ACC) throughout their life history, thus they are thought to reflect integrated effects of ecological and climate changes especially in relation to changes in sea ice. However, mechanisms that alter prey availability in relation to sea ice still remain not well known especially in East Antarctica. In this context, studying characteristics of their foraging through a breeding season will provide us a key to understand how they respond to regional changes in marine environment. One of the largest Adélie populations in East Antarctica inhabits the Prydz Bay region where has a variety of physical oceanographic environments, productivity and plankton/nekton species. In this talk we describe results from recent work on changes in foraging behaviour of Adélie penguins within a breeding season, in terms of habitat such as continental shelf, shelf break and various concentrations of sea ice. The field study was conducted on Hop Island, Prydz Bay region from November 2011 to January 2012. We deployed GPS loggers (CatTraQ™, 30g) on 15, 6 and 3 birds during incubation, chick guarding and crèche stages, respectively. Using the GPS foraging tracks, we calculated First Passage Time (FPT) to extract Area Restricted Search (ARS) zones where the birds concentrated foraging efforts. A total of 50, 14, and 5 ARS zones were detected during incubation, chick guarding and crèche stages. ARS zones as an index of foraging intensity were explained by a combination of sea ice concentration (SIC), distance from shelf break, and breeding stage. The ARS zones were classified into three groups: (i) shelf break with occasional sea ice ($43.1 \pm 31.6\%$ in SIC, 53.7 ± 27.1 km from shelf break), (ii) on-shelf sea ice ($65.4 \pm 14.8\%$ in SIC, 203.1 ± 26.1 km from shelf break), and (iii) open water ($16.0 \pm 11.8\%$ in SIC, 203.6 ± 21.9 km from shelf break). During incubation and crèche birds mainly used the shelf break with occasional sea ice and on-shelf sea ice habitats. During the chick guarding birds used only open water habitat. These results together with previous studies on plankton/nekton community suggest that habitat selection of the penguins reflects different type of prey and their vertical distribution, as well as energy requirements by offspring and changes in sea ice distribution.

Behavioural plasticity in response to a changing environment: the effect of tidal oscillations on beach crossing behaviour of the Little penguin, *Eudyptula minor*.

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Predation risk may be countered by morphological or behavioural anti-predation traits. When an animal occupies more than one habitat (multi-habitat animal) morphological traits may result in a cost in the habitat or niche where morphology is not optimal. Behavioural anti-predation tactics are then relied upon to reduce this risk or cost. Little penguins, a marine-terrestrial species, represent the extreme of a multi-habitat animal – taking advantage of vastly different habitat types. They make short but frequently inter-habitat transitions from foraging grounds at sea, across the beach to the colony and back. The little penguin is morphologically less suited to walk across the beach.

In this study, we examined the effect of tidal oscillations on the behaviour of a multi-habitat species, the little penguin, when changing habitats using their secondary sub-optimum locomotion. At low tide and a consequently wider beach, little penguins formed larger groups and crossed the beach more slowly. When the tide was low they spent more time at the water's edge before crossing later, when it was darker. Their responses to tidal oscillations could indicate anti-predation adaptations while crossing larger extent of the open beach, despite of that actual predation was not observed. Penguins may take this conservative behaviour at such brief event of their daily cycle (compared to time spent at sea or in colony nesting grounds, for instance) when their escape abilities are not ideal.

The Polar Geospatial Center: enhancing penguin science with satellite imagery

Michelle LaRue and Paul Morin

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The environment is rapidly changing in Antarctica, and it is becoming ever more imperative to understand the potential impacts and threats to penguin populations. Several long-term studies across the continent provide detailed information regarding population growth rates, diet, foraging strategies, and predator-prey interactions. However, adequate tools for assessing larger-scale population questions (i.e., regional or continental) have been lacking, primarily due to difficult logistics and inaccessibility of most penguin colonies. We address this paucity in penguin science by presenting the geospatial services and capabilities of the Polar Geospatial Center (PGC), at the University of Minnesota. Here we will present case studies for population assessment of penguins using various geospatial tools and resources, including high-resolution satellite imagery (0.5-5m resolution), historic aerial photography, and remote sensing techniques. The PGC has enabled several projects over the past 2 years, including landmark papers on emperor, chinstrap, and Adélie penguin populations. The high-resolution archive of imagery at the PGC contains >1 million images spanning >6 years, from 5 imagery platforms. We also provide imagery products and image processing to better enable scientists to work with such imagery. Because scientists funded by the National Science Foundation conducting research in polar regions can utilize the PGC as a resource for research, we hope to provide information on capabilities and open discussion on future penguin research.

Extreme microclimate conditions in artificial burrows for Endangered African penguins

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For many threatened avian species, artificial nests are deployed to increase reproduction by offering a suitable habitat, but nest microclimate is an important factor in the success of these conservation measures.

Spheniscus penguins from the low-latitudes naturally nest in burrows dug in guano for protection against thermal stress. Former guano harvesting reduced substrate available, forcing many penguins to breed in surface nests, exposed to extreme weather and aerial predators. In South Africa, artificial nests have been deployed to provide shelter for the endangered African penguin *Spheniscus demersus*, with variable success among different types of artificial nests. We compared climate conditions (temperature and humidity) between two types of artificial nests (fibreglass and concrete burrows) and natural nests (surface and burrows) on Bird Island, Algoa Bay, in the 2012 summer and winter breeding seasons.

Mean temperatures were systematically higher in both types of artificial nests than ambient temperatures experienced by surface nests and in natural burrows in both summer and in winter. Artificial nests also retained high temperatures (>30°C) for much longer periods of time, although concrete nests experienced slightly lower temperatures than fibreglass nests. Temperatures >30°C induce active thermoregulatory behaviours in *Spheniscus*, thus increasing energy expenditure. Mean levels of humidity in artificial nests (60%) were low in comparison to natural burrows (90%), which could lead to damaging water-loss by the eggs.

These nests nonetheless provide appropriate shelter against rains and aerial predators, thereby increasing chick survival. Presently, concrete nests seem the better artificial nest option for *Spheniscus demersus*. However, their current design must be improved and additional research should be conducted towards engineering an artificial nest that can better mimic conditions of natural burrows, especially in terms of ventilation and humidity. Such information is crucial to increase the observed low hatching success in these nests, and to maximize conservation efforts for these endangered penguin populations.

Growth and decline of a penguin colony and the influence on nesting density and reproductive success

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Colonial breeding is characteristic of seabirds but nesting at high density has both advantages and disadvantages and may reduce both survival and fecundity. African penguins (*Spheniscus demersus*) initiated breeding at Robben Island, South Africa in 1983. The colony there increased in the late 1990s and early 2000s before decreasing rapidly until 2010. As numbers breeding at Robben Island increased, preferred nests sites (under trees and bushes) at the north of the island, where the colony was initiated, were mostly occupied. This probably caused a southward expansion in the area used for breeding and an increase in sites at which penguins accessed the island. The area occupied by breeding birds expanded as the population increased but did not contract as it decreased, so that there was substantial variation in nesting density. Fledging success was negatively related to nest density and to numbers breeding in the monitored area, but not to the overall population at the island or to the combined number breeding at Robben Island and neighbouring Dassen Island. These results suggest that, if density-dependent effects operated during the study period, they did not do so through local resource depletion. Although the nest density measured in the study was not high, nesting burrows, which probably reduce the incidence of aggressive encounters in the colony, are scarce at Robben Island and it is possible that habitat alteration has modified the strength of density-dependent relationships for African penguins. Gaining a better understanding of how density dependence affects fecundity and population growth rates in colonial breeders is important for informing conservation management of the African penguin and other threatened taxa.

Characterization and antimicrobial resistance of *Escherichia coli* isolated from the cloaca of Magellanic penguins undergoing rehabilitation

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Escherichia coli is the most relevant commensal bacteria in the intestinal flora of endothermic vertebrates, and is also ubiquitous in the water, soil, food and organic matter in general. Although most strains are non-pathogenic, the acquisition of virulence genes may result in strains that produce intestinal or extraintestinal infections. Strains that produce severe extraintestinal infections in birds are referred to as APEC (Avian Pathogenic *E. coli*), and these strains may produce significant mortality in wild birds as well as in commercial poultry, and may also become pathogenic to humans. Because of the relevant economic and public health significance of these bacteria, concerns have been raised on the role of migratory birds in dispersing and maintaining pathogenic strains of *E. coli*. On September 2012, a total 222 Magellanic penguins (*Spheniscus magellanicus*) found along the coast from southern Bahia state to northern Rio de Janeiro state were undergoing rehabilitation at Instituto de Pesquisa e Reabilitação de Animais Marinhos, Brazil. Birds had not been oiled but presented signs of hypothermia, starvation and dehydration, and only two were adults whereas the remaining were juveniles. Cloacal swabs were collected from six individuals from the intensive care unit (recently admitted juveniles that were still moderately dehydrated, prostrated and hypothermic), which had not received antimicrobial treatment. Samples were subjected to standard methods of bacterial isolation and identification, and the bacterial isolates were tested for sensitivity to antimicrobials. *Escherichia coli* isolates were also characterized using PCR for plasmidial virulence genes (*iroN*, *ompT*, *hlyF*, *iss*, *iutA*) and for genes that reflect phylogeny (A, B1, B2, D). Seven strains were retrieved from the six samples: five pure *Escherichia coli* cultures, and one mixed cultures (*E. coli* and *P. mirabilis*). *P. mirabilis* and four *E. coli* isolates (71%) presented some degree of antimicrobial resistance; *E. coli* resistance was observed for the following drugs: aminoglycosides (66% of isolates presented resistance), penicillins (33%), tetracycline (33%), chloramphenicol (16%), fluoroquinolones (16%), sulphonamide-trimethoprim (16%); resistance was not observed for cephalosporins, nitrofurantoin, polymyxin B, amikacin and gentamicin. *Proteus mirabilis* showed multidrug resistance. *E. coli* strains were characterized as follows: Group A (50%), Group B2 (33%) and Group D (17%). Two *E. coli* strains had avian virulence-associated genes (*ompT* and *hlyF*; *iroN* and *iss*). The broad migration of Magellanic penguins renders them good targets for microbial surveillance, and these results indicate the species is exposed to bacterial strains with pathogenic/zoonotic potential and antimicrobial-resistance even when they were not directly exposed to antimicrobial treatment.

We are grateful to the São Paulo Research Foundation (FAPESP 2009/53956-9, 2010/51801-5, 2010/51943-4).

Oral abscesses in Magellanic penguins undergoing rehabilitation: Bacterial characterization and antimicrobial resistance

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It is not uncommon for migrating juvenile Magellanic penguins (*Spheniscus magellanicus*), presumably motivated by hunger and inexperience, to feed on unusual prey such as thorny fish, developing oral lesions as a result. These lesions tend to develop secondary bacterial infections and form abscesses that difficult foraging. On September 2012, a total 222 Magellanic penguins found along the coast from southern Bahia state to northern Rio de Janeiro state were undergoing rehabilitation at Instituto de Pesquisa e Reabilitação de Animais Marinhos, Brazil. Birds had not been oiled but presented signs of hypothermia, starvation and dehydration, and only two were adults whereas the remaining were juveniles. Upon clinical examination, twenty individuals (9%) had oral abscesses. Samples were collected from the oral lesions of nine of these, none of which had received antimicrobial treatment. Samples were subjected to standard methods of bacterial isolation and identification, and the bacterial isolates were tested for sensitivity to antimicrobials. *Escherichia coli* isolates were also characterized using PCR for plasmidial virulence genes (*iroN*, *ompT*, *hlyF*, *iss*, *iutA*) and for genes that reflect phylogeny (A, B1, B2, D). Twelve bacterial isolates were retrieved from the nine samples: four samples had pure cultures (1 *E. coli*, 2 *Citrobacter freundii*, 1 *Serratia liquefaciens*) and four samples had mixed cultures (two strains of *E. coli*; *E. coli* and *Enterobacter cloacae*; *E. coli* and *Proteus mirabilis*; *E. coli* and *Pseudomonas aeruginosa*). Ten isolates (83%) presented some degree of antimicrobial resistance, and eight (67%) presented resistance to two or more antimicrobials. Bacterial resistance was observed for most tested antimicrobials: penicillins (75% of isolates presented resistance), sulphonamide-trimethoprim (58%), aminoglycosides (41%), tetracycline (41%), cephalosporins (33%), chloramphenicol (33%), nitrofurantoin (33%), fluoroquinolones (25%), polymyxin B (25%); resistance was not observed for amikacin and gentamicin. Phylogenetic analysis of *E. coli* revealed: three strains in Group A (50%) and one in Group B1 (16%), which are most frequently associated to Avian Pathogenic *E. coli* (APEC); and two in Group B2 (33%), which includes most human Extraintestinal Pathogenic *E. coli* (ExPEC). One or more virulence-associated genes were identified in four *E. coli* strains (66%), and it is particularly concerning that two of these presented all five investigated predictors of avian pathogenic *E. coli* virulence as well as multiresistance. These findings indicate an important involvement of Enterobacteriaceae in such oral lesions, and demonstrate that in some cases the strains involved may be resistant to antimicrobials and/or associated to pathogenic/zoonotic lineages of *E. coli*.

We are grateful to the São Paulo Research Foundation (FAPESP 2009/53956-9, 2010/51801-5, 2010/51943-4).

