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ABSTRACTS –

ORAL PRESENTATIONS

Note:

- **The abstracts in this booklet have been directly copied from the author(s), and the Local Organising Committee have not edited them in any way.**
- **Students are identified for the purposes of voting for the best oral presentation.**

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KEYNOTE PRESENTATION ABSTRACTS

LANGSBURY, Hoani

Kaitiakitech - The blending of Matauraka and European Science in the management and protection of Taoka Species

Author / Presenter: Hoani Langsbury

Author Affiliation:
Te Rūnanga o Ōtākou, Kāi Tahu, Kati Mamoe, Waitaha, Rapuwai, Kati Hawea, Yellow-eyed Penguin Trust, Blue Penguins Pukekura, New Zealand

Abstract: Indigenous people have a holistic perspective on their approach to species conservation and Māori of Aotearoa are not unique in this. I will specifically take the perspective of Kāi Tahu taka, or the way that my Iwi or tribe approach their responsibilities to Kaitikaitaka or guardianship of penguin species within their takiwa or Rohe. Takiwa is the area of land or sea that we are traditionally have authority over as a Hapu/Whanau or family. Kaitiaki also have responsibilities to the wider rohe, through tribal or Iwi affiliations. Most importantly it is the species that reside in these areas alongside us, that we are responsible for that drives us.

Māori are unique within Aotearoa with regard to the various opportunities and methodologies we utilize as kaitiaki to give effect to our responsibilities. From the hands on work of Little Blue Penguin Husbandry at Pilots Beach, to responding to research proposals or resource management that affect our Taoka(treasured) species . I will also provide insight at a governance level on the aspirations we have for our taoka species and how this is given effect through our relationship with our Crown Treaty Partners. How we utilize legislation, planning and consultation to ensure that penguins survive to be appreciated by our children's children.

This inter-generational way of thinking helps us with the understanding and commitments we make as kaitiaki to the real challenges of modern conservation. It also provides us with some solace through new understandings or technology that can assist our mahi (work).

BOERSMA, Dee

Penguins in the Era of the 6th Great Extinction

Author / Presenter: Dee Boersma

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Abstract: Penguins inhabit high productivity areas in the Southern Hemisphere, ranging from Antarctica to the Equator. Some are migratory and wide ranging; others stay put near their breeding colonies. The extremes are Emperor penguins that breed in the frigid Antarctic winter and Galapagos penguins that can lay eggs several times a year at the Equator.

Penguin natural history is remarkably variable. When ecosystems are intact, penguins can quickly take advantage of new habitats or re-colonize locations when invasive predators are removed. Penguins have a catastrophic molt, but molt timing is not fixed. Some penguins molt before they breed, some molt while others are breeding and some after raising chicks; individuals in poor condition may skip a molt. Gentoo and Galapagos penguins stay around their breeding colonies feeding their young after they fledge, but fledglings of other penguin species are on their own after fledging.

Given that flexibility, how will penguins fare during the 6th great extinction? Penguins live in dry environments, but with climate warming they experience temperature extremes, increased rainfall, greater variability in ocean productivity, sea level rise, and more frequent El Niños. None of these changes benefit penguins.

Humans are now pushing penguins to the edge of their ability to adapt by removing and introducing competitors for their food, polluting the ocean, catching them in nets, and providing inadequate Marine Protected Areas. By fragmenting ecosystems, growing our population, continuing over consumption and increasing human longevity, humans inadvertently drive population declines in penguins. Penguins are resilient birds. Most populations are likely to survive, but their chances could be improved if humans carve out, connect, and protect habitats in a few places where they can thrive.

WILLIAMS, Mike

Understanding changing climates and changing oceans

Author / Presenter: Mike Williams

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National Institute of Water and Atmospheric Research, New Zealand

Abstract: There are many pressures on the oceans, but climate change and the associated ocean acidification are potentially the most significant. While we have observations to understand historical changes, to understand the future we need climate models. These models use prognostic equations which represent the physics and chemistry of the atmosphere, ocean and cryosphere to predict the future. The most complex climate models, Earth System Models, also include the carbon cycle and ocean biogeochemistry. Significantly, this allows us to look at both climate change and ocean acidification, within the same framework.
Earth System Models are global in extent, but here I will focus on two regions: New Zealand, and Antarctica, particularly the Ross Sea. To understand change in these regions I will use the New Zealand Earth System Model (NZESM). This model has a unique high-resolution representation of the oceans around New Zealand nested within the global model. This makes it ideal to understand how the oceans and seas around New Zealand are changing and are projected to change in the future. I will focus on the New Zealand Subantarctic, including the Campbell Plateau, as it has been hypothesised this region could be the most vulnerable to rapid ocean warming associated with changing currents. The Ross Sea is experiencing significant changes in sea ice both at seasonal and inter-annual timescales. But sea ice is often poorly represented in climate models, so I will discuss the changes we have seen, and what the future might look like.

VANSTREELS, Ralph

What can we learn about penguins by studying their health and diseases?

Author / Presenter: Ralph Vanstreels

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Abstract: Health is a dynamic state that fluctuates over an individual's life in response to intrinsic factors such as its age, stage of the annual cycle and individual experience and fitness, and extrinsic factors such as food availability, oceano-climatic conditions and exposure to pathogens and parasites. By studying the health of penguins, we can gain valuable knowledge on the challenges experienced by their populations and how they interact with their ecosystems. However, since showing external signs of illness might put them at an increased risk of predation, penguins are exceptionally skillful at concealing their health status. Therefore, as researchers we need to employ a combination of clinical and diagnostic tools to discover their health status and explore how their bodies respond to internal and external pressures. Integrating data obtained at the individual level (diagnostic test results, physiological parameters, etc.) with population and ecosystem data (demographic change, breeding success, climate conditions, fish stocks, etc.) is a challenge that requires transdisciplinary collaboration and innovative analytical approaches. In this presentation, I will discuss some of the challenges and opportunities in this field, and make the argument that health monitoring should be an integral component of penguin population monitoring and conservation efforts.

ŽYDELIS, Ramūnas

Seabird bycatch in the fishing nets – global problem or local issue? Can net fisheries be managed in a sustainable way with respect to seabird populations?

Author / Presenter: Ramūnas Žydelis

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Abstract: About 150 species of seabirds forage by diving and thus are susceptible to entanglement in the fishing gear designed to catch animals swimming underwater. The highest densities of susceptible species occur in temperate and sub-polar regions of both hemispheres, with lower densities in tropical regions. Gillnet fisheries are widespread and particularly prevalent in coastal areas. At least 80 species of seabird have been documented being caught in gillnets and although reports of seabird bycatch in gillnets are relatively numerous, the magnitude of this phenomenon remains poorly known. A review study conducted a few years ago estimated that at least 400,000 birds die in gillnets each year. The highest bycatch in terms of numbers of birds killed has been reported in the Northwest Pacific, Iceland and the Baltic Sea. But species suffering potentially significant impacts of gillnet mortality have been identified across the globe.