The Demography Is In the Details: A Review of Life Tables From Ten Species of Captive Penguin

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Captivity presents a unique opportunity, not always available to field researchers, to monitor and document life history events (births/hatches and deaths) of known-aged individuals throughout their entire lifetimes as each individual is tracked through birth/hatch, reproduction, and death in a national or international database known as a studbook. Collecting this scope of data in the field can be especially difficult for long-lived species such as penguins. Captivity may be a confounding variable as constant food availability, predation release, veterinary care, managed breeding programs, and other factors certainly influence vital rates. The observed rates still, however, represent biological possibilities and limits that may otherwise be unknown to field researchers. Life tables of penguin species exhibited in AZA (Association of Zoos and Aquariums) accredited facilities will be presented. These data represent more than 9000 individuals from ten species over several decades. Age-specific mortality and fecundity rates including first and last reproduction, median and maximum life expectancy, and other demographic parameters are derived from these life tables. Additionally, factors influencing the applications of these data from captive populations to field studies will be discussed.

The Center for Conservation of the Humboldt Penguin in Punta San Juan, Peru: An Integrated and Focused Conservation Partnership

Michael Macek, Curator of Birds, Saint Louis Zoo, USA

Saint Louis Zoo, Center for Conservation of the Humboldt Penguin in Punta San Juan, Peru

The IUCN currently identifies some 13% (1200) of evaluated species of birds (including 11 of the 17 penguin species) as being threatened with global extinction. Conservation breeding and reintroduction are the most frequently cited conservation actions contributed by zoos, but almost every member institution of the World Association of Zoos and Aquariums also actively participates in *in-situ* conservation endeavours representing approximately US\$350 million spent each year on wildlife conservation. With more than 300 zoo members and 700 million visitors each year potentially exposed to environmental education, World Association of Zoos and Aquariums' institutions have incredible potential to change the course of the 1200 Red Listed birds and at the same time cultivate public empathy for one of the most diverse taxonomic groups in animal kingdom.

Although actively involved in wildlife conservation since its inception, in 2007 The Saint Louis Zoo made a concerted effort to potentially increase its conservation impact by focusing its efforts both geographically and taxonomically. This was accomplished through the formation of the Saint Louis Zoos WildCare Institute, which now serves as a dedicated conservation arm of the zoo. Through comprehensive strategic exercises, 12 species/geographic centers of conservation interest were identified. One of these centers is The Center for the Conservation of the Humboldt Penguin in Punta San Juan, Peru. Located on the southern coast of Peru, it is home to approximately 50% of the breeding population in Peru.

The Center for Conservation of the Humboldt Penguin has assembled a dedicated core team of institutions and professionals to monitor and steward the vulnerable population of this unique species of marine bird. To date the Center has contributed and raised more than US\$400,000 to support the conservation of this critically important site. It has also procured more than US\$80,000 in grants to support numerous *in-situ* research projects as well as providing staff and expertise.

As the world population surpasses two billion inhabitants, more world citizens than ever will rely on zoos to introduce them to the 'natural' world. Our conservation partners will also look toward zoos to play a larger role. The Center for Conservation of the Humboldt Penguin has helped to create an opportunity for real change. By forging a bond between zoo staff, Peruvian partners, NGOs and government agencies, the Center has taken the first steps in the formation of a true conservation coalition.

Trends in numbers and breeding success of two *Eudyptes* penguins at South Africa's Prince Edward islands, 1994–2012

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Two species of crested (*Eudyptes*) penguins breed at South Africa's Prince Edward Islands (Marion Island and Prince Edward Island) in the south-west Indian Ocean: Macaroni *Eudyptes chrysolophus* and Southern Rockhopper *E. chrysocome* Penguins. Since 1994, numbers of these two penguins breeding at Marion Island have been estimated. At some colonies, numbers breeding, hatching success, fledging success and breeding success also have been monitored as part of South Africa's contribution to the CCAMLR (Convention for the Conservation of Antarctic Marine Living Resources) Ecosystem Monitoring Programme (CEMP). After 1994 numbers of Macaroni and Southern Rockhopper Penguins at Marion Island decreased by about 30% and 70%, respectively. At two large colonies of Macaroni Penguins at Marion Island, there was a progressive decrease in the densities of nests. At each of these colonies, large decreases in numbers breeding followed outbreaks of disease, attributable to avian cholera *Pasteurella multocida* in one instance and an unknown agent in the other. Since 1994, the mass of Southern Rockhopper Penguins returning to breed at Marion Island decreased by 20%, and it was significantly correlated with breeding success of the same species. Reduced breeding success of Southern Rockhopper Penguins was initially attributable to failure during chick rearing, but more recently abandonment during incubation also has had an impact.

Self-organized pattern formation in penguin colonies

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Self-organizing spatial patterns have been observed in a range of biological systems, operating at a variety of spatial scales from honeybee comb formation to fish schooling behavior. Considering the often ignored spatial arrangement of a system and understanding the individual processes that lead to non-random pattern formation can provide us with information on the stability of a system and how it is likely to respond to change. We use satellite imagery to investigate the spatial arrangement of nesting sites within penguin breeding colonies on the Western Antarctic Peninsula, and conclude that spatial patterns are non-random and may form even in the absence of abiotic factors or landscape topography.

Penguins breeding on the peripheries of a colony have lower breeding success than those with more centrally located nests and chinstrap colonies in declining populations maintain their pre-decline nest density, suggesting that aggregated nesting is advantageous at local spatial scales. Small colonies have a higher ratio of edge to core; lower average reproductive success in these colonies may produce a demographic Allee effect with important consequences for the dynamics of colony decline and patch persistence and dispersal. We use spatially explicit individual based models to examine how these patterns arise and the effects that colony shape may have on the rates of decline of penguin populations. We find that a combination of high site fidelity and local aggregation of nesting sites maintains nest density and stabilizes potential colony decline rates when compared to a randomly arranged null mode. The results of these simulations will help us to understand the potential Allee effects associated with being a colonial seabird on the WAP, how these effects may impact the persistence of existing colonies, and the ability of individuals to form new colonies amid changing conditions on the WAP.

Winter weight changes in Emperor Penguins across the breeding season

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Breeding through the Antarctic winter, emperor penguins (*Aptenodytes forsteri*) must endure harsh conditions that include long periods of fasting. As part of a larger study on the presence of disease agents, we sampled 400 adults and 200 young of the year at various times over the breeding cycle. We also determined the gender of most subjects genetically. Here we demonstrate significant weight changes over the winter/spring breeding cycle.

During the courtship period (May) males at 31.7 kg (n=38) were significantly heavier than females at 25.4 kg (n=56) ($t=15.6$, d.f.=92, $P<0.0001$). In contrast in August, after their long incubation fast, males (24.8 kg, n=72) had lost 6.9 kg (21.7%) of their starting weight making them lighter than females (26.9 kg, n=122) who had just returned from 2.5 months at sea ($t=5.05$, d.f.=192, $P<0.0001$). By November, both sexes had made several foraging trips to feed their chicks. Despite getting time at sea after the chicks hatched, males did not regain the weight they had lost but maintained a lower weight of 24.5 kg (n=36). Females who had returned in August at their heaviest to take the first stint of brooding their chick, however, lost 4.2 kg over their foraging trips and were down to 22.7 kg (n=62) in November. They were significantly lighter than males by 1.8 kg ($t=5.172$, d.f.=96, $p<0.0001$). Emperor penguin males are typically heavier than the females, but it is clear that the requirements of breeding through the winter make weight a dynamic trait.

We first sampled chicks about 5 weeks after hatch once they had left the feet of their parents. We did not determine sexes for the young chicks, but by late September, the chicks were 2.95 kg (Std. = 0.778, n=100) with a culmen length of 24.8 mm. We did separate the sexes by November when the chicks were about 4 months old. Males (9.8 kg, n=58) were slightly lighter than females (10.1 kg, n=37), but the difference was not significant ($t=0.684$, d.f.=93, $p=0.496$). There were no significant differences between male and female chicks in culmen length, head length, or foot length either. It seems that whatever differences may develop between males and females have not appeared before the age of 4 months. Given the vagaries of years, ice conditions and foraging, we would not expect clear differences to arise before fledging.

Evaluation of the reproductive system of Magellanic Penguin: an approach about paternity analysis and Extra-pair Paternity (EPP)

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In the last few decades, it was believed that great part of avian species presented monogamous sexual behaviour. However, recent studies have identified extra-pair copulation (EPC) and paternity (EPP) in many of these species, showing that some of them are socially, but not sexually, monogamous.

The use of molecular markers proved to be very effective when deeply evaluating the mating systems, since these techniques have led to important corrections on the systems classification. Penguins present intense biparental care, meaning that it can be expected a strictly monogamous behaviour with insignificant extra-pair paternity rates. But up to this moment, their sexual behaviour from the genetic point of view was poorly studied.

Within this context, the present study aims to evaluate the reproductive behaviour of the Magellanic penguins (*Spheniscus magellanicus*), through the use of microsatellites, trying to identify the offspring's parentage and the EPP rate in a colony from the Argentinean coast, located on Chaffers Island. 50 nest's samples, each one including 2 adults (possible parents) and 2 offspring, were analyzed. All individuals were genotyped with six microsatellite loci previously designed for penguins. Less than 60% of the offspring presented parentage according to expectations. Furthermore, among the offspring of each nest, only 32% presented full siblings relation. Although this is a preliminary result of the study, we can already observe that relations among penguins may not be as consistent as we expected.

Is the Eastern Rockhopper Penguin population on Campbell Island still in decline?

Kyle W. Morrison

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Over the 43 year period from 1942 to 1985 the population of Eastern Rockhopper Penguins (*Eudyptes chrysocome filholi*) on New Zealand's sub-Antarctic Campbell Island declined by an estimated 94%, from ~800,000 to ~51,500 breeding pairs. Concurrent and on-going population declines of a similar proportion have been documented at multiple other breeding sites throughout the species' range, resulting in an IUCN threat ranking of 'vulnerable' and 'nationally critical' in New Zealand. The most important cause of these declines is likely reduced food availability related to ocean warming.

I estimated colony-specific population changes over the 27 year period from 1985 to 2012 by comparing colony areas and nest densities from photographs and physical measurements. I found a huge degree of inter-colony variation in recent population change from a decline of ~60% to an increase of ~30%. This variation appears related to how the physical characteristics of some colony sites facilitate predation, rather than being linked to differences in food availability. The current overall population trend on Campbell Island appears relatively stable compared to the previous period of rapid decline. The relative stability of the Eastern Rockhopper Penguin population in recent years may be linked to a shift to the positive phase of the Interdecadal Pacific Oscillation from 1978 to 1999, associated with cooler ocean temperatures in the region. Additional research on how oceanographic conditions relate to food availability is required.

A Charitable Trust Model for Penguin Conservation in New Zealand

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Yellow-eyed Penguin Trust, PO Box 5409, Dunedin 9058, New Zealand

The Yellow-eyed Penguin Trust is New Zealand's first single species trust which, together still with it's principal sponsor, has celebrated 25th year of delivering penguin-centered coastal ecosystem conservation. This unique partnership is thought to be the longest cause-related marketing sponsorship in the southern hemisphere and is used as a showcase example at many fundraising and corporate events.

Our poster highlights the major milestones achieved together within a changing sponsorship environment, including the sponsor's evolution from a family-based business to being owned by one of NZ's largest corporates.

Towards an Antarctic-wide and multinational monitoring program for penguin colonies

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Changes in number of individuals, spatial distribution and species composition of penguin colonies are noticed all over the Antarctic. The reasons are assumed to be in a chain from climate change over shifting ice regimes to modified distribution of food resources and accessibility of breeding sites. Krill fishery is in discussion to be another possible trigger of these changes as well. It is obvious, that monitoring on a continental scale is only possible by use of remote sensing technique. For this reason a feasibility study, commissioned by the German Federal Environmental Agency, examined the chance of detecting alterations in penguin colonies by using different optical systems and a radar system too.

During the SCAR XXXII Delegates' Meeting 2012 in Portland, USA the SSG recommended "... the formation of a new cross action group to coordinate the development and adaptation of remote sensing methodology to promote new avenues of research..." As a consequence a SCAR Action Group with the primary name "Development of a satellite-based, Antarctic-wide, remote sensing approach to monitor bird and animal populations" was established.

One of the first approaches that contribute to the work of this Action Group is a project, which aims to the preparation of a proposal for an Antarctic-wide and multinational monitoring of penguin colonies by

- data-mining for available census and satellite data and databases
- validation of existing satellite- and ground-based monitoring methods as well as testing of new approaches.
- Proposing possible test sites
- technical recommendations for the database design

The project will be carried out in close cooperation and exchange with the experts of the Action Group which is open for all scientists working in the field of penguin monitoring and remote sensing.

Antarctic Site Inventory, 1994-2013

Ron Naveen / Dr. Heather J. Lynch

Ron Naveen (Oceanites, Inc.) / Dr. Heather J. Lynch (Stony Brook University)

The Antarctic Site Inventory (ASI) has been collecting data since 1994 and is the *only* long-term monitoring project tracking penguin and seabird population changes throughout the Antarctic Peninsula — and it is the *only* nongovernmental, publicly supported, scientific research project working in Antarctica.

Long-term monitoring/assessment are critical to detecting environmental changes everywhere, especially in the Antarctic Peninsula where it's warming faster than — or as fast as — anywhere else on Earth. The ASI involves two interconnected research activities: (1) ongoing, regular censusing of penguin and seabird populations and (2) the synthesis and quantitative analyses of numerous datasets detailing long-term environmental changes at diverse sites throughout the Peninsula.

As described in this poster, these syntheses and analyses have been used to characterize decadal scale changes in penguin populations on the Peninsula; discern how Antarctic penguin species are changing in abundance, relative abundance, and spatial distribution; and identify the factors specifically driving these long-term changes. Over its 19-year history, the ASI has made over 1,250 site visits and collected census and descriptive data at 169 Antarctic Peninsula locations. These data represent a comprehensive knowledge base that has been used to help Antarctic Treaty Parties implement the Environmental Protocol, and is being used to develop visitor site guidelines for effective management of Antarctic tourism. As well, the ASI represents a well-established model for how opportunistic visits can be used to monitor the health of penguin populations efficiently and effectively over large spatial scales.

Clinical presentation of Pox virus disease in Magellanic penguins in Brazil

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From a total of 61 Magellanic penguins treated at the CETAS (Centro de Triagem de Animais Selvagens) in Florianópolis- SC/Brazil, all of them admitted after stranding around Florianópolis – SC/Brazil region from July to November 2012 due to petrolization and/or emaciation, five developed ulcerative wart-like lesions on apteric areas, such as the eye lids, during the rehabilitation process. Blood samples for haematological and serum biochemistry analyses were collected by jugular venipuncture. The results were compared to those found in healthy and released birds and we found statistically relevant differences ($P < 0.05$) in total protein, cholesterol, urea and uric acid serum concentration. The lesions were surgically removed and frozen during transportation. We used phenol-chloroform/proteinase K protocol to extract nucleic acids from a maceration of lesion scabs for molecular diagnosis. Polymerase chain reactions (PCR) and primers for the pox virus 4b core protein were identical to those described by Lee and Lee (1997). To get a better sequence, a sample was cloned using *E.coli* (JM109 strain) from which seven different clones were sequenced obtaining two different 475bp fragments from genera *Avianpoxvirus* that showed a nucleotide identity of 99.5% between them. We constructed *Neighbor-joining* trees using Kimura 2 evolutive modelling parameter and calculated estimates of the phylogenies by performing 1,000 NJ bootstrap replicates, using MEGA version 5 to create the phylogenetic trees. Phylogenetic analysis from these two cloned sample amplicons revealed they were 92.8% similar to a canarypox strain (GeneBank AY318871) from USA. Comparing to the Avianpox identified in Magellanic penguin samples in Argentina in 2007 (GeneBank JN615018) our clone strains AM190C1 and AM190C2 presented a low similarity of 74.8% and 74.4% respectively. Further analyses such as histopathology of necropsied positive penguins will be done to improve the knowledge of the poxvirus infection on these birds and whether this disease is an important threat to the species.

We are grateful to the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and São Paulo Research Foundation (FAPESP 2010/51801-5)

Morphometric and molecular sex determination of adults and chicks sex ratio of Magellanic penguins from Puerto Deseado, AR

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The recognition of sex ratios is a primary tool to start understanding the conservation status of species. Unequal sex ratios reduce the effective size of populations affecting the genetic diversity and increasing the inbreeding coefficients. Theory about sex ratios is well developed, however the structure and sex ratios of wild populations is less documented. Males of Magellanic penguins (*Spheniscus magellanicus*) are slightly bigger than females, but a geographical variation in size characters was verified for wide distribution, which may limit the accuracy of sex determination in the field. Here we tested the morphometric sexing for adults and sex-ratio of chicks from a colony of Magellanic penguins, based on molecular sexing techniques. The samples were collected from 30 adults and 21 chicks from Chaffers colony, Puerto Deseado, Argentina, during the breeding season of 2010. Bill depth and length were measured from the adults and blood samples were taken for all individuals to obtain the DNA used at the sex identification by PCR for the CHD1 gene using P2/P8 primers. The PCR products yielded one band for males and two bands for females when examined on a 3% agarose gel. The morphometric measures were checked for normality and then compared by the Student's t-test for differentiation between sex. The sex-ratio of chicks was done through Pearson's chi-squared test. Every statistical analysis were made using the Stats package in the R program. The three measures were significantly different between sexes ($p < 0.01$), and bill depth correctly classified 29 of 30 individuals (96.6%), what corroborates with other studies where bill depth had been the best parameter to differ sexes in Magellanic penguins. Only one male was misclassified according to bill depth, that could be an age dependent variation, which was also observed in other works. Bill length and weight even been different, were unable to distinguish sexes (70% and 36.6%, respectively). Chicks sex ratio does not differ from 1:1 proportion ($p = 0.65$), but just a little female skewed. As they were at crèche stage, it represents an equal investment of parents. Adults sex ratio at this stage was not performed because visits of nest are random. Finally, we can see that molecular sexing remains the best tool and bill depth measures could be useful to infer sex ratios and have an eyesight of the conservation status of penguin colonies, where this proportion is normally expected to be 1:1.

Population status of Fiordland crested penguin and Snares crested penguin

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New Zealand has four species of crested penguins, which breed on the mainland, offshore and sub-Antarctic Islands. Efforts to detect and monitor the population trend of the four species are being undertaken. Here we report on the known status and trend for Fiordland crested penguin and Snares crested penguin. Fiordland crested penguin (tawaki, *Eudyptes pachyrhynchus*) has had the most intensive monitoring effort, with both nest counts and chick counts, as well as banding to estimate adult survival. Analysis of the monitoring data for Fiordland crested penguin showed that nest counts indicated a 2.7% annual rate of decline and matrix population modelling indicated an annual rate of decline of between 1.4 and 7.0%, depending on the rate of chick survival used in the model. For Snares crested penguin (*Eudyptes robustus*), nest counts on two of three islands in the Snares archipelago in 2000, 2008 and 2010 indicated that the population is stable, with a total population of around 26,000 – 32,000 birds.

Introduction of a group of African Penguins (*Spheniscus demersus*) in a new exhibit: behaviour and visitor effect

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The conservation of an endangered species held in captivity is possible only if its welfare is guaranteed. Behaviour, a welfare index, may also be affected by the presence of human visitors. The aim of this study was to evaluate the behaviour of *Spheniscus demersus* (endangered species) specimens transferred from the South Lakes Animal Park (UK) to the Bioparco Zoom (Cumiana, Italy).

A large pool is at the disposal of the penguins in their new exhibit; the pool visually communicates with a swimming pool for visitors, from which is separated by two glass windows. In our study, we evaluated both the differences in the time spent by penguins to perform different behaviours and the visitor effect on their pool use.

The data collection, carried out on 7 penguins, took place during the months (June-July) of greatest visitor attendance; the sampling period was divided into three time periods of 15 days each (T1, T2, T3). Observations were carried out following the focal animal sampling method. Behaviour patterns are ascribable to 7 behavioural categories: "impassive postures", "vigilance", "comfort behaviour", "allopreening", "aggressive behaviour", "locomotion", and "pool".

The use of the pool by each penguin was measured in relation to the number of visitors located in front of the windows. The number of people in the swimming pool has been indicated in abundance classes from 0 (no visitors) to 3 (more than 30).

The observation lasted a total of 84 hours.

The results showed a significant difference in the duration of the categories "impassive postures" ($p = 0.018$), which decreases, and "aggressive behaviour" ($p = 0.009$), which increases.

Use of the pool by the penguins in relation to the number of visitors shows a negative correlation in all three time periods (T1: $p = -0.759$; T2: $p = -0.693$; T3: $p = -0.296$), statistically significant only in the periods T1 ($p < 0.001$) and T2 ($p < 0.001$).

We can interpret the decrease of inactivity and increase in aggressive interactions of the penguins as an improvement in the welfare of these animals, after an initial phase of acclimatization: the subjects show a more active and less inhibited behaviour. The number of visitors significantly affects the duration of the time spent by penguins in the pool during the first two periods, while in the third period this is influenced to a lesser extent, a result that allows us to hypothesize adaption to human presence.

The value of disease diagnostic work in rehabilitation centres and the value of this on the conservation of the African penguin

Dr. Nola Parsons

SANCCOB

Rehabilitation has been shown to have a beneficial impact on the population of the African penguin. There is also a caution that diseases acquired in rehabilitation could impact the health of wild birds. The African penguin has been reclassified as Endangered and all aspects that may affect the population decline should be considered. Disease has been raised as a concern especially in a vulnerable species and this importance increases with the decline of a population. Research done at rehabilitation centres may help to understand diseases seen in the wild, those seen in rehabilitation and the relevant importance of these on the wild population. It can also highlight other concerns such as endoparasitism, ectoparasitism and heavy metal and toxin levels that may be affecting the health of wild birds. Examples discussed include avian malaria, babesiosis, herpes virus, Newcastle's disease and cryptosporidiosis. Challenges include diagnosis and assessment of the disease in wild populations.

How do African penguins tolerate humans?

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Penguin colonies are popular wildlife tourist destinations, and African penguins (*Spheniscus demersus*) in South Africa present a major attraction for hundreds of thousands of tourists annually, generating important revenues partially reinvested in their conservation. Recent dramatic decreases in African penguin numbers make it important to identify whether human presence negatively impacts populations, as well to assess the potential habituation of penguins to human exposure. Short term behavioural responses of breeding African penguins to a single pedestrian approach were investigated on four colonies with different human exposure: Boulders beach colony (high), Bird Island (continuous), Robben Island (intermittent) and St Croix Island (rare). Prior to approach, levels of alertness of penguins differed between colonies (except for similar low levels at Boulders and Bird Island) and breeding stages. However, birds from the three least exposed colonies all reacted similarly and strongly to a human approach. After the approach, levels of alertness returned to pre-approach levels only in the most exposed colony, while levels of alertness followed the gradient of human exposure in the other three colonies. Our results suggest that habituation to human disturbance is limited in African penguins, eliciting strong aggressive responses even in birds continuously exposed to low levels of human presence. The high tolerance of penguins breeding at Boulders may have resulted from selection of disturbance-tolerant birds during colony formation at this mainland site, with further reinforcement by years of very high human exposure. We conclude that management practices need to be tailored to different African penguin colonies with distinct visitor guidelines and strategies for each.

Female-biased mortality in African penguins

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Biased sex ratios in wild populations can be of major concern for the survival of a species, and are easily overlooked in the wild due to the logistical difficulty of measuring sex ratios especially in rare species, where large sample sizes are logistically challenging. The main origin of skewed sex ratios is differential mortality between sexes. We investigated the sex ratio and mortality of African penguins admitted to a rehabilitation centre in the Western Cape of South Africa, at different age classes (adults, juveniles and chicks) and following different causes of admission (i.e. diseases/starvation, injuries or oiling).

Females constituted a significantly larger proportion of both adult and juvenile birds admitted at the rehabilitation centre, whereas sex was equally distributed among chicks. Oiling affected both sexes equally, but more females were admitted following injuries or starvation. While in adults the proportion of birds admitted due to starvation or injuries was similar, the large majority of juvenile birds (89.8%) were admitted due to starvation. Finally, a larger proportion of females admitted died, in all age classes (included chicks), compared to males.

This study showed strong female-biased mortality in African penguins in every age-cohort (chicks, juveniles and adults), mainly due to starvation or diseases. The higher mortality of female chicks reveals a higher vulnerability of females already at an early stage of life. Disparity in survival between sexes may be due to the smaller size of females that may limit their resilience, and mortality is increased during time of food shortage. The African penguin population experienced a large decrease in numbers recently mainly due to food shortage, and evidences exist that female African penguins travel further to forage than males when breeding. Such assessment of strong female-bias mortality at every age-class obviously suggests a male-skewed adult sex ratio (ASR) in the African penguin population, certainly increasing in the age-cohort. Skewed ASR can act as an Allee effect, for example increasing aggressive competition between males which fights can induce nests usurpation or loss, or reduced productivity. Skewed ASR increases the risk of extinction of threatened populations, and may accelerate the rate of decline of the Endangered African penguin.

Foraging distribution and diet of king penguins at marion island

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King Penguins are one of the four penguin species breeding at the Prince Edward Islands. At Marion Island, one of the two islands making up the island group, they number around 450,000 breeding pairs, which constitutes round 15% of the world population. They breed at 15 sheltered sites with gently sloping landing beaches where they import nutrients and act as a local agent of erosion. Due to their relatively high biomass in the Southern Ocean, King Penguins form an important constituent of this ecosystem. In this study we report on three years of tracking work (2008, 2011 and 2013) on King Penguins at Marion Island. We used both GPS loggers and satellite transmitters to study the at sea foraging distribution of breeding and post-breeding animals. Further on this, the diet of King Penguins has been monitored on an annual basis over the same study period. We here report on their diet which primarily comprises myctophid fish (*E. carlsbergi*, *K. anderssoni* and *Protomyctophum* spp.) and small squid (juvenile *K. longimana*).