Considering high mortality of bird in fishing nets, there is a need for development of bycatch mitigation measures. Successful solutions for reducing seabird bycatch have been identified in other types of fishing gear – longline and trawl fisheries. However, there are no recognized technical means that would work efficiently in reducing seabird bycatch in gillnet fisheries. Some solutions hold promise locally for specific fisheries and seabird species, but operational fisheries management seems being the only effective way to reduce seabird mortality in gillnets for the time being.

CHIARADIA, André

What would the penguin world be like if human-induced habitat and climate change didn't exist?

Author / Presenter: Andre Chiaradia

Author Affiliation:
Phillip Island Nature Parks, Victoria, Australia

Abstract: Our planet is experiencing rapid, far-reaching and unprecedented changes in the environment with progressive and devastating impacts in the last 160 years. The environmental losses we confront from waiting too long are now unacceptable. Penguins, like most iconic species, are facing a wide range of threats. They have evolved over 60 million years ago, and perhaps the biggest challenge will be for some species to survive the next 60 years. Under our watch, almost 70 % of all penguin species populations are decreasing. By breeding on land but foraging at sea, penguins are forced to deal with problems in both ecosystems. And the climate deterioration has added newer and additional difficulty altering the structure and functioning of terrestrial and marine systems. Penguin biologists, like most researchers working on long-lived animals, became incidental climate change scientists. This talk is about the inevitable doom and gloom affecting penguins but also positive stories of penguin conservation over the globe. We have ways of reducing the damage if we act now using new and unprecedented levels of science and advocacy.

ORAL PRESENTATION ABSTRACTS - Saturday

RAYA REY, Andrea

Penguins connecting the world: the global social-economic power of penguins

Presenter: Andrea Raya Rey

Authors: Andrea Raya Rey (1,2,3), Cristobal Pizarro (4,5), Falk Huettmann (6), Klemens Pütz (7)

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Abstract: Penguins can be considered mega charismatic wildlife. They attract hundreds of thousands of tourists to their nesting sites ever year. However, social ecological economic benefits and impacts from penguin colony visitation have been poorly studied. Here we adapted and pursued the coupled human and natural systems (CHANS) approach and telecoupling framework. This allows to integrate social and biological information and to obtain a more holistic understanding of current human-penguin dynamics and trends. We synthesized research outputs at three sites/penguin colonies. The Antarctic Peninsula receives 40,000 tourist per year with a flow of money of around 201millon U$S. Martillo Island (Tierra del Fuego) receives 29,000 tourists representing 1.8 million U$S and Punta Tombo (Chubut) receives 90,000 tourists and 4 million U$S, plus 0.5 million U$S in fees used for maintenance, infrastructure and salaries. Transnational tourism to visit penguin colonies provides economic benefits for local residents and foreign people involved in the tourism industry, although none of the money generated by visits to penguin colonies in these places is re-invested for penguin conservation. Moreover, tourism is known to pose serious potential threats to penguin populations (i.e. decrease in numbers) and the ecosystem (i.e trampling of habitat, carbon emission). Integrating results from telecoupling into the management of penguin tourism would help ensure that humans continue to enjoy meaningful relationships with this unique and charismatic species and it can reinforce responsible tourism as a local-global strategy for sustainable development and global penguin conservation.

PISTORIUS, Pierre

At-sea vocalisation in penguins

Presenter: Pierre Pistorius

Authors: Pierre Pistorius (1), Andrea Thiebault (1), Thierry Aubin (2), Isabelle Charrier (2) Lorien Pichegru (1), Cuan McGeorge (3), Alistair McInnes (1)

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Abstract: Penguins, like most seabirds, are often very vocal at their breeding colonies where vocalisation is, among others, associated with interference competition and interactions between partners and with their offspring. Due to the difficulties of studying vocalisation at sea, little is known about the potential occurrence and significance of penguin vocalization while foraging. Here we report on results obtained from deployment of video-cameras with built in microphones on four species of penguins to better understand at-sea vocalisation in penguins. We found unique calling behaviours dependent on the social-ecological contexts. For some species, the frequency and types of calls emitted at sea were clearly dependent on behavioural modes (commuting, sedentary and dive bout) and social status (solitary versus group). The timing and frequency of calls were also different dependent on prey type, and call acoustics were specific to benthic or pelagic foraging. Results of this study provide evidence for functionally mediated divergence in seabird calling behaviour at sea. We highlight the need for further investigations into this poorly studied behavioural aspect in penguins that potentially plays a large role in foraging success and ultimately in population demographics.

DAVIS, Lloyd

Murray Levick: the world's first penguin biologist

Presenter: Lloyd Davis

Authors: Lloyd Davis

Author Affiliation:
University of Otago, New Zealand

Abstract: On 18 February 1911, Murray Levick and five others landed at Cape Adare in Antarctica, site of the world's largest Adelie penguin colony. The party was expected to undertake exploration, but unfavourable ice conditions left them stranded at Cape Adare. Levick, a surgeon, set about conducting the first detailed study of penguins, which he published in 1914 as the first book about penguins, "Antarctic Penguins: a study of their social habits." It provided a baseline description of the penguins' behaviour, but its somewhat anthropomorphic tone reinforced the belief that penguins are monomorphic monogamously-breeding seabirds.

However, in 2012, an unpublished manuscript was discovered about the sexual behaviour of Adelie penguins that had been written by Levick in 1915. It revealed mating behaviours in these birds that included infidelity, homosexuality, necrophilia, paedophilia, rape and gang rape. Levick's paper had been prevented from being published, although Levick also contributed to the censorship of his data: in his field notebook, he covered up many of his most extreme observations with a code using Greek letters.

Here I summarize Levick's study, and the extraordinary circumstances surrounding it, based upon an examination of his diaries and field notes. I reveal that he discovered much about the behaviour of penguins that it would take the rest of us the best part of a century to rediscover. How different our understanding of penguins may have been had Levick's findings not been censored and those of Lancelot Richdale on the sexual habits of Yellow-eyed penguins not gained such prominence.

SØRENSEN, Kenneth

Behavioural reactions to underwater sounds of Gentoo penguins (Pygoscelis papua)

Presenter: Kenneth Sørensen

Authors: K. Sørensen (1), C. Neumann (1), M. Dähne (2), K. A. Hansen (1), M. Wahlberg (1)

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Abstract: Diving birds face several physiological challenges under water, affecting their thermoregulation and locomotion as well as their sensory systems, for example their ears.