Minimally invasive endoscopic surgery in penguins

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There are few reports of minimally invasive endoscopic surgery in penguins. In other captive and free ranging wild animals minimally invasive techniques hold notable advantages over open surgery, including small wounds, rapid recovery, minimal post-operative pain, rapid healing, and low rates of wound complications. These advantages also allow a more rapid return to aquatic environments, important in marine animals. Endoscopy provides magnified visualisation of organs, as well as some anatomic regions difficult to adequately visualise in open surgery. The Royal Zoological Society of Scotland (RZSS) was the first to successfully breed penguins in captivity, and since 1917 1423 captive penguins have been examined at post-mortem, with the findings analysed in efforts to improve captive penguin husbandry and veterinary treatments. 22 minimally invasive endoscopic surgical procedures were performed over a 3 year period from 2009-2012 in Gentoo penguins (*Pygoscelis papua*), King penguins (*Aptenodytes patagonicus*), and Northern rockhopper penguins (*Eudyptes moseleyi*). In 68% of cases (n=15) rigid endoscopic techniques were used, with 2.7mm-5mm diameter endoscopes, and in the remaining cases flexible endoscopy was used (n=7). The majority of cases were in gentoo penguins. The most frequent application was for gastrointestinal foreign bodies and obstructions (n=12). 10% of all previous penguin mortalities in the collection have been due to gastrointestinal foreign bodies and obstructions (n=147). Adult birds with gastric foreign bodies and obstructions were managed successfully using only flexible endoscopy, and all birds survived (n=3). Three recently hatched chicks had gastric obstructions of leaves and stones. These could not be resolved with endoscopy alone, and required conversion to open gastric surgery. 50% (n=6) of foreign body obstructions were intestinal and not reachable with flexible endoscopy. Two could be accessed via rigid coelomic endoscopy, and the obstructions then successfully surgically removed. Four birds were found on rigid endoscopic examination to have ruptured or perforated intestines, with severe coelomitis, and were euthanased under anaesthesia. The remaining endoscopy cases were diagnostic (n=10); most were rigid surgical endoscopy of the coelomic cavity and air sacs (n=9), for diagnostic and prognostic assessment of fungal air sac infections (n=8). Fungal respiratory tract infections, commonly due to *Aspergillus* species, have accounted for 36% of all penguin deaths (n=510) at the RZSS in the 1423 penguins examined at post-mortem. Minimally invasive endoscopic techniques appear to hold potential for further development and applications in penguins.

The effect of dietary change on mortality in a large captive gentoo penguin (*Pygoscelis papua*) population over a 47 year period

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Analysis was performed of the possible effects of diet on a captive population of gentoo penguins (*Pygoscelis papua*) between 1964-2011. This included analysis of mortality and reproductive data over the collections 100 year existence, and findings from 764 gentoo penguin post-mortem examinations. 335 of these were adult gentoo penguins examined post-mortem during the 47 year study period. The population reached a peak of 235 live birds in 2011. The population was self-sustaining, and between 1964-2004 the population was closed, with no birds imported into the collection. A change in diet from fresh whiting (*Merlangius merlangus*) to vitamin supplemented frozen herring (*Clupea harengus*) for a 7 year period until 2004 appeared to result in an increase in annual adult mortality rate from 5.41% to 20.83%, a difference of 15.41% (95% Confidence Interval of the difference 12.29-18.87%). Kaplan–Meier cumulative probabilities of survival confirmed a significant difference, (Wilcoxon ranked test p-value <0.001). Adult gentoo penguins on the frozen supplemented herring diet demonstrated a 18.93% decrease in 5-year cumulative survival probability (95% Confidence Interval of 13.54-24.32%), in comparison to birds on fresh whiting with no supplementation. Full nutritional analysis and comparison with published values of Antarctic krill (*Euphasia superba*) which is a significant component of wild gentoo penguins diet, was performed. The most notable differences were in oil and vitamin E content. Fresh whiting contained 3.9% oil and 0.74mg/kg Vit E, while supplemented frozen herring contained 15.9% oil and 28.08mg/kg Vit E. In comparison, Antarctic krill contained 2.8% oil and 0.78mg/kg Vit E in the published literature. On the basis of these finding the diet was changed to frozen blue whiting (*Micromesistius poutassou*), containing 3.5% oil and 0.73mg/kg Vit E, with no supplementation except thiamine, from 2005-2011, based on fish availability and cost. This change resulted in an improvement in annual adult mortality to 5.75% (95% Confidence Interval of 4.18-7.04%), similar to the mortality rate seen on the original diet, and consistent with the hypothesis. It is recommended on the basis of these findings that captive gentoo penguins are fed a low fat content fish species such as whiting (*Merlangius* and *Micromesistius* spp.) or hake (*Merluccius* spp.), supplemented with thiamine if the fish is frozen, and no additional Vit E or other vitamin supplementation.

Oxidative Status and Sexual Signalling in the Gentoo Penguin (*Pygoscelis Papua*)

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Oxidative stress results from the imbalance between reactive oxygen species production and the antioxidant capacity. Some penguin species appear to modulate their blood plasma oxidative status by adopting different foraging strategies such as feeding on krill that are rich in antioxidants. In the Gentoo penguin (*Pygoscelis papua*) beak color, which acts as a sexual signal of an individual's fitness depends on the intake in carotenoids, the main antioxidants in krill. To examine the interactions between oxidative status, diets, and sexual signals we compared blood plasma oxidative status, stable isotope, body condition and beak color in Gentoo penguins across breeding adults and non-breeding juvenile birds of both sexes at King George Island, Antarctica in December of 2010. Preliminary results suggest that while diets (i.e. plasma stable isotope values) were similar between these four groups, adults of both sexes had higher plasma antioxidant capacity and better overall body condition than juveniles. Interestingly, oxidative damage was highest in adult males but only differed significantly from juvenile males. Beak color analyses are on-going and will aid in identifying age and sex-specific trade offs between antioxidant defence and sexual signals.

Establishment and development processes of new Magellanic penguin colonies: Structure, breeding parameters, foraging distance and demography

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The process of colony establishment and development remains largely unknown. Few studies document the formation of new seabird colonies. We describe the ecological variables and breeding parameters of two new colonies of Magellanic penguins (*Spheniscus magellanicus*) in Patagonia Argentina that we studied early in their formation. We used the general principles of colony development models to compare with our observations. Penguins started to prospect at El Pedral colony (42°56'S, 64°20'W), a mainland location, in 2008, with 6 individuals occupying nests but laying no eggs. First eggs were laid and chicks hatched in 2009. The colony showed a very rapid growth ($\lambda=3.11$). Breeding success was highly variable, ranging from complete failure to 1.5 chicks fledged per active nests. Penguins foraging trips were very short with an average maximum distance from the colony of 26.69 km (range=16.45-38.61, n=222). The founder group settled down along the first line of vegetation adjacent to the beach. First nests were high quality deep burrows (up to 1.8 mts deep) dug under bushes, 5 to 30 meters from each other. The following years, nesting density increased at varying rates. During the breeding season, 80 to 150 non-breeders spent the day on the beach, prospected the colony at dusk, and overnighted in new nest sites. The number of penguins prospecting on the beach or molting increased steadily each year. Complejo Isote Lobos colony (41°26'S, 65°01'W), an island location, was found in 2002 with 22 pairs. By 2008 the growth rate of the colony was 1.91, (2.18 between 2002-2008 and 1.26 between 2008-2011). Breeding success was high and stable (1.14-1.34 chicks/pair). Foraging maximum distances averaged 45.46 km (range=38.73, 51.99, n=63). Nests were first built under bushes but after 6 years some penguins dug burrows while others occupied adjacent islets. Dunlop (2005) says that when colonies form, immigration is more important than natal recruitment. Emigration of breeders from other colonies was the unique factor that fueled the observed growth for El Pedral and the major factor for Complejo. Both new colonies were established in very close proximity to oceanographic fronts (thermal, haline and tidal) and wind driven upwellings, likely increasing prey density and enhancing foraging opportunities close to these colonies. As these colonies age, we expect immigration to become less important and natal recruitment more important in colony growth.

Vitiligo in an African Penguin...Black-footed, Well Not Exactly

Angela Pizza and Reagan Quarg

Jenkinson's Aquarium, New Jersey, USA

The year was 2007, Saba, a 12 year old female South African penguin housed at Jenkinson's Aquarium molted and soon after lost the black pigmentation in her beak and feet, leaving those areas fully pink. We ran a full avian blood profile screening for thyroid function, nutritional deficiencies, heavy metal toxins and aspergillus; nothing out of the normal.

Research into this change suggested skin inflammation, autoimmune or even a condition called "Vitiligo." In these cases, nutritional deficiencies ultimately alter melanin production. In the case of Vitiligo, patients low blood levels of B12, Folic Acid, and Vitamin C were the common factor.

Beginning November 2007 to present day we have supplemented her diet daily with vitamins B12, Folic Acid and Vitamin C. In a relevant study, prolonged oral administration of these vitamins followed a repigmentation without side effects. Treatment has shown some signs of improvement with black pigmentation on the bottoms of her feet, though we are not seeing repigmentation of the beak at all.

Despite several years of research reaching out to both captive and wild facilities her unique condition ultimately persists.

A multidisciplinary approach to the feeding ecology of a marine, central place forager, the Magellanic penguin *Spheniscus magellanicus*

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Central-place foragers and recent advances in the fields of habitat and species distribution modeling, animal tracking and isotopic ecology offer a unique opportunity to investigate the feeding response of marine predators to spatiotemporal variations in the availability of marine food resources. Accordingly, we present here a case study in which previous information on a well-known central-place forager, the Magellanic penguin (*Spheniscus magellanicus*) breeding at the Argentinean Patagonia, was analyzed in light of recent advances in habitat and species distribution modeling and Bayesian isotopic framework. This work provides the first quantitative evidences on the role of marine productivity patterns, fishing pressure, and intra-specific competition in constraining the diet and foraging distribution of penguins. Following their main prey distribution, obtained results suggested that penguins mainly feed on relatively warm waters (16 to 21°C) over the continental shelf (>200 m depth), thus suggesting a strong aggregative response of penguins towards the richest prey patches available within their foraging range. However, other commonly neglected features involving competence for food resources, i.e. abundance of conspecifics and fishing pressure, were also important factors constraining the diet and foraging distribution of penguins. Given the observed relationship between penguins' diet and breeding parameters, we argue that spatiotemporal variations in marine productivity patterns, fishing pressure and intra-specific competition may play a significant role in regulating penguins' reproductive performance, and hence, population dynamics. Proposed methodology could be extended to a large suite of central-place foragers, thus providing an important advance in the way we approach the feeding responses of marine predators to environmental variations in a rapidly changing world.

Gene diversity involved in Thermoregulation in Penguins

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Thermoregulation is a physiological process that controls the balance between the production and loss of heat in an organism to maintain body temperature. Birds and mammals are capable to maintain their body temperature constant minimizing thermal conductance. There are physiological processes that act from the cellular level to maintain temperature, these depend on the expression of proteins with a thermoregulatory role. The integrated regulation of all these proteins, involved in different aspects of the cellular physiology, largely determine the capability of tissues and organisms to maintain functional balance, despite facing environmental condition fluctuations. However, the physiological adaptations that an organism can perform will always be limited by its genetic constitution, then reducing the range of environmental conditions that the organism can tolerate. In humans there are gene variants involved in thermoregulation determined by selective pressure influenced by climate. Penguins represent a suitable model to study gene diversity involved in thermoregulation, as they are found in a wide range of environments and temperatures across different latitudes in the Southern Hemisphere. Climate played an important role in penguins' speciation in Antarctica (*Pygoscelis*) followed by the South American continent (*Spheniscus*). Likewise, recent climate change is affecting the Antarctica continent, and therefore the distribution and population size of the three *Pygoscelis* species (Gentoo *P. papua*, Chinstrap *P. antarctica*, and Adelie *P. adeliae*). Thus, we are studying polymorphism in genes associated to temperature to understand adaptation to different climate between penguin's species from South America (*Spheniscus mendilicus*, *S. humboldti* and *S. magellanicus*) and Antarctica (*Pygoscelis papua*, *P. antarctica* and *P. adeliae*). We have collected blood samples from Antarctic penguins (*Pygoscelis*) and South American penguins (*Spheniscus*) from 18 populations. To detect selected genes we have amplified and sequenced mitochondrial DNA sequences (ATP6, CytB, COX1) and nuclear genes (UCP3, HSPs). We are evaluating selection signature in genes involved high temperature regulation in *Spheniscus* genus when compared to *Pygoscelis* species. We are also evaluating selection signature in genes related to low temperature in *Pygoscelis* ssp. The information obtained in this study can contribute with knowledge about the health of the penguin populations, given the climate change threat.

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Challenges of drug therapy for the treatment of chronic Aspergillosis in Magellanic penguins (*Spheniscus magellanicus*)

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Aspergillosis is the most common infectious disease in captive or rehabilitation penguins. The early diagnosis and treatment are considered one of the major challenges in penguin medicine.

One individual of Magellanic Penguin (*Spheniscus magellanicus*), kept in captivity at the Aquário de São Paulo, started showing a progressive case of lethargy, anorexia, leukocytosis with heterophilia, reactive lymphocytes, hyperproteinemia and hyperglobulinemia. Treatment with Enrofloxacin, Itraconazol, Meloxicam, Ranitidine and Sylimarín was established. The animal had intermittent worsening and improvements in the following weeks. Sorological test revealed positivity for *Aspergillus*; PCR for *Chlamydophila psittaci* showed negative results. Radiographic examination revealed a structure in the left ventral thoracic region (6.1 x 6.7 x 7.4 cm), hollow, with thick walls and intensely radiopaque (2.0 cm). Treatment with Voriconazol (VFEND® 4mg/kg, PO, BID), for 20 days was established. The previous treatment was maintained. After three months of the initial diagnosis the animal was extremely lethargic and isolated from the group. The animal died with heavy dyspnea and pale mucous membrane. At the necropsy it was confirmed that the thoracic mass was the left cranial thoracic air sac. The wall was thickened with white-grayish solid purulent material. *Aspergillus fumigatus* was cultured. Histologically the lesion was characterized as pyogranuloma, with fungal hyphae visible at periodic acid-Schiff. The Voriconazol has shown promising results in the treatment of aspergillosis in humans and other birds, however, more studies are needed to establish the optimal dose to achieve effective concentrations and the effects of this drug in penguins. We concluded that surgical excision could have been an alternative to reverse this clinical case, however, the severe debilitation, commonly observed in the cases of aspergillosis, would remain a limiting factor.

Collaboration is good news for African penguins

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Concepts coined to differentiate, such as in- and ex-situ, are losing their shine as more and more zoos and aquariums actively support field conservation and research projects as extensions of species in their collection, leading to enhanced visitor experience, inspired staff, and more conservation dollars being invested into projects in the field.

African penguins are held at over 100 institutions throughout Europe and the United States. Research shows that they are the most popular exhibit with visitors, which makes them perfect ambassadors to share the conservation concerns for this species in decline.

SANCCOB in South Africa is a hub for rehabilitation, chick rearing, breeding, research, education and advocacy for African penguins and other seabirds– it is a touchstone for animal keepers, researchers, volunteers, interns, funders and penguin friends.

Examples of collaboration include the multi-partner African penguin Chick Bolstering Project, Keeper-exchange programme, disease- and health-related research of mutual benefit; education lessons, Africana penguin awareness day, fresh visual and factual information for exhibits, and a focused approach towards messaging about the species.

Survival and movements of Magellanic penguins rehabilitated from oil fouling along the coast of South America, 2000-2010: an update

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Oil pollution is a significant threat to all species of penguins. We examined data from six institutions rehabilitating penguins along the coast of South America: Emergency Relief Team of the International Fund for Animal Welfare, *Fundación Mundo Marino*, *Centro de Recuperação de Animais Marinhos-FURG*, *Associação R3 Animal*, *Natura Patagonia*, and *Mar del Plata Aquarium* and data from band resightings and recoveries in Argentina, Brazil, Chile and Falkland Islands/Islands Malvinas.

From 2000 to 2010, 2183 oiled Magellanic penguins were rehabilitated as part of these organizations' routine activities or during emergency responses to eight oil spills. All rehabilitated penguins were flipper banded and released after meeting specific health criteria. In the time between their release and 31 December 2012, 43 penguins were resighted or their bands were recovered. Of these, 72% were alive when resighted. In many cases, the rehabilitated penguins travelled between several hundred to more than 2400km from their release location. Resightings extended for up to 9 years with two rehabilitated juveniles resighted after 8 and 9 years as breeding adults. Our results clearly indicate that rehabilitated oiled Magellanic penguins are able to survive for extended periods and swim considerable distances after being released far from their breeding grounds.

While the implementation of preventive measures, policies and surveillance should remain priorities in the reduction of negative impacts of oil exploitation on seabirds, our results demonstrate that rehabilitation is an important contribution to the mitigation of adverse effects of oil spills on Magellanic penguins.

Avian malaria diagnosis and MHC gene diversity in Humboldt penguin (*Spheniscus humboldti*) and Magellanic penguin (*Spheniscus magellanicus*)

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Avian malaria is a disease caused by species of the *Haemoproteus*, *Leucocytozoon* and *Plasmodium* genera. It affects all bird species, causing varied symptoms depending on the susceptibility of the host species. In penguins (Sphenisciformes), a high mortality (50%) has been evidenced in captive colonies. In Chile, few epidemiological studies of penguins have been done. Furthermore, two Magellanic penguins were found to be positive to *Plasmodium* in a rehabilitation center in Chile in 2010. The evolutionary and adaptive potential of endangered populations and species relative to the threat of an emerging disease such as avian malaria has been studied assessing the major histocompatibility complex (MHC). The MHC is a gene family related to vertebrate Lymphocyte T immune response and thus resistance to pathogens. Evolutionary mechanisms, such as the heterozygous advantage and the frequency-dependent selection are pathogen-driven selected to maintain the high variation at MHC loci. Two classes of MHC genes, MHC class I and MHC class II, are described for birds. Therefore for the epidemiological study of avian malaria and MHC gene diversity in wild Humboldt and Magellanic penguin colonies we obtained blood samples from 450 Humboldt penguins and 240 Magellanic penguins from 10 different colonies in Chile, Argentina and Peru. To identify the presence of malaria we used specific primers for the mtDNA cytochrome b for all three genera, and to analyze the MHC gene diversity we used specific primers for the exon 2 and 3 loci of the MHC I and II genes. The presence of avian malaria in most of the analyzed colonies was inexistent, with exception of Punta San Juan in Peru where we obtained one positive sample. The small amount of infected penguins could be due to the high morbidity and mortality of the species in wild populations due to avian malaria, where the infected individuals don't reach the reproductive fazes (sampled individuals). This could be supported by analyzing individuals that end up in rehabilitation centers in the Chilean territory. On the other hand, it is possible that the low prevalence of malaria found in this study is simply due to low prevalence in the wild populations of penguins. Furthermore, in a parallel study analyzing the terrestrial bird ensemble that inhabits the same habitat we found a prevalence of approximately 14%; therefore, these species can act as reservoirs for the disease in these localities.

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The Detroit Zoological Society's Penguin Conservation Centre: re-establishing the state of the art for captive penguin wellbeing and extreme guest experiences.

Scott Carter and Tom Schneider

Detroit Zoological Society

The Detroit Zoo's innovative physical master plan includes the establishment of a unique Conservation Campus to provide focused visitor experiences highlighting the conservation of unique groups of animals. Central to this area will be the new Penguin Conservation Center, which is currently in development.

The Detroit Zoo's Penguinarium, opened in 1968, was the country's first and largest indoor facility designed for and devoted to penguins. With year round climate control, the Penguinarium provides captive penguins with conditions similar to their natural habitat. The Penguinarium established the state of the art for captive penguin environments in 1968, but we have learned much over the past forty years about exhibiting penguins and about problems penguins face both in captivity and in the wild. The new Penguin Conservation Center redefines state of the art for captive penguin environments as well as for dramatic, immersive learning environments for zoo visitors.

Antarctic field experience and expertise is key to the authentic design of the new Penguin Conservation Center. The Detroit Zoo works with leading Antarctic ecology and penguin expert Bill Fraser to tap into decades of learning about penguins and Antarctic ecology. Bill's knowledge and experience helps form the penguin environment, the visitor experience and education messages.

The existing facility has several unique features such as a circular pool and walking paths that are important to penguins, and the new facility will expand on these features. The volume of water will increase nearly ten-fold, from 35,000 to 300,000 gallons. The land area will more than triple and have a variety of substrates, nesting areas, water features, and climbing surfaces.

The Penguin Conservation Center will be a one-of-a-kind, 4-D immersion experience for visitors. Visitors will be exposed to some of the extreme conditions of Antarctica through digital projection and 4-D theatre technology from the very beginning of their experience. Visitors will experience passage on a research ship crossing the Drake Passage to Antarctica as they descend to one-of-a-kind underwater passages and viewing galleries where they will experience penguins underwater through a 5 meter by 9 meter under water window and just-for-kids acrylic viewing bubbles.

The Detroit Zoological Society's Center for Zoo Animal Welfare is developing pre- and post-occupancy studies of the penguins to document behaviour in both the current and planned environments. Knowledge of impacts on penguins is critical to establishment of penguin design standards for current and existing penguin facilities.

***In-situ* conservation of the Humboldt-Penguin (*Spheniscus humboldti*) – sustainable protection measures for a popular, threatened species by means of research, networking and environmental education in South America and Europe**

Schubert, Christina, Knauf, Gabriele, Knauf, Werner

Sphenisco – Conservation of the Humboldt-penguin / Zoo Landau in der Pfalz, Germany

The wild populations of Humboldt-Penguins (*Spheniscus humboldti*) offshore the coasts of Chile and Peru are threatened by a variety of factors. The reduction of the fish population by overfishing and climatic changes, ocean pollution, and illegal harvesting of guano is taking away the Penguin's, and other threatened marine species', basis for life. In addition animals die as being trapped in gillnets, by fishing through the use of dynamite, or they are caught and eaten, used as fish bait or illegally traded and held as pets. Uncontrolled tourism destroys the breeding colonies and reduces the clutch's chance of success. The IUCN states the species' population trend as decreasing and protection measures such as protection of breeding sites, creation of marine reserves and establishment of awareness programmes must be implemented and intensified in the short term. The German non profit organisation "Sphenisco – Save the Humboldt-Penguin" aims to support the *in-situ* conservation actions of this species in co-operation with scientists and conservationists in Chile and Peru, such as Prof. Guillermo Luna (Universidad Católica del Norte, Coquimbo, Chile), Dr Alejandro Simeone (Universidad Andres Bello, Santiago, Chile), MODEMA (Movimiento en Defensa del Medio Ambiente), ACOREMA (Areas Costeras y Recursos Marinos) and others. Since its foundation in 2008 Sphenisco supports research on population dynamics, projects to eradicate invasive species on breeding islands, environmental education campaigns and local ecotourism companies. One of the most important as well as successful actions in the past was the fight against the planned coal power plants that threatened the National Protection Area of the Humboldt-Penguin. Future aims are the reduction of bycatch and the support of the creation of a new marine reserve around one of the most important breeding sites. The Humboldt-Penguin is a very popular species held in over 80 zoos in Europe. Its popularity makes it a perfect ambassador for the problems its conspecifics are facing in the wild. Besides the environmental education campaigns in the natural range of the species, information about its threats and the relationships of modern consumers' behaviour, for example regarding consumption of fish and use of fertilizers, and the impact for threatened species such as the Humboldt-Penguin on the other side of the globe are highly important. Sphenisco's work is supported by 13 European zoos, Antarctic Research, a scientific association and other institutions whose environmental education efforts multiply the publicity of the problems of this highly threatened species and the aims of the association.

A collective effort to save yet another African penguin: Beak's long journey to recovery

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The African penguin is one of southern Africa's flagship endemic seabird species, and was recently re-classified as endangered on the IUCN Red Data List due to the alarmingly rapid population decline. Rehabilitation has played a major role in the conservation-story of these birds, and the specialist veterinary care given to this one bird, could have a significant impact on how wild penguins with severe beak injuries are treated in the future.

In October 2012, an adult penguin from the Boulders penguin colony was involved in a motor vehicle accident and the bird suffered extensive injuries to its mandible and head. The bird was stabilized and rehabilitated for two months by SANCCOB, before it was flown to Johannesburg, where an internationally renowned dental expert based at the Faculty of Veterinary Science of the University of Pretoria, conducted surgery to successfully reconstruct the mandible. Pre- and post-operative care was provided by the National Zoological Gardens of South Africa. *Beaky* is now recovering at the Zoo, and his post-surgical recovery progress and adaptation to his new beak has been remarkable. The desired outcome is that the mandible will develop new bone formation that will deem *Beaky* fit to return to the wild.

This collaborative effort amongst rehabilitation experts, specialist veterinarians, and a zoo has advanced knowledge and technical expertise in the rehabilitation field, which will benefit birds suffering from similar injuries in the future, with the hope to release even more birds back into the wild following major surgery.

The initial journey of an endangered penguin: implications for seabird conservation

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Marine top predators are important for ecosystem functioning, but often have poor conservation statuses. Many range over large areas throughout their lives, making use of specific ecological hotspots. Their conservation demands that these hotspots are identified and managed appropriately, but tracking studies focus predominately on breeding and post-breeding adults. The at-sea behaviour of post-fledgling seabirds is severely understudied, despite the fact that juvenile survival and recruitment into breeding populations can have critical impacts on population dynamics.

We report the first deployment of satellite transmitters on fledgling African penguins as a preliminary step in determining the key habitats used by non-breeding members of this species. During 2011, five hand-reared chicks were released at breeding colonies and tracked during their initial dispersal. In 2012, another three partially hand-reared chicks and three naturally-reared chicks were tracked from Robben Island, on South Africa's West Coast. Location data were received for a mean (\pm SD) of 65 ± 33 days, during which time the birds dispersed in a clock-wise direction around the coast. The birds travelled quickly away from breeding colonies (>100 km within 6 days) to a mean (\pm SD) maximum distance of 1023.2 ± 549.9 km from their points of release in 2011 and 733.7 ± 352.6 km in 2012. In 2011, three birds were tracked up to central Namibia, while in 2012 one bird went north of Lüderitz, southern Namibia. The remaining birds stayed along South Africa's West Coast. Two key foraging areas were identified in regions of high and reliable primary productivity, one off central Namibia, and one off South Africa's West Coast, close to a known nursery area for forage fish.

A shift in the relative abundance of forage fish away from the West Coast has been noted in South Africa, while in Namibia penguins rely on low-energy prey following overfishing. So, while the areas utilized by the fledglings may have historically represented profitable foraging grounds, movement onto the West Coast and into Namibia today suggests minimal capacity for individual adaptation to local habitat degradation. An additional 40 fledglings will be tracked throughout the species' breeding distribution in 2013 to confirm if the patterns observed here are stable and reproducible. In any event, neither of the foraging areas identified has any formal protection, underlining the importance of adaptive strategies to preserve key foraging hot spots for seabird conservation.