Penguins, auks and cormorants are actively chasing prey while diving, but marine bird underwater hearing has only been studied in the great cormorant (*Phalacrocorax c. sinensis*) and the black duck (*Anas rubripes*). This means we entirely lack information on whether or not penguins make use of underwater sound cues while diving.

There is very little known about penguin hearing in general, and the only study made so far was made in air. An earlier study found that African penguins showed avoidance to their preferred foraging areas due to seismic activities, even within a radius of 100 kilometers.

To find out if penguins react to underwater sound, we observed the behavioral reactions of gentoo penguins (*Pygoscelis papua*) in a zoological setting, to acoustic playbacks of broadband stimuli with various intensities. Results indicate consistent behavioural reactions to sound at modest sound levels, above some 110 dB re 1 µPa rms. The responses were always directed away from the sound source, indicating that penguins can detect the direction of underwater sounds.

Their directional hearing abilities under water are currently being studied further through acoustic conditioning. Both experiments strongly indicate that hearing is an important cue for diving penguins and possibly also for other marine birds.

VENEGAS LI, Ruben

Protecting the food security of little penguins

Presenter: Ruben Venegas Li

Authors: Ruben Venegas Li (1,2), Richard Reina (2), Andre Chiaradia (1)

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Abstract: Phillip Island, Australia has one of the largest colonies of the little penguin species, with a success story of conservation on the land. The future challenge, however, is to address risks at sea, where penguins spend 80% of their lives. Multi-year tracking and acceleration data from penguins have enabled identifying their foraging hotspots, and how these areas change spatially with variable environmental conditions and years of different breeding success. Using this information, we are applying zoning schemes to protect foraging areas according to the expansion and contraction of feeding hotspots in years of low and high breeding success. The zoning will be guided by marine spatial prioritisation methods to achieve management targets, e.g. protecting different amounts of core and home ranges, while resolving or minimising conflicts with different users of the marine environment. First, we identify and map coastal and ocean-based potential threats to the little penguins, e.g. shipping, desalination plants, tourism and fisheries. We then create different scenarios, setting protection targets using the spatial distribution of the core and home ranges in years when foraging zones reduce or expand. The results will allow us to highlight the importance of obtaining bio-logging data from multiple years, as capturing variability in the distribution of feeding hotspots. The ultimate goal is to create dynamic protection zones in the waters off Phillip Island that promotes food security for the penguins, also benefitting all associated marine species while minimising conflicts with other users of the ocean.

BOST, Charles-André

First odyssey into the Southern Ocean: The early life of juvenile penguins

Presenter: Charly Bost

Authors: Charly Bost (1), Florian Orgeret (2), Sara Labrousse (3), Eugénie Tessier (1), Jean-Baptiste Thiebot (4), Henri Weimerskirch (1)

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Abstract: The early life stage of penguins is still poorly understood despite its importance for the viability of their populations. To investigate the exploratory behavior and foraging skills of juvenile penguins throughout their first months at-sea, we deployed splash tags recording on fledged king penguins from Crozet Islands (n=17), emperors penguins from Adelie Land (n=15). In addition, PTTS tags were deployed on fledged gentoos (n=6) and macaroni penguins (n=9) on Kerguelen islands. We investigated the distribution range, main travelling directions, changes in sinuosity, diving skills in relation to diel cycle and hydrological features, and at-sea survival form tags records.
All the chicks from the 4 species (including inshore foragers such gentoos) exhibited wide dispersions, with no overlap with the migration of non-breeding adults. Juveniles of long distance foragers such king penguins dispersed over a very large area toward the West, moving against the direction of the Antarctic Circumpolar Current. All birds used both an upstream and downstream orientation strategy, depending on current strength. Diving skills were initially well developed but also improved with time, in comparison to adults. Juvenile emperor penguins firstly dispersed northward over large distances, outside the sea ice ecosystem and then turned back to sea ice from autumn where they remained through the winter. They were consistently associated with the mixed layer depths.
Based on the combination of penguins travel speed and diving behaviour, we were able to define new important foraging areas situated far from their colony during autumn and winter. The relevance of the observed dispersion behaviour and the ability of juveniles to reach such important foraging areas is discussed in the context of the fast climate change.

MANCO, Fabrizio

The delights and challenges of building habitat models from tracking devices. A case study on chinstrap penguins in the South Orkney Islands

Presenter: Fabrizio Manco

Authors: Fabrizio Manco (1), Philipp N. Trathan (2)

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Abstract: Modern tracking devices and associated biologging instruments allow researchers to gather data on animal movement at a very high frequency and resolution. From these datasets, it is possible to infer several behavioural states, including bouts of foraging and prey capture. Plotting these events in space and time enables us to create foraging habitat models that are crucial to understanding how keystone species such as the chinstrap penguin (*Pygoscelis antarctica*) use their environment. This is useful to measure, predict and mitigate human activities, or natural and human induced changes in how penguins use their environment in both space and time.

This work reveals how high resolution tracking data from several breeding seasons and different colonies around the South Orkney Islands can be used to build a general foraging habitat for the entire chinstrap penguin population around the archipelago. Tracking data is combined with time-depth recorders to describe three-dimensional habitat use. Time series segmentation, in combination with animal-borne video cameras, is applied to identify and validate foraging events along the tracks. Finally, machine learning algorithms are used to combine environmental and geographical variables and foraging locations to build predictive feeding habitats. The spatial and temporal resolutions of the data as well as the contributions of the different devices and variables are discussed to assess the advantages and limitations of the method and which parameters and equipment contribute to the highest predictability and best models.

LABROUSSE, Sara

First odyssey beneath the sea ice of juvenile emperor penguins in East Antarctica

Presenter: Charles Bost (for Sara Labrousse)

Authors: Sara Labrousse (1, 2), Florian Orgeret (2), Andrew R. Solow (1), Christophe Barbraud (2), Charles A. Bost (2), Jean-Baptiste Sallée (3), Henri Weimerskirch (2), Stéphanie Jenouvrier (1,2)

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Abstract: Adult emperor penguins *Aptenodytes forsteri* breed on fast ice and forage within sea ice in winter. However, it remains unknown whether juveniles exhibit similar foraging behavior during their early life at-sea movements, and how it links with the oceanographic conditions. We investigated the first at-sea odyssey of 15 juvenile emperor penguins from Terre Adélie in 2013−2014. The average tracking duration was 167 ± 110 d SD (range 86−344 d). After departing the colony in December/January, the juveniles traveled north up to 53.76° S before heading south in April/May to forage within the sea ice. The juveniles spent 49 ± 14% of their total recorded trips (n = 12) in the sea ice, over both the continental slope and deep ocean regions. The penguins dived primarily during daylight. Within sea ice, the juveniles performed both shallow and deep dives, with the proportion of each varying seasonally. The switch to primarily deep dives in the autumn and winter within sea ice may be a consequence of (1) a seasonal change in the krill distribution from surface to deep waters and/or (2) the presence of macrozooplankton at depth due to a reduced/absent diel migration. Furthermore, we showed for the first time that the diving behavior of juveniles was associated with the mixed layer depth. We suggest they feed on mesopelagic prey aggregating near the thermocline. This study provides insight into an important, but poorly understood, part of the emperor penguin life cycle, essential to predict their response to future climate change.

MATTERN, Thomas

A birds-eye view on food – Using animal-borne cameras to study Yellow-eyed penguin foraging ecology

Presenter: Thomas Mattern

Authors: Thomas Mattern (1,2,3), Ursula Ellenberg (2), Richard Seed (1,3), Yolanda van Heezik (1), Philip Seddon (1)

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Abstract: The Yellow-eyed penguin/hoiho is one of the rarest penguin species, with current population trends pointing to a potential regional extinction within this century. While many factors contribute to the species' ongoing decline, the penguins face a substantial portion of these out at sea. On the New Zealand mainland, poor reproductive success and, by extension recruitment, seem to be linked to deteriorating prey availability and quality, as well as to disease events which might be causally linked. With the situation for Yellow-eyed penguins becoming increasingly dire, intrusive research, such as diet studies involving stomach flushing, has fallen out of favour. Using animal-borne camera loggers it is now possible not only to obtain quantitative information about penguins' diet composition, but also to investigate in detail the ecological context in which specific prey are captured. Deployments of camera loggers on Yellow-eyed penguins across a substantial portion of their mainland range revealed significant small-scale regional and temporal differences in diet composition. We show how video data allows us to make assumptions on energetic requirements to catch certain prey types, to assess prey quality as a function of reproductive success, and to draw conclusions about environmental conditions affecting prey composition. The use of video loggers has allowed us to start to gain a rich understanding of the ecological trials the species faces at sea and what this might mean for future population developments.

CHEREL, Yves

New information on the foraging habitats of penguins using stable isotopes of sulphur (δ34S)

Presenter: Yves Cherel

Authors: Yves Cherel (1), Paco Bustamante (2), Charles-André Bost (1)

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Abstract: Stable isotope analysis of carbon (δ13C) and nitrogen (δ15N) is now commonly used to detail the foraging habitat and diet of consumers, respectively. The isotopic method was validated in the Southern Ocean, with δ13C values of seabirds varying with latitudes and along an inshore-offshore gradient, and their δ15N values increasing with trophic level. On the other hand, stable isotopes of sulphur (δ34S), another proxy of foraging habitat, was generally not considered due to a general lack of δ34S gradients in the marine environment. We challenged this traditional view by measuring whole blood and feather δ34S values in seven Antarctic, subantarctic and subtropical penguin species with contrasted food and feeding ecology. Three main methodological and biological features emerge from our detailed isotopic investigation. (i) δ34S values are consistently higher in feathers than in whole blood of penguin chicks, meaning that a correction factor is needed to compare δ34S values between the two tissues. (ii) Unexpectedly, δ34S values vary from Antarctic to subtropical penguins, but the δ34S gradient is smaller, and thus less discriminant, than the well-known latitudinal δ13C gradient. (iii) By contrast, δ34S values discriminate better than δ13C the foraging habitats of an inshore feeder, the gentoo penguin, both within and between colonies located in various coastal environments. In conclusion, our isotopic investigation indicates that δ34S is a relevant tool to better define the penguin foraging habitat at various spatial scales, and that the method is at its best to study inshore species (e.g. Galapagos, gentoo, little blue and yellow-eyed penguins).

HANDLEY, Jonathan

Knowledge gaps regarding the distribution of penguins at sea: Where do we need to get to for informed marine spatial planning?

Presenter: Jonathan Handley

Authors: Jonathan Handley, Maria Dias

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Abstract: Penguins largely rely on resources within close proximity of their breeding colonies, making them excellent indicator species for the state of local ecosystems. Additionally, their charismatic nature and economic value (through tourism) in certain regions makes them key focal species for the understanding, management and conservation of natural environments. Yet, despite major advances in the knowledge of penguin species distribution at sea, priority gaps that could inform conservation action are still prevalent. Therefore, we performed a global gap analysis, reviewing 230 peer-reviewed papers from 1992 to present, to identify major gaps in penguin distribution at sea. We considered the three contemporary methods used to track penguin species in the horizontal space: geolocation sensors (GLS), platform terminal transmitters (PTTs) and global positioning systems (GPSs). Key research areas that could strengthen conservation actions for penguin species and their surrounding environments are: juvenile tracking studies, adult tracking during the pre-moult period, improving the representativeness of samples both within sites and across the numerous sites each species inhabits, maintaining long-term tracking studies and further investigation into potential interactions with anthropogenic activities, e.g. fishing, pollution and disturbance through development, and tourism. Specific globally threatened species, for which new knowledge of their at-sea distribution could enhance conservation and management measures, include: the Galapagos, Erect-crested, Yellow-eyed, Fiordland, Snares and Royal Penguins. Finally, we show several case studies where effective collaboration regarding the use of penguin tracking data in marine spatial planning has led to positive conservation initiatives for penguin species.

LE GUEN, Camille

Deep Scattering Layers: a mesopelagic buffet for King Penguins (Aptenodytes patagonicus)?

Presenter: Camille Le Guen *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Camille Le Guen, Roland Proud, Richard Sherley, Akiko Kato, Yan Ropert-Coudert, Norman Ratcliffe, John Arnould, Lars Boehme, Andrew Brierley

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Abstract: Mesopelagic fish (e.g. myctophids), zooplankton and other organisms migrate down to the mesopelagic zone (200-1000m) to avoid visual predators during the day. There, they form layer-like aggregations known as Deep Scattering Layers (DSLs), which can be detected by echosounders. Myctophids are abundant in these layers. They are potential resources for fisheries but are also important in the diets of Antarctic predators such as King Penguins (*Aptenodytes patagonicus*). During the 2017 Antarctic Circumnavigation Expedition (ACE), we investigated the interaction between myctophids and King Penguins by monitoring simultaneously DSL characteristics and penguin foraging behaviour. We compiled a dataset of geographic variability in DSL depth and echo-intensity throughout the Southern Ocean and concomitantly, we collected positions, dive profiles and accelerometry data from King Penguins breeding at South Georgia. We found that DSL echo-intensity (a proxy of biomass) can be modelled accurately using sea surface temperature, and that sun angle plays a major role in DSL depth. Habitat modelling techniques revealed that King Penguins preferentially selected habitats based on DSL availability. They targeted zones characterised by dense and shallow DSLs, initially suggesting that they rely on DSLs to optimize foraging. However, a more detailed analysis of diving activity showed that the penguins' dive depths were generally shallower than the DSL depth, indicating that they might not feed on the layers themselves. King Penguins instead seem to target prey patches above the DSLs. This work aims to improve our understanding of predator-prey interactions to inform conservation management before any large-scale exploitation of mesopelagic fish begins.