Minimal invasive blood sampling from penguins with blood sucking bugs

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Conventional sampling of blood from small and/or wild animals is very difficult since the animals are stressed strongly and can be severely affected by the procedure and/or anesthesia. Triatomines are the largest blood-sucking insects and feed on all warm-blooded animals including warm amphibia and reptiles. These insects develop through five nymphal instars ingesting increasing amounts of blood which is stored in the distensible stomach. There it is concentrated by the withdrawal of the fluid components and remains essentially undigested. Since the blood can be withdrawn easily with a syringe and used for determination of blood and physiological parameters and for the identification of pathogens, triatomines offer a minimal invasive method to obtain blood samples. This fulfils the main goal in zoos to avoid a disturbance of the animals, which are very valuable and can easily be damaged or even killed in the course of anesthesia. In addition, zoological staff is also endangered if they try to catch zoo animals for anesthesia. So far these "Living syringes" have been used in our studies in regular zoo veterinary practice for the determination of blood parameters in total in over 150 samples from 61 species.

In the present investigation, the application possibilities of the blood sucking bug *Dipetalogaster maxima* was tested in common zoo practice with African penguins (*Spheniscus demersus*) and King penguins (*Aptenodytes patagonicus*). Blood values up to 1.1ml could be obtained from single blood-sucking bugs. Thereby, the stomach content taken from just one bug was sufficient to obtain all relevant clinical parameters via photometric, potentiometric or counting methods. Blood obtained of bloodsucking bugs was used for example for determinations of concentrations of blood sugar, leukocytes or kidney parameters. First results showed no significant changes in the first six hours after blood ingestion of the bug. The concentrations of potassium were a good indicator to judge the haemolytic process in the sample collected via blood-sucking-bugs and therefore to conclude the use of this gentle method to obtain blood samples without disturbing the animals.

Tristan da Cunha – SANCCOB’s remote response to save oiled Northern Rockhoppers

Venessa Strauss

SANCCOB

The sinking of the *MV Oliva* and the subsequent oiling of more than 4,000 Northern rockhopper penguins resulted in a wildlife response on the world’s most remote island, Tristan da Cunha, in the South Atlantic. A team from SANCCOB (Southern African Foundation for the Conservation of Coastal Birds) was despatched to work with islanders for a period of 4 weeks to undertake the task to rehabilitate the penguins affected as a result of this spill. As with all wildlife responses, there were unique challenges encountered as a result of the remoteness of the spill location; lessons learnt in terms of equipment required, capacity building and training, facilities, and adapting standard operating procedures for species which has never been rehabilitated on a large scale. The incident turned international focus onto the Northern Rockhoppers and Tristan. As a result SANCCOB and Tristan are working towards conservation measures to mitigate the effects of future spills.

Climate Change in Areas of Penguin Inhabitation – A Brief Overview

Dan Suri

Met Office

The Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report, published in 2007, presented a consensus opinion regarding the state of climate change around the world. Pertinent to regions inhabited by penguins, this report, and subsequent published research (for example Turner et al 2011), has presented evidence showing that the Antarctic Peninsula and parts of the surrounding ocean area have warmed quicker than the rest of the Southern Hemisphere. A warming trend has also been noted across Australia and New Zealand, including offshore islands such as Macquarie Island. Meanwhile, elsewhere around the Antarctic a cooling trend has been observed over East Antarctica whilst climate change trends are less distinct across West Antarctica.

With the next IPCC Assessment Report due to be published in 2013/2014, heightened and widened interest in the current state of climate change thinking is anticipated during the next twelve to twenty-four months. With this in mind, a brief overview of current thinking regarding climate change, including prognoses for future trends, in areas where significant penguin populations exist is presented with a view to updating some of the findings published in the 2007 report.

This overview draws heavily on the author's own experience working as a weather forecaster on the Falkland Islands and current research being undertaken at The Met Office Hadley Centre, one of the world's leading centres for climate science research. It is hoped that this overview will be of interest to those involved in penguin research, for example in conservation planning, as well as offering some basis for selecting areas of interest for future research.

Are artificial burrows an ecological trap for Little Penguins?

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The persistence of many cavity nesting animals is threatened by habitat modification and a shortage of suitable breeding sites. Providing nest-boxes on suboptimal habitat is an effective conservation strategy only if populations avoid an 'ecological trap' whereby animals are lured to nest-sites which result in poorer breeding output and a decline in population growth rates. We evaluated the effectiveness of providing nest-boxes for Little Penguins *Eudyptula minor* compared with natural nests over 25 years. Little Penguins readily adopted nest-boxes and breeding attempts were recorded in about 92% of nest-boxes installed for seven years or more. Breeding productivity from 6081 monitored clutches was higher from nest-boxes than natural burrows. Survival rates to hatching and fledging were 8.4% and 8.6% higher in nest-boxes, respectively. Similarly, the total observed mass of chicks produced per clutch was 14% higher. However, annual site fidelity of 6166 breeding penguins was 1.1% lower in nest-boxes than at natural burrows despite an average 35% of natural burrows collapsing each year. Nest-boxes are not an ecological trap for Little Penguins but the long-term goal of a self-sustaining population must address underlying processes inhibiting local population recovery and manage the transition of the population back to natural nest-sites.

Population trends in a substantial colony of Little Penguins

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Estimating long-term population trends is vital for the conservation and management of species, yet few trends exist and fewer still are verified with independent measures. We compared three independent measures of population size change over 27 years (1984 to 2011) for a significant Little Penguin colony in south-eastern Australia: (1) a series of 15 colony-wide surveys conducted in 10 separate years, (2) mean nightly counts of penguins returning to breeding sites (365 counts x 27 years) and (3) population growth rates based on survival and recruitment rates. Trends indicate a doubling of the population from 1984 to 2011 despite a marked population contraction linked to a mass mortality of a key prey species. The measure of beach counts was not representative of population trends for the population as a whole. The colony appears secure but is vulnerable to changes in the marine and terrestrial environments.

Activity Report of Penguin Fund

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In this poster we report the activity of “Penguin Fund” in Japan.

Penguin Fund in Japan, founded in 1986, is a volunteers’ group of penguin lovers in Japan with a motto: “Sharing our future with Penguins”.

The aims of Penguin Fund are as follows: (1) To open and sustain contacts with individuals and groups engaged in penguin research and protection all over the world, and provide support in any way possible, (2) to coordinate the sending of volunteers to penguin habitats and reserves, (3) to publish books, brochures and other informative materials on penguins, and (4) to collect literature on penguins and penguin goods.

To accomplish these aims we have meetings every two months to hear talks of people such as penguin researchers, keepers of zoological gardens, artists and penguin lovers. We also do fund-raising by auctioning penguin-related goods every two month. Through these activities and donations we have contributed to conservation and research of wild penguins in all over the world, including Phillip Island Nature Park in Australia, Charles Darwin Research Station in Ecuador, New Zealand’s Yellow-eyed Penguin Trust in New Zealand, and SANCCOB (Southern African Foundation for the Conservation Birds). Donations went to many individual penguin researchers as well.

When the First International Penguin Conference (IPC) was held at Dunedin in New Zealand in 1988, Penguin Fund of Japan offered to help finance the conference. Since then Penguin Fund has continuously supported IPC, which has been held every 4 years. Some of the members have attended IPC conferences to report new research results and to exchange information with researchers in the world.

Occasionally, we publish new books, translations, brochures and post cards, all of which are related to penguins from many aspects.

Some of our members visited penguin habitats to observe and investigate wild penguins. We call the tour PENRE (Penguin Research Expedition). Since 1989, our members visited King George Island and Patagonia (1989~1990), New Zealand South Island, Stewart Island, Auckland Islands (1989~1990), New Zealand South Island (1996), Sub-Antarctic (1994~1995), Galapagos Islands (1997), and Tasmania (2009).

We are doing these kinds of activities for penguins with great pleasure. The details will be presented on our poster.

Censussing Humboldt Penguins in Peru; techniques and teamwork for a common goal

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The Humboldt penguin (*Spheniscus humboldti*) is currently listed as “vulnerable” by IUCN Red List. Its range in the wild extends from La Foca point in northern Peru to Puniuil Island in Chile. Its population decline can be attributed to many factors, including overfishing of the main food source, Anchovetta, by industrial and artisanal fishermen, the depletion of prey items during severe ENSO weather events, the loss of suitable nesting habitat and human disturbance. Censussing of the birds started as a result of the 1998 PHVA (Population Habitat and Viability Analysis) where biologists from Peru and Chile met to discuss the issues at hand and how to get an annual count on the penguins in order to better monitor the population. This meeting happened to coincide with the 1997-98 El Nino event that occurred along the coast, when populations of marine animals, mammals, birds and invertebrates, plummeted to an all time low. Resulting from the meeting, was a methodology by which both Peruvian and Chilean biologists would do simultaneous counts along the coast during the same time period, therefore ensuring accuracy in the counts. After completing several censuses the collaboration of biologists from the Peruvian community grew into “teams” including biologists and NGO’s to reach the common goal of monitoring the Humboldt penguin population. Each “team” being responsible for counting their section of Peruvian coastline. This publication summarizes the techniques, the international cooperation of fellow biologists and the love for spending long days in slow fishing boats, all for acquiring over 10 years of census data for Humboldt penguins along the Peruvian coast.

Does the condition of adult African penguins (*Spheniscus demersus*) at onset of breeding affect breeding success?

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The African Penguin (*Spheniscus demersus*) was listed on the IUCN Red List as Endangered in 2010, due to continuing population declines since 2000. The penguin population on Robben Island, Cape Town, South Africa has been declining each year and many aspects are being investigated to explain this occurrence, with food availability being considered one of the main issues. An aspect of this that has not had much focus is observing the condition of adult penguins when they return for the start of the breeding season. Regional food availability during the non-breeding season could determine the condition of the adult prior to breeding. If an adult is in poor condition at the start of breeding then it could have an effect on their ability to provision their chicks and consequently impact chick survival and growth rates. Local food availability also plays an important role in ensuring that an adult stays in good condition during chick rearing. To evaluate this, a new system has been implemented for recording the weights of birds as they enter and leave the nest. This is done by setting up a scale on the ground in front of the nest, which will record a weight and automatically tare every 4 seconds, preventing the need for continuous handling and reducing stress to the birds. A camera trap is also set up so that it is possible to match up a recorded weight with when a penguin is standing on the scale. The images will also be used to distinguish between the partners and thus make it possible to determine the individual condition of each of the breeding pair prior to incubation and during the early stages of the breeding attempt. After weights are obtained, the breeding pair will be monitored to determine if the chicks successfully fledge. This system for recording weights has been successfully tested in the field with penguins breeding in wooden nest boxes, demonstrating that this technique has the potential to be a successful non-evasive method for measuring the mass of adult penguins. Data collection will be ongoing and completed during the 2013 breeding season in order to determine whether or not condition at onset of breeding has an effect on breeding success. The results of this will show the importance of ensuring sufficient food availability during the non-breeding period, which will help identify appropriate conservation strategies such as spatial management of fisheries.

Sex determination of Gentoo Penguins (*Pygoscelis Papua*) using molecular procedures to generate discriminant functions.

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Species sex determination in a short period of time is a useful tool for behavioral and ecological field studies; however, the sexing procedure for the Gentoo penguin (*Pygoscelis papua*) is difficult, due to the fact, that this species shows little sexual dimorphism which is the case for most seabirds. To avoid invasive techniques to sex penguins the use of discriminant functions has been of upmost importance. We collected a total of 200 blood samples of adult Gentoo Penguins from three locations in the Antarctic Peninsula. We used the amplification of CHD1 gene to determine the gender of each individual, and evaluate the use of different primer pairs (P2/P8, 2550F/2718R and PL/PR). Additionally, seven morphological measurements were obtained from each individual of these three different colonies which were used to evaluate spatial morphological variation, and to generate discriminant functions to predict the sex of *Pygoscelis papua*. The achieved equations will be very useful to obtain a correct gender determination which will contribute for future studies of the species.

Key words: Gentoo Penguin, *Pygoscelis Papua*, CHD1 gene, discriminant function.

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Avian malaria and Magellanic Penguins along the Atlantic coast of South America

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Avian malaria is a disease caused by *Plasmodium* sp protozoans, and may lead to rapid and dramatic mortality of penguins in captivity. Malarial infection of free-ranging penguins has been reported in a number of species (*A. patagonicus*, *Eudyptes moseleyi*, *E. pachyrhynchus*, *Megadyptes antipodes*, *Spheniscus demersus*, *S. mendiculus*) and locations (Galápagos Islands, New Zealand, South Africa, South Georgia Islands, Gough Islands). In the case of Magellanic penguins (*S. magellanicus*), there are numerous reports of avian malaria in specimens maintained in captivity or undergoing rehabilitation, and cases tend to occur in rapid outbreaks with elevated mortality. The infection of free-ranging Magellanic penguins, however, remains undocumented. As part of an on-going research project, we have conducted a large sampling effort to detect *Plasmodium* infections in live and dead Magellanic penguins from zoos, beach surveys and rehabilitation centres in Brazil, as well as at breeding colonies along the Argentinean coast. This project, which has included fourteen institutions and has examined nearly a thousand penguins, attempts to investigate the epidemiology, pathology and conservation implications of this parasite in Magellanic penguins along the Atlantic coast. In this presentation, we will review the literature and present our preliminary findings on the occurrence and distribution of *Plasmodium* parasites infecting Magellanic penguins from breeding colonies in Argentina, wintering grounds in Brazil, and rehabilitation centres and zoos in both countries. We will conclude by discussing whether avian malaria may be a threat to the conservation of Magellanic penguins.

We are grateful to the collaborating organizations, Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP 2009/53956-9, 2010/51801-5).