ELLENBERG, Ursula

Penguin plasticity: surprisingly versatile marine life-style in Fiordland penguins/tawaki

Presenter: Ursula Ellenberg

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Abstract: The enigmatic Fiordland penguin, or tawaki, remain one of the least known penguin species. Their population is <10,000 and they breed along a stretch of only 500 km of coastline in New Zealand's rugged and inaccessible southwest. Despite their limited distribution, tawaki occupy remarkably diverse marine habitats. In 2014, the Tawaki Project set out to study the penguins' ecology across their breeding range. We examined their foraging behavior during and outside of the breeding season at three sites representative of the species' varied marine habitats. Over the course of five years, we documented the impact of El Niño on foraging range and breeding success, quantified the impact of a stoat incursion, and tracked extreme long-distance movements in the non-breeding period. These data paint an intriguing picture of a crested penguin species that lives outside the zone occupied by other crested penguin species (subtropical instead of sub-Antarctic waters). Instead, tawaki have established themselves in a variety of ecological niches, an adaptability that may enhance the species' resilience to environmental change.

SOUTHWELL, Colin

Environmental drivers and constraints of Adélie penguin population dynamics: Emerging insights from spatially extensive observations across East Antarctica

Presenter: Colin Southwell

Authors: Colin Southwell, Louise Emmerson

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Abstract: Until recently, most of our understanding of the environmental influences on Adélie penguin population dynamics has come from intensive, long-term studies of local populations responding to temporal variation in local environmental conditions. A complementary approach, which is being increasingly used as new technologies and methods allow larger scale observations, is to use spatial variation in the environment to better understand Adélie penguin-environment interactions. In this talk, we describe spatial variation across East Antarctica in attributes of the marine and terrestrial environments that are important for Adélie penguins, outline some results from a spatially extensive remote camera network and broad-scale population surveys, and present some insights into the environmental influences on Adélie penguin population dynamics that are emerging as the spatio-temporal data set grows. The observations cover a range of population characteristics including breeding phenology, breeding success, breeding distribution and occupancy, and population growth across 5000 km of the East Antarctic coastline. These results will help us identify drivers and constraints of differential growth rates for different populations and identify which factors, if any, are initially limiting regional and local populations and to use these to predict outcomes for the future in relation to expectations of environmental change.

GRIGG, Jennifer

Shining light on the lost years to inform conservation planning: investigating the movement ecology of immature African penguins (Spheniscus demersus)

Presenter: Jennifer Grigg *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Jennifer Grigg (1), Steve Votier (1), Alison Cotton (2), Lauren Waller (3, 4), Katrin Ludynia (3, 5), Christina Hagen (6), Andrew de Blocq (6), Azwianewi Makhado (7, 8), Richard Sherley (1)

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Abstract: In long-lived species, immature age classes can represent large proportions of the total population. Yet they are often cryptic and difficult to study, meaning our knowledge of their ecology is limited. For species threatened with extinction, this hinders our ability to design and implement effective conservation strategies. In marine vertebrates, spatial protection at sea is often based on knowledge of the distribution of breeding adults, despite evidence that immature birds use different marine habitats. This problem is typified by the Endangered African penguin (*Spheniscus demersus*), which has undergone a drastic population decline and for which protection of breeding colonies and key foraging habitats is a major component of the species' conservation management plan.

We will use GPS-GSM loggers to carry out the first study of the at-sea behaviour of immature (1-2 year old) African penguins. We will track the movements of up to 30 immature penguins from three colonies in the Western Cape of South Africa (Robben Island, Dassen Island and Stony Point) to investigate their habitat use and determine if they use current and proposed Marine Protected Areas. Here we will present our preliminary results and outline plans to examine habitat preferences and how these are influenced by prey availability, fishing activity and environmental variables. Finally, we will discuss the implications of our work for the spatial management of the South African small-pelagic fishery.

ANDERSON, Dean

Over-winter migration of Adelie penguins from Cape Adare, northern Ross Sea

Presenter: Dean Anderson

Authors: Dean P. Anderson, Kimberly T. Goetz, Morgan Coleman, Taylor Hamlin, Matthew Schofield, Phillip Seddon, Gary Wilson, Phil O'B. Lyver

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Abstract: The world's largest Marine Protected Area was gazetted within the Ross Sea in 2017. Adélie penguins (*Pygoscelis adeliae*) are potentially a bio-indicator because of their sensitivity to changes in the marine ecosystem. The breeding-season ecology of Adélie penguins in the southern Ross Sea is well studied, but much less in known about the ecology of the penguins breeding in their northern range. Indeed, their over-winter movement behaviour has not been studied. To address this knowledge gap, we deployed Biotrack geolocator tags on 19 breeding adult Adélie penguins at Cape Adare, the largest (~330,000 breeding pairs) and northern-most colony inside the Ross Sea Marine Protected Area. We develop a hidden Markov movement model to examine how migratory movement behaviour is influenced by sea ice concentration, ocean currents and ambient light level. Our study will be important for understanding what proportion foraging range and time of Adélie penguins at Cape Adare occurs within the Ross Sea MPA. Results will be discussed in terms of potential impacts on Adélie penguins population dynamics due to changes in sea ice conditions.

CARPENTER-KLING, Tegan

The diet of gentoo penguins as a response to the dynamic nature of the sub-Antarctic front

Presenter: Tegan Carpenter-Kling *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: T Carpenter-Kling (1, 2), J M Handley (1), M Connan (1, 2), R J M Crawford (3, 4), A B Makhado (3), B M Dyer (3), W Froneman (6), T Lamont (3, 7), A C Wolfaardtd (4), M Landman (5), M Sigqala (1, 2), P A Pistorius (1, 2),

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Abstract: Bio-physical processes govern the distribution and abundance and hence availability of prey such fish, crustaceans and cephalopods to marine predators. Frontal zones, such as the sub-Antarctic front, are important in this regard as they shift in latitude in response to prevailing climatic conditions. This has the potential to indirectly influence predators like penguins through influencing lower-trophic-level prey species. While breeding, penguins are spatially constrained in terms of their foraging effort due to parental duties to young. Thus, spatiotemporal variability in prey availability within their restricted foraging ranges during this time is expected to be reflected in their diet. We investigated the prey assemblage within the diet of the gentoo penguin *Pygoscelis papua* at the Prince Edward Archipelago 21 years apart (1994-2015). Using the water off-loading technique, stomach content samples were collected monthly over three years (1994-1996) and then annually during 2012, 2014 and 2015. We show how prey assemblages within the diet coincide with the proximity of the sub-Antarctic front to the archipelago. Due to the plasticity gentoo penguins exhibit in their diet and foraging behaviour, our results suggest that they are important sentinel species for the local marine ecosystem around the Prince Edward Archipelago. Continued sample collection from these birds, albeit stomach content samples and/or tissues for stable isotope analysis, is recommended to enable a better understanding of climate-mediated changes in Southern Ocean marine ecosystems.

ORAL PRESENTATION ABSTRACTS - Sunday

BORBOROGLU, Pablo Garcia

Towards a Penguin Global Conservation Agenda promoted by the IUCN SSC Penguin Specialist Group

Presenter: Susie Ellis and Pablo G Borboroglu

Authors: García Borboroglu, P. (1,2,3), Boersma, P. D. (1,2), Ellis, S. (4), Bost, CA. (5), Chiaradia, A. (6), Schneider, T. (7), Seddon, P.J. (8), Simeone, A. (9), Trathan, P.N. (10), Waller, L.J. (11,12), Wienecke, B. (13), Gownaris, N.J., (1)

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Abstract: Penguins are in trouble. The International Union for Conservation of Nature lists 10 of the 18 species as threatened, making penguins the second most threatened family of seabirds. The IUCN Penguin Specialist Group (PSG) is developing a Penguin Global Conservation Agenda. In 2016, the PSG coordinated threatened status reviews for the IUCN Red List based on penguin status data and conservation needs from its membership. The PSG also held two conservation strategy workshops to: 1) identify gaps in penguin research and conservation towards increasing population resilience in wild penguins and minimising threats and impacts, and 2) develop consensus on the species considered to be conservation priorities. We will summarise the PSG work to-date to guide and support future penguin research and to inform much-needed policy and legislative interventions. Among the top 12 research priorities, four are relevant to all penguins: (i) assessing population trends, (ii) determining vital rates, (iii) documenting environmental changes, and (iv) improving understanding of foraging ecology. We also identified four other conservation priorities relevant to several species: (v) improving understanding of effects of fisheries, (vi) enhancing support for marine spatial planning, (vii) developing species-specific action plans, and (viii) improving stakeholder engagement. Conservation action is needed for all penguin taxa, but we recognised that African, Galapagos and Yellow-Eyed Penguins need immediate scientific collaboration and policy interventions. We discuss crucial avenues for improving science-informed conservation of these species. The conservation actions for penguins would have broad biodiversity benefits in the Southern Hemisphere's biodiversity hotspots.

CANNELL, Belinda

Is climate change to blame for the halving of a high conservation value little penguin colony over a mere 10 years?

Presenter: Belinda Cannell

Authors: Dr Belinda Cannell, Dr Jenny Sinclair (3), Dr Sandra Vardeh (3), Prof William Sherwin (3)

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Abstract: The range-edge of Little Penguins in Western Australia is located on Penguin Island, 50 km south of Perth. This colony has been identified as of high conservation value. But since 2007, the population is estimated to have halved, to under 1000 penguins. Over this past decade, the coastal waters have experienced a record marine heatwave and many consecutive years of above average temperatures. Local abundance of previous important prey have drastically changed according to commercial fishermen, and satellite tags deployed on penguins during incubation show that penguins are consistently travelling over 150 km to foraging grounds. A PVA conducted in 2011 indicated that the colony would disappear in 30-50 years. However, relationships between demographic and environmental parameters indicate that changes in SST have accelerated this decline. Is there any hope for resilience within the coastal marine ecosystem and for this important penguin colony?

AINLEY, David

Geographic structure of Antarctic penguin populations

Presenter: David Ainley

Authors: Jarrod Santora (1), Michelle LaRue (2), David Ainley (1)

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Abstract: We tested the hypothesize that regional spatial organization of Adélie, emperor, chinstrap and gentoo penguin colonies is dependent on proximity and size of adjacent colonies, availability of breeding habitat, and proximity of polynyas and submarine canyons. The hypothesis of Furness & Burkhead (1984), that large colonies affect size of adjacent colonies of seabirds, was tested previously, before the availability of extensive biologging results to quantify colony foraging areas and when assessments of colony size was a compendium of historical counts (Woehler 1993). Results were problematic but interesting. The critical data sets, updated, are now available following 20 years of biologging and real-time satellite assessment of colony locations and sizes continent-wide. We collated colony counts from Schwaller *et al.* (2013), Fretwell *et al*. (2012), Lynch and LaRue (2014) and MAPPPD, as well as the literature on foraging ranges, to determine the relative importance of the four factors reviewed above. Indeed, except for emperor penguins, colonies occur in clusters. In general large colonies do not exist adjacent to one another, within a zone characteristic of the outer edge of the foraging area of large colonies. Foraging area increases with colony size. Therefore, inter- and intraspecific competition importantly affects geographic structure, as does access to polynyas and canyons among Antarctic penguins. Results are relevant to assessing effects of climate and other factors on penguin population trends, it being necessary to evaluate trends in entire colony clusters rather than individual colonies.

LARUE, Michelle

Emperor penguins in the Ross Sea: habitat and population trends over 15 years

Presenter: Michelle LaRue *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Michelle LaRue (1,2), Rose Nichol-Foster (2), David Iles (3), Sara Labrousse (3), Stephanie Jenouvrier (3)

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Abstract: Emperor penguins rely on fast ice for the majority of their life cycle and as such are uniquely susceptible to changes in sea ice distribution and extent, both of which show regionalized trends around Antarctica. However, direct observation of colonies is limited to locations where proximity to research stations allows over-flights or ground visits – thus, gaining consistent population trends beyond these few locations has been impossible. Here, we present 15 years of population trends and fine-scale habitat descriptions for 7 emperor penguin colonies in the Ross Sea. Using high-resolution satellite imagery (0.31-0.60 cm spatial resolution), we delineated habitat variables and conducted a supervised classification to determine number of penguin pixels on images taken during austral spring, 2003-2018. By comparing counts from aerial surveys to our results, we then created a generalized linear model to translate penguin pixels into number of adult birds present at each colony. We found substantial variation in habitat variables between years, most notably decreases in fast ice extent around Franklin and Beaufort Islands since ~2015. Ross Sea emperor penguins tend to remain within ~4 km of either open water or cracks in the ice. Population size at colonizes varied substantially over time, including fluctuations >50% in <2 years, though the Ross Sea metapopulation remained mostly stable. Our work lends credence to the notion that emperor penguins operate in a regional metapopulation and that the Ross Sea in particular is likely to be climate change refugia for the species.