Avian malaria (*Plasmodium* sp) in Magellanic Penguins at Fundación Mundo Marino (San Clemente del Tuyú, Argentina)

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Plasmodium sp is a mosquito-borne protozoan, and approximately 40 species are known to infect birds. Although most avian species tend to develop relatively asymptomatic plasmodial infections, in some cases clinical disease (avian malaria) may develop and even death may occur. For reasons yet unclear, some avian hosts are more susceptible than others, and penguins are known to be among the most susceptible to this infection. Whenever they occur, avian malaria outbreaks tend to produce mortality of captive penguins, with up to 60-90% of the birds dying within a few weeks. Five species of *Plasmodium* have been reported infecting penguins: *Plasmodium* (*Haemamoeba*) *relictum*, *Plasmodium* (*Haemamoeba*) *cathemerium*, *Plasmodium* (*Haemamoeba*) *tejerai*, *Plasmodium* (*Huffia*) *elongatum*, and *Plasmodium* (*Bennettinia*) *juxtannucleare*; no *Plasmodium* species of the subgenera *Giovannolaia* or *Novyella* have been reported to infect penguins. In March 2010, two adult Magellanic penguins that were held at the reproduction colony of the Oceanarium Mundo Marino (San Clemente del Tuyú, Buenos Aires Province, Argentina; 36°20'17" S 56°45'14" W) died suddenly. Necropsy revealed liver and spleen enlargement and hydropericardium. Liver imprinting smears were collected and Giemsa-stained, and revealed abundant tissue meronts characteristic of *Plasmodium*. Thin blood smears that had been collected on the week prior to mortality also revealed erythrocytic meronts and gametocytes. The morphological characteristics of the blood parasitic forms suggest these parasites belong to the subgenus *Novyella*; gene sequencing analyses will be conducted in the future and combined to a detailed morphological description to confirm the subgenus and identify the parasite species. This is the southernmost record of *Plasmodium* infecting penguins in Argentina (36°20' S) and is only 500 km north to the northernmost breeding colony of Magellanic Penguins (Islote Lobos, 41°25' S).

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Early diagnosis of aspergillosis in penguins through serological monitoring

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Aspergillosis is one of the most important diseases in captive penguins. It is caused especially by *Aspergillus fumigatus* and is characterized by non-specific clinical signs; most cases are confirmed only through post-mortem examination. Here we evaluated the efficacy of the antibody anti-*A. fumigatus* detection by double radial immunodiffusion in agar gel (IDGA) as an early diagnostic method for aspergillosis in Magellanic penguins (*Spheniscus magellanicus*). One hundred and thirty-four penguins that were in rehabilitation at Centro de Recuperação de Animais Marinhos (CRAM – FURG) between June 2009 and December 2011 were included in the study. Blood samples were collected from each penguin upon admission and every 7-15 days thereafter. IDGA was performed using commercially antigen and positive control (IMMY®). Necropsies were conducted for all penguins deceased during the study and used as the gold standard to diagnosis to calculate the sensitivity (S), specificity (Sp), positive predictive value (PPV) and negative predictive value (NPV) of IDGA. The diagnosis precocity of serology was analysed considering the period between the first positive IDGA and the appearance of clinical signs and death. From the 134 studied penguins, 33 died of aspergillosis: 31 by *A. fumigatus* (93,9%) and two by *A. flavus* (6,1%). Another four penguins died from other causes, and 97 were successfully rehabilitated. None penguin presented positive IDGA at arrival in CRAM. During serological monitoring, antibodies anti-*A. fumigatus* were detected in 27 animals: 22 of these died of aspergillosis, and five were released after 11 days of the positive IDGA without clinical signs. Another 108 had negative IDGA and 11 of those died of aspergillosis. Sensitivity and specificity rates were 81% and 89%, respectively, and PPV and NPV were 66% and 95%. The mean period to clinical signs appearance was 34 days after the first positive IDGA. Other studies with S, Sp, PPV e NPV rates from the IDGA technique to the diagnosis of aspergillosis in birds are not described. The sensitivity and specificity values above 80% observed in our study are similar to those described for this method for the diagnosis of sinonasal aspergillosis in dogs and aspergilloma and rhinosinusitis in humans, for which the technique is considered the golden standard. In conclusion, IDGA can be used as a valuable technique to serological monitoring for an early detection of aspergillosis in captive penguins.

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Investigating blood parasites of little penguins in Tasmania, Victoria and New South Wales – Australia

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Known blood parasites of penguins include *Aegyptianella* sp, *Borrelia* sp, *Babesia peircei*, *Haemoproteus* sp, *Leucocytozoon tawaki*, *Plasmodium* spp., *Trypanosoma eudyptulae* and nematode microfilariae. Of these, only two have been identified in wild little penguins (*Eudyptula minor*) in Australia: *T. eudyptulae* was identified in samples collected from 1986/87 in Tasmania, and *Babesia* sp was detected in samples collected from 1990-92 at New South Wales. On the other hand, *Plasmodium* sp was detected in blood samples collected in 2003-2009 from little penguins on Hauraki Gulf, New Zealand. The yellow-eyed penguin (*Megadyptes antipodes*) is sympatric to little penguins in New Zealand and has been found infected with *Plasmodium* sp at numerous locations throughout its distribution. During the 2012/13 season, we sampled blood from little penguins in Tasmania, Victoria and New South Wales, at the same locations where blood parasites had been previously detected and at previously unstudied sites. Blood smears were prepared, fixed with methanol, stained with Giemsa and Wright-Rosenfeld stains, and examined for a minimum 50,000 erythrocytes; differential leukocyte counts for 200 leukocytes were also conducted. The results will be presented and discussed in terms of epidemiology and health impacts of the blood parasites and their implications for the conservation of little penguins.

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Lethal concurrent avian malaria and aspergillosis in a Magellanic penguin (*Spheniscus magellanicus*)

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Avian malaria (*Plasmodium* sp) and aspergillosis (*Aspergillus* sp) are the two most relevant infectious diseases for captive penguins. We report the case of an adult Magellanic penguin (*Spheniscus magellanicus*) washed ashore at the coast of Rio de Janeiro state, Brazil, and that was transferred and died while undergoing rehabilitation at Centro de Recuperação de Animais Marinhos (CRAM-FURG), Rio Grande do Sul state, Brazil. Upon admission to CRAM-FURG on 13/11/2005, the bird was moulting off-season and had a low body mass (2.9 kg). Standard rehabilitation protocols were applied during the following two months, however hyporexia and progressive weight lost were observed. On 30/01/2006, with a body mass of 2.6 kg, the penguin presented apathy, pale mucosa, anorexia and dyspnoea, dying within 24 hours. Necropsy findings were characteristic of aspergillosis (thickened air sacs with multifocal fungal colonies) and suggestive of avian malaria (spleen enlargement with rupture and haemorrhage, lung congestion and oedema, liver enlargement). Histopathology, Gomori-Grocott histochemistry, microbiological culture and electron microscopy confirmed the involvement of both *Plasmodium* sp and *Aspergillus fumigatus*. Histopathology suggested the animal had a slow and progressive *A. fumigatus* infection until the more abrupt *Plasmodium* sp infection developed and produced death; it is, however, difficult to determine the extent to which *Aspergillus* was a predisposing condition facilitating the development of the malarial infection. Because the gross findings of aspergillosis are exuberant and promptly detected, institutions sometimes bypass histopathology or complementary diagnostic tests and conclude aspergillosis was the cause of death, thus potentially underestimating the prevalence of avian malaria and other pathological processes. This case therefore illustrates and emphasizes the importance of conducting histopathology and complementary diagnostic tests regardless how exuberant the aspergillosis necropsy findings.

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A range-wide conservation genetic study of Little Penguins (*Eudyptula minor*): Augmenting population genetics at neutral loci with the immunogenetic MHC

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I study conservation genetics and demography of Little Penguins (*Eudyptula minor*), the smallest penguin species and the only one to breed on mainland Australia. A main objective of my PhD project is to assess connectivity between an endangered population at Manly in Sydney Harbour and other penguin colonies along the coast of New South Wales (NSW). I therefore conduct a fine-scale analysis of genetic structure for NSW penguins to determine the extent of dispersal among these populations. I also collect demographic data on population size and survival rates using existing data and mark-recapture surveys. This information will be used to build a forecasting model to assess the likelihood that threats listed in the Manly Little Penguin Recovery Plan could significantly alter the population's growth rate or probability of extinction. Results will be used to facilitate the choice of management strategies for Little Penguins in NSW.

In addition to using neutral genetic markers, i.e. genes that are not influenced by natural selection, we present the first study investigating non-neutral genetic diversity in Little Penguins. Sequencing of an immune gene of the major histocompatibility complex (MHC) showed high allelic diversity at the functionally relevant peptide binding groove of the MHC molecule in penguins from WA. To conduct a range-wide population genetic study including microsatellite genotyping, sequencing mitochondrial DNA and the novel immunogenetic marker, wild populations have been sampled in WA and NSW, where care was taken to minimise disturbance and impacts on animals and ecosystems. We therefore trialled non-invasive techniques for both genetic sample collection and demographic estimates. Moulting feathers proved to be an unreliable source of DNA, whereas plucked feathers could be viable alternatives to blood sampling of penguins. For estimating survival rates and population sizes, burrow occupancy and beach counts could replace mark-recapture approaches.

It is very important for me to network with other penguin researchers. The International Penguin Conference (IPC) will be the first scientific conference outside Australia and the only one of its kind that I will be able to attend during my three-year PhD project. It will be a great opportunity to meet other scientists, present findings and get input for future directions of my work.

I plan to present my current work on Little Penguins in NSW, focusing on first results of genetic dispersal rates along the coast and a comparison of demographic surveys. I expect to get valuable feedback from other attendants of the conference.

PCR as a method of detecting avian malaria (*Plasmodium* sp.) and babesia (*Babesia* sp.) in African penguins (*Spheniscus demersus*) and its potential in research and crisis management

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African penguins (*Spheniscus demersus*) are hosts to various blood-inhabiting parasites. Traditionally diagnosis of infection is made by examination of blood smears. *Babesia* is relatively easy to diagnose from blood smears, but *Plasmodium* is often missed due to its extremely low concentrations in blood. Moreover, examining blood smears is time-consuming and requires observers experienced in recognising the parasites within erythrocytes to avoid incorrect diagnoses.

Although all efforts are being made to prevent the further decrease in African Penguin populations, the threat of potential crises (such as oil spills or natural weather anomalies) is always a major concern. A detection system based on the polymerase chain reaction (PCR) would be very effective during such crises, when hundreds or thousands of birds could be affected simultaneously, overwhelming rehabilitation centres and rescue efforts. Slide analysis is too labour-intensive and time-consuming when dealing with very large numbers of birds, and if the situation arose where certain birds needed to be prioritized, PCR could expedite the decision.

PCR is a sensitive technique that allows the simultaneous diagnosis of infections in multiple birds with low levels of blood-inhabiting parasites. However, to date, there are no published accounts of successful diagnosis of *Plasmodium* or *Babesia* in African penguins via PCR. This is possibly because traditional PCR methods require DNA extraction from blood samples prior to the reaction due to the presence of multiple polymerase inhibitors in blood.

PCR was performed on both dried and frozen whole blood samples, using a commercially available kit designed to perform PCR using whole blood as a template. Primers in the literature, designed to specifically amplify regions of *Plasmodium* and *Babesia* genes via PCR, were used to diagnose infected birds. The results of the PCR tests were cross-validated with traditional blood smear analysis, and a human malaria culture was used as a positive control for the *Plasmodium* primers.

Similar PCR tests could also aid in research surveys of population health, which are very important for endangered species. Parasite presence becomes more significant and aggravated when the birds are stressed, resulting in decreased body condition. Future research could include investigating this technique on other penguin species and potentially widening the range of tests to other blood-inhabiting parasites that penguins are exposed to, such as *Borrelia* and *Leucocytozoon*.

Chick Condition in African Penguins

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This study provides information on the development of a body condition index for African penguin (*Spheniscus demersus*) chicks, and subsequently provides results on the use of this condition index at a number of South African colonies.

The body condition of altricial seabird chicks is directly related to the amount of food they receive from their parents, which can in turn be related to feeding conditions at sea. An index of body condition is therefore a useful tool for assessing variation in food availability between different breeding colonies and over time. Quantile regression techniques were used to develop a body condition index for African penguin chicks based on maximal growth relative to structural size. The index is used to compare the body condition of a group of chicks, varying in size and of unknown age, between breeding colonies.

Breeding African penguins, being central place foragers, are sensitive to local food availability, which, in the Benguela upwelling ecosystem can vary substantially and thus influence the condition of chicks. Condition of chicks was measured at a target sampling interval of five to ten days at five South African colonies in 2008 and 2009. These colonies were Dassen and Robben Islands along the west coast, Dyer Island along the south coast, and Bird and St Croix Islands along the south east coast of South Africa. The condition index was used to compare chick condition between colonies, years and seasons. Data collected for African penguins at Robben Island in 2004, a year of average breeding success, was used as a baseline reference. Overall chick condition was significantly poorer in 2009 (0.287) than in 2008 (0.358), and poorer in 2008 than at Robben Island in 2004 (0.537). Chicks at Dyer Island had the poorest condition in both 2008 (0.280) and 2009 (0.207). In light of an experimental fishing closure that involved four of the South African colonies, the condition index was shown to be a useful tool to compare the body condition of cohorts of chicks between breeding colonies irrespective of their body size and when age was unknown. On account of the variable nature of the Benguela system, the chick condition index should preferably be interpreted together with other demographic and foraging information to assess local feeding conditions.