MCGILL, Patricia

Using the Annual Molt Census to Improve Understanding of Humboldt Penguin Populations in Peru

Presenter: Patricia McGill

Authors: Patricia McGill, Anne Tieber; Julio Reyes Robles

Author Affiliation: AZA SAFE African penguin Program Leader; Curator of Birds, St. Louis Zoo; President—ACOREMA

Abstract: Humboldt penguins (*Spheniscus humboldti*), once seen in hundreds of thousands along west coasts of Peru and Chile, are now considered 'vulnerable' by IUCN. During the Population and Habitat Viability Analysis (PHVA) workshop conducted in 1998, international working groups proposed standardized census methodology to use in both countries to refine estimates of total population and to document changes. Since 1999, approximately 70 sites have been counted and a number of patterns have emerged: overall populations of penguins in Peru have increased substantially; the top few sites are consistent from year to year, with the top 5 sites representing about 60% of the total penguins counted; over 90% of penguins in Peru are at sites with full or partial protection; patterns of increase/decrease can vary by site; human activity along the coast changes over time, e.g. use of dynamite and gillnets for fishing, hunting for food or pets, and increasing access to the coast; El Niño events associate with irregular patterns of penguin numbers. During the past 20 years, standardized counts of Humboldt penguins have been undertaken 17 times in Peru; key challenges of maintaining absolutely complete and consistent counts every year will be exposed. These censuses should be considered an index to monitor the population over time, rather than an absolute number of penguins. However, as international biologists prepare for another PHVA in late 2019, it is vital to assess two patterns: how annual molt censuses may correlate with total population and what patterns are revealed about stability of penguin populations.

SARAUX, Claire

Life-history trait effects on fitness in little penguins: the secret of high quality individuals

Presenter: Claire Saraux

Authors: Claire Saraux (1), Andre Chiaradia (2)

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Abstract: Using a path analysis, we investigated direct and indirect effects of the main life-history traits and strategies on the fitness of 147 little penguins monitored throughout their entire life. The number of fledged chicks per year and longevity positively affected fitness. The direct negative effect of age at first maturity on fitness was compensated by its indirect effect through an increase in longevity for birds which mature later. Similarly, while skipping reproduction had a direct negative effect on fitness by decreasing the number of breeding events, its total effect (i.e. sum of direct and indirect through longevity) was not significant, suggesting that this strategy (displayed by 35% of the individuals) might be a solution to avoid impairing survival and fitness. Further, half of the birds laid more than one clutch in at least one year, enabling them to increase their fitness. While the number of clutches increased the number of fledged chicks per year (though not significantly), it did not impair survival and longevity. Surprisingly, the number of clutch had actually a positive effect on longevity, suggesting that only good quality individuals (which also have high longevity) might lay second clutches. These inter-individual differences in fitness were not explained by sex or weight at fledging but other parameters such as foraging efficiency warranty further investigation. This notion of better quality individuals also seemed confirmed by a strong positive correlation between longevity and the number of chicks fledged per year, observed both across an individual lifetime or when we focused on its first three breeding events.

CRAWFORD, Robert

Comparative natural history and population ecology of the world's four banded (Spheniscus) penguins

Presenter: Lauren Waller

Authors: R J M Crawford (1,2,), PD Boersma (3,4), P Garcia Borboroglu (3,4,5), A B Makhado (1,6), A Simeone (7)

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Abstract: The four banded penguins breed between the equator and 55º S; all are threatened or near-threatened. Equatorial Galápagos penguins *Spheniscus mendiculus*, the smallest species, can moult twice annually and breed in any month. The other three species have a single annual moult, better-defined breeding seasons and may commence breeding later. Humboldt *S. humboldti* and African *S. demersus* penguins, endemic to the Humboldt and Benguela upwelling ecosystems, respectively, adapt their annual cycles to local conditions. Magellanic penguins *S. magellanicus* have the most southern distribution of the four species. Unlike the others, they attempt only one brood annually and migrate northward in winter. Adults of all species show high fidelity to breeding localities but first-time breeders may settle at non-natal colonies. Whereas non-breeding birds range over considerable distances, breeders are constrained to feed close to colonies, particularly during chick rearing. Small shoaling fish are important dietary items, as on occasion are squids and crustaceans. High adult survivals have been estimated for Galápagos, Magellanic and African penguins, but a delayed age at breeding renders especially the latter two species susceptible to increased mortality. Management interventions aimed at securing the conservation status of the banded penguins will have the best chance of success if they target identified limiting factors and account for the species' known flexible and less plastic traits. All species would benefit from marine spatial planning that minimises threats from fisheries and oil spills and from management protocols that exclude feral predators, improve breeding habitat and minimise risks of disease and disturbance.

DANN, Peter

Long-term trends in survival of first-year and adult little penguins on Phillip Island, southeastern Australia

Presenter: Peter Dann

Authors: Billie Ganendran (1), Peter Dann (2), Leesa Sidhu (1)

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Abstract: Long-term, continuous studies are necessary to investigate change in seabird demography and to determine the consequences of climate change. Temporal variation in survival was investigated over a 46 year period for a population of little penguins on Phillip Island in southeastern Australia. Penguins were marked with flipper bands for the first 30 years of the study and subsequently with injected transponders (PITs). We modelled the dependence of survival on time for two age classes, first-year and adult birds. A series of models using different combinations of survival dependencies (constant and time-varying) as covariates was fitted to the data.

Results showed that the best model describing time-variation in first-year and adult little penguins is one which is fully time varying and includes the negative effect of flipper-banding. A statistically significant decreasing trend in first- year survival for flipper-banded and PIT-marked birds was found, whereas there was no significant trend in the survival of flipper-banded or PIT-marked adults. These results will be discussed in terms of the spatial segregation of the two age classes, intraspecific competition and a range of climatic and oceanographic variables.

SIMEONE, Alejandro

Recent decline in Humboldt Penguin populations in Chile, reduction or extreme population fluctuations?

Presenter: Alejandro Simeone

Authors: Alejandro Simeone (1), Guillermo Luna-Jorquera (2), Roberto Aguilar (3)

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Abstract: The Humboldt Penguin (*Spheniscus humboldti*) has undergone extreme fluctuations in population size in Peru and Chile due to severe El Niño events and the extensive habitat destruction. At present, there are considerable uncertainties in the population size and trend of this species. With the aim of determining the size of the breeding population, we conducted a census of active nests (i.e. containing adults, eggs and/or chicks) along the Chilean coast between October and December 2017. We detected a total of 38 breeding colonies along 2,375 km of coastline (20°45´ to 42°11´S). Total breeding population was estimated in 5,067 pairs (95% CI= 4,158-5,976 pairs), with >75% concentrated at two islands (1,045 at Chañaral and 2,859 at Choros). Data compiled by the IUCN-Penguin Specialist Group, suggested during the period 2002-2008, a total of 10,327 breeding pairs were present in Chile, with 80% concentrated at two islands (7,000 at Chañaral and 1,320 at Tilgo). In October 2018, a further census of active nests at Chañaral Island revealed nearly 400 pairs. These data suggest that a major decline in the size of the Chilean population has occurred during the last 15 years. Chañaral has been historically the largest colony of Humboldt penguins, so any threats affecting this colony may severely compromise the fate of this species. Urgent studies are needed to understand whether the population is experiencing a true reduction or if this may be part of an extreme fluctuation. Financial support was provided by Project FIPA 2016-33.

HICKCOX, Rachel

Environmental, climatic, and biological interactions influencing the marine distribution of yellow-eyed penguins (Megadyptes antipodes)

Presenter: Rachel Hickcox *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Rachel P. Hickcox, Yolanda van Heezik, Thomas Mattern, Melanie J. Young, Philip J. Seddon

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Abstract: The relationship between environmental predictors and the distribution of a species is a crucial indicator of ecosystem resilience under the pressure of environmental change. As central place foragers, penguins depend on the ocean to obtain food and the land for nesting. Understanding which environmental factors determine or limit foraging sites is important for conservation planning. We identify climatic, environmental, and anthropogenic factors that influence yellow-eyed penguin (*Megadyptes antipodes*) foraging distribution off mainland New Zealand. Using GPS foraging data from penguins breeding throughout Otago, we compare travelling and foraging areas with environmental spatial data. By determining the environmental conditions that yellow-eyed penguins require for foraging, we are able to highlight marine hotspot areas that are critical to population persistence and vulnerable to anthropogenic activities (fishing, mineral exploitation) and future environmental change.

MULLER, Chris

Factors affecting yellow-eyed penguin breeding and population dynamics in the New Zealand subantarctic

Presenter: Chris Muller *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Muller, C. G.; (1,2), Chilvers, B. L. (1), Battley, P. F (2), French, R. K. (2)

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Abstract: The yellow-eyed penguin (*Megadyptes antipodes*) is endangered and endemic to New Zealand, with populations and breeding success declining on the mainland. With less than 2% migration between mainland and subantarctic populations, these need to be managed separately. The subantarctic area is an important stronghold, representing over 60% of the total population. However, despite this importance the last population estimate for the Auckland Islands, the largest subantarctic breeding area, was in 1989 due to the difficulties of research there.

We carried out population estimates using methods developed specifically for yellow-eyed penguins which are non-colonial and cryptic breeders. Results demonstrated significant variation in the breeding population between years, particularly in the three decades since the historic count.

We also investigated foraging parameters including location, distance travelled, dive depth, and diet of breeding yellow-eyed penguins. All factors varied significantly between years, but correlated with each other leading to key conclusions about factors affecting breeding and population growth. In particular, the severe El Nino of 2015 illustrates the importance of large-scale effects on prey quality and availability. These factors are likely to become more significant with the influence of climate change, and this raises important concerns for future conservation and management of the species.

HOUSEMAN, Meg

Going my way? Validation of indicator sites for penguin population monitoring at a landscape scale

Presenter: Meg Houseman *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Meg Houseman, Stefan Meyer, Melanie J. Young, Yolanda van Heezik and Philip J. Seddon

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Abstract: Independence among subpopulations confers population stability at a landscape scale and has vital implications for the conservation management of endangered species. Monitoring of "indicator sites" is often a compromise where resources are limited, but this subset might not reflect the overall population trends. We explored the spatial population dynamics of yellow-eyed penguins, to understand whether synchronising mechanisms drive subpopulation declines on mainland New Zealand. The Boulder Beach subpopulation has declined in response to rising SST; however, it is unclear whether increased SST has equally affected other mainland sites, or whether population diversity provides a buffering effect against environmental impacts.

Using a multivariate state-space model fitted to 25 mainland breeding sites (1992 – 2016), we assessed the spatial structure of subpopulations of mainland yellow-eyed penguins, including growth rates, temporal variances, and how population dynamics are temporally correlated. Whilst there was synchrony, each site exhibited independent variation due to local factors or random variation.

Based on the estimated rates of population change and temporal correlation, we predict a high extinction probability for 23/25 breeding sites, suggesting that yellow-eyed penguins might become locally extinct within three decades. The moderate temporal correlation of population dynamics suggests that monitoring at Boulder Beach provides information that is generally indicative for the mainland population. The fact that two extensively managed monitoring sites exhibited positive population trends, albeit being temporally correlated with other sites, suggests intensive management is mitigating negative environmental impacts.

COLE, Theresa

Contrasting demographic histories between widespread and endemic penguin taxa

Presenter: Theresa Cole *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Theresa L. Cole (1, 2), Ludovic Dutoit (1), Nic Dussex (3, 4), Tom Hart (5), Alana Alexander (4), María José Frugone (6, 7), Jane L. Younger (8), Gemma V. Clucas (9), Yves Cherel (10), Richard Cuthbert (11), Ursula Ellenberg (12, 13), Steven Fiddaman (5), David Houston (14), Pierre Jouventin (15). Thomas Mattern (1), Gary Miller (16, 17), Colin Miskelly (18), Paul Nolan (19), Michael Polito (20), Petra Quillfeldt (21), Peter Ryan (22), Adrian Smith (5), Alan JD Tennyson (18), David Thompson (23), Barbara Wieneke (24), Juliana Vianna (6), Jonathan M. Waters (1)

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Abstract: The end of the Last Glacial Maximum 10,000 years ago resulted in demographic expansions in many taxa, particularly those with widespread distributions and high dispersal ability. Penguins are iconic marine birds that inhabit coastlines of all major landmasses in the Southern Hemisphere, including the subantarctic islands throughout the Southern Ocean and the sea ice around continental Antarctica. Although penguins are philopatric, many penguin species have high dispersal potential, with several taxa represented by colonies separated by thousands of kilometres of open ocean. Recent population genomic datasets have been generated for Aptenodytes and Pygoscelis penguins, although no genomic dataset has yet been developed for the species-rich Eudyptes clade. We generated a population genomic dataset of 261 individuals, spanning the entire distribution of seven Eudyptes penguins, including all widespread and most island endemic species.

We first tested for the presence of population level clustering and admixture within each species. We then tested for demographic expansions following the Last Glacial Maximum. To supplement our Eudyptes dataset, we obtained population genomic datasets encompassing an additional 341 individuals spanning all Aptenodytes and Pygoscelis species. Our results supported a scenario of high dispersal within each Eudyptes species, including island endemic and widespread species. Our demographic analyses across nine penguin species revealed contrasting histories following the Last Glacial Maximum, which may be linked to habitat preferences. Our genomic analyses reveal important insights into the histories of penguins and highlight the importance of species distributions in buffering the impacts of global climate change.

JONES, Fiona

Large-scale assessment of gentoo penguin breeding success using a remote time-lapse camera network

Presenter: Fiona Jones *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Fiona M. Jones (1), Casey Youngflesh (2), Joan Arthur