Pododermatitis in Captive Penguins During the 2011 Rena Oil Spill

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There are many husbandry considerations when dealing with penguins in a captive environment. Some are simple and easily managed; others are multifactorial and more complex. One of the issues for captive penguins is pododermatitis.

On 5 October 2011, the CV *Rena*, a cargo vessel en route from Napier to Tauranga, North Island, New Zealand struck the Astrolabe Reef off Tauranga and grounded. On 11 October 2011, the vessel suffered further damage, losing 350 tonnes of heavy fuel oil into the marine environment. For several days, thick oil washed up along the Bay of Plenty coastline with major impacts on local wildlife populations.

During the *Rena* oil spill response 383 live oiled Little blue penguins (*Eudyptula minor*) were collected from the wild and housed in a temporary treatment facility in Tauranga. Their care was undertaken by an experienced husbandry team led by veterinary personnel from Massey University, New Zealand. Despite specialist care some secondary captive conditions arose during the response, the most common being pododermatitis.

In a clinic setting pododermatitis is managed by addressing obesity, hygiene, nutrition and substrate issues. During an oil spill the animals are managed according to herd health principles as opposed to case by case basis. This paper will address these key management differences.

A challenge during the *Rena* response was the delay in release due to ongoing oil discharge from the vessel and re-contamination of release sites. Therefore the penguins were kept in the temporary facility longer than expected. A key management issue was the use of rubber tube matting as the substrate in rehabilitation aviaries. Initially this substrate increased the incidence of pododermatitis until a similar product with more cushioning was sourced.

The treatment plan for pododermatitis during the response included a grading system for each bird, oral pain relief, antibiotic therapy, surgical debridement under sedation, and increased durations of enforced swim to reduce time the penguins spent on their feet.

Critical lessons learned from this spill will be applied to manage pododermatitis during future spills as necessary.

Foraging ecology and diving behaviour of crested penguins at Marion Island, sub-Antarctica

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Global populations of Macaroni (*Eudyptes chrysolophus*) and Southern Rockhopper Penguins (*E. chrysocome filholi*) are decreasing and both species are listed as Vulnerable. Drivers of their declines are poorly understood, perhaps linked to recent climate shifts in the Southern Ocean, and thus it is important to gain deeper insights into the foraging ecology of these species at breeding sites where data is insufficient.

The Prince Edward Islands (PEIs) support ~4% and ~7% of the global populations of Macaroni and *filholi* Southern Rockhopper Penguins, respectively, and in the last two decades their numbers at Marion Island have declined by 30 and 70%. In recent years Rockhopper Penguins arriving at Marion Island after the overwintering period have been in poor body condition, suggesting that prey availability at their winter feeding grounds has either decreased or shifted. Also, there is evidence of a southward shift in the position of the Sub-Antarctic Front, which means that intrusions of warmer and less productive sub-Antarctic waters to the islands are becoming more common.

In order to better understand how these species might adapt to ecosystem changes it is necessary to establish baseline data on how they utilise their marine environment. Global Positioning System (GPSs) loggers and Time-Depth Recorders (TDRs) were used to investigate at-sea spatial usage and diving behaviour of both penguin species during the austral summers of 2011/12 and 2012/13*. We present information on incubation, brood-guard, crèche and pre-moult foraging trips.

During incubation, Macaroni Penguins travelled 463-755 km SE of the islands (n=3). During the brood-guard phase, Macaroni Penguins foraged for longer (37.3 h) and further away (53.1 km) than Rockhopper Penguins (25.1 h and 41.8 km). Macaroni Penguins also dived deeper (32.8 m) and for longer (106 s) than Rockhopper Penguins (25.6 m and 70 s). During chick crèching, both species exhibited short and long trips, with average trip durations and ranges of short trips being 15.8 h and 30.0 km for Macaroni Penguins and 13.2 h and 11.2 km for Rockhopper Penguins. Respective trip durations and ranges of long trips were 195.5 h and 323.2 km, and 300.5 h and 314.1 km. Finally, during their pre-moult trips, Macaroni Penguins travelled 747-1182 km SSW of the islands for 27-45 days (n=5).

These results provide a useful baseline for comparison with future years and further our understanding of the links between land-based top predators and life in the water column at the PEIs.

Heart rates of emperor penguins diving at sea: implications for oxygen store management

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In penguins, heart rate contributes to control of blood oxygen (O_2) depletion through regulation of the magnitude of pulmonary blood flow/gas exchange and through regulation of peripheral blood flow, especially to muscle. Therefore, we measured heart rates (f_H s) during dives of emperor penguins (*Aptenodytes forsteri*) in four birds equipped with digital electrocardiogram (ECG) recorders and time depth recorders (TDRs) during foraging trips from the Cape Washington colony. In 398 dives as deep as 454 m and as long as 9.4 min, dive f_H (total beats / duration) and minimum instantaneous f_H decreased significantly with increasing dive duration. Mean dive f_H was 57 ± 1 beats min^{-1} for dives > the previously measured 5.6 min aerobic dive limit (ADL; dive duration associated with the onset of a net accumulation of lactic acid above resting levels), significantly < the dive f_H of 66 ± 1 beats min^{-1} for dives < the ADL; both values were less than the previously measured resting heart rate of 73 ± 2 beats min^{-1} . Heart rate profiles in shallow, short duration dives were similar to those of other free-ranging penguin species. However, heart rates as low as 10 beats min^{-1} , during the deepest segments of deep dives suggest that gas exchange and peripheral blood flow occur primarily at shallow depths with minimization of pulmonary/peripheral flow and subsequent reliance on myoglobin-bound O_2 for aerobic muscle metabolism at greater depths. Total number of heartbeats in a dive increased until depths and dive durations near 150 m and 6 min, respectively, after which, total number of heartbeats remained near 400 – 450. Although heart rate is low during the deepest segments of deep dives, heart rate profiles and the greater number of heartbeats in deep, long dives suggest overall increased pulmonary gas exchange and peripheral blood flow, in agreement with previously estimated larger respiratory O_2 stores in these dives. However, a true bradycardia and a limit to the total number of heart beats, especially in longer, deeper dives, are also consistent with a greater reliance on myoglobin-bound O_2 stores in emperor penguins than in other penguin species.

The Fossil record of penguins in Chile

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The study of fossil penguins has increased in the last decades. Chile is not the exception and provides the opportunity of study almost exclusively the Southeastern Pacific Ocean and the influence in bird communities of the cold Humboldt system in the Cenozoic. Fossil localities in Chile with penguin remains are from north to south: La Portada Fm, Bahía Inglesa Fm., Coquimbo Fm., Horcón Fm., Río Baguales Fm., Río Turbio Fm., and Loreto Fm.

La Portada Fm. is known by *Spheniscus chilensis*, an endemic species of this locality Pliocene in age. Bahía Inglesa Fm. is the most studied and more abundant unit, with the presence of five species identified to date: *Spheniscus urbinai*, *Spheniscus megaramphus* (these two originally identified in the Pisco Fm., southern Peru), *Spheniscus muizoni* (this last, was also recognized in middle Miocene strata of Pisco Fm. as the oldest record of the genus) *Pygoscelis grandis*, and *Pygoscelis calderensis*, fossils of Spheniscidae that could not be identified at generic or specific level are abundant in this geological unit. *Pygoscelis* species are endemic to Bahía Inglesa Fm.

The middle Miocene Coquimbo Fm presents remains assigned as cf. *Palaeospheniscus*. A northern exposure of Coquimbo Formation have reported fossil of *Spheniscus urbinai*, correlating this unit with Pisco and Bahía Inglesa Fm. Horcón Fm. (Pliocene in age) also is abundant in *Spheniscus* fossils, being absent big sized species as *S. urbinai*.

The southernmost localities have being preliminary studied and are middle to late Eocene in age, Baguales, Río Turbio and Loreto formations have only presented fragmentary bone of fossil penguins, diverse in size, with only a humerus from Río Turbio that could be identified as *Palaeudyptes*, a widespread genus during the Paleogene, but mainly abundant in the La Meseta Formation, Seymour Island, Antarctica.

Some penguins remains have being recognized in Pleistocene strata in Mocha Island and Caldera city, Atacama region. In Caldera, the Estratos de Caldera unit have being recorded in a marine terrace assigned to the Marine Isotopic Stage 5, remains of *Spheniscus* penguins.

The fossil record of the family Spheniscidae in Chile is mainly concentrated in Neogene strata, the recent study of Paleogene units allows to correlate fossil penguins from South America and Antarctica. The large distribution of some species during the Neogene (e.g. *Spheniscus* species in Bahía Inglesa, Coquimbo, and Pisco formations) suggest migratory behaviour that should be analysed in detail.

First record of *Spheniscus muizoni* in Bahía Inglesa Formation, Atacama desert, northern Chile

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Bahía Inglesa Formation is the most abundant and better studied unit of vertebrate Cenozoic fossil, reports of birds include Diomedidae, Procellariidae, Pelagornithidae, Sulidae, and Phalacrocoracidae, together with them, cetaceans, pinnipeds, sirenians, marine sloths, sharks, bony fishes, chimaeras and crocodiles were also found.

Penguins comprise several species including *Spheniscus urbinai* and *Spheniscus megaramphus*, these species are also found in the late Miocene Pisco Formation in southern Peru. *Pygoscelis calderensis* and *Pygoscelis grandis* are endemic to Bahía Inglesa Fm., these species have been found, until the date, in the better studied localities between Caldera city and Bahía Inglesa village, particularly, Los Negros, Mina Fosforita, and El Morro sites.

During summer 2012, we visited an outcrop of the Bahía Inglesa Formation, nearly 75 km south to Caldera city in the Bahía Salado locality.

All fossils here mentioned are housed in the Museo Nacional de Historia Natural (National Museum of Natural History) in Santiago, Chile (SGO.PV)

Several shark teeth of the species *Cosmopolitodus hastalis* were identified (suggesting a Miocene age), together with remains of pinnipeds of the Phocidae family and remains of a cormorant *Phalacrocorax* sp.

Fossil penguins that could not be identified at specific or generic level correspond to: ulna (SGO.PV.21334), coracoid (SGO.PV.21335), two radius (SGO.PV.21336; SGO.PV.21339), proximal fragment of humerus (SGO.PV.21337), and a humerus diaphysis (SGO.PV.21338).

Five humeri (SGO.PV.21340; SGO.PV.21341; SGO.PV.21342; SGO.PV.21343; SGO.PV.21344) a tibiotarsus (SGO.PV.21345) and a tarsometatarsus (SGO.PV.21346) were identified as belonging to the species *Spheniscus muizoni*.

Spheniscus muizoni was originally described in the Cerro La Bruja locality of the Pisco Fm. Southern Peru, and is recognized as the oldest species of the extant genus *Spheniscus*. Its presence in the Bahía Inglesa Fm. suggest a widespread distribution during the Late Miocene, also support that (if correlated with Cerro La Bruja) Bahía Salado can be the oldest outcrop of the Bahía Inglesa Formation.

The large extension of Bahía Inglesa Formation (nearly 160 km through the Atacama desert coast) demands prospection and stratigraphical correlations.

Which key factors influence foraging patterns of little blue penguins (*Eudyptula minor*) in New Zealand?

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Little blue penguins are well distributed around the coasts of New Zealand and Australia, however, little is known about what factors influence their micro-scale patterns of movement and behaviour. Movement trajectories of free-ranging animals can provide information on their energy expenditure related to surrounding environments. During the breeding season, penguins have extra energetic demands as they provide food for their developing chicks. Understanding what drives characteristics of their foraging patterns can help us gain valuable insights into their ecology. As land-based breeders, at-sea behaviours of penguins are difficult to follow by direct observation. With the continued improvement of GPS (global positioning system) technology, tracking devices are now small enough to fit on this smallest of penguin species. We collected foraging trajectories of breeding- stage little blue penguins from two distinct colonies in New Zealand: Burgess Island in the Mokohinau Archipelago (175°E 36°S) located offshore the North Island, and Matiu/Somes Island (174°E 41°S) located within the heavily urbanised Wellington Harbour. Ours is the first study in which high-resolution (every 1min) GPS tracking data have been collected from this species in New Zealand. We also simultaneously collected dive-profile data from temperature depth recorders (TDRs attached to some individuals that were tracked with GPS units. Using spatial and temporal parameters of the foraging trajectories from the two colonies, we investigated factors affecting the foraging range and search efforts of little blue penguins, specifically: geographical features including ocean bathymetry, landscape features near their colony, surface currents, weather patterns, and human activity. Initial results indicate foraging effort was concentrated in areas near river mouths in/near Wellington Harbour and at zones of upwelling in the Mokohinaus. Human activity did not appear to be an important factor determining where the penguins forage. Our study demonstrates the value of high-resolution GPS telemetry for elucidation of patterns of behaviour and ecology of penguins and other marine birds.

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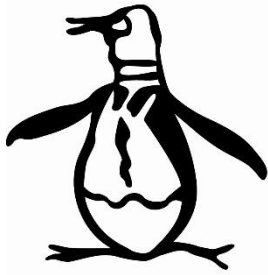
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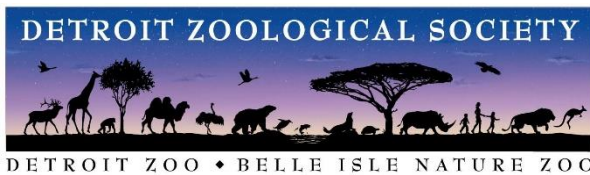
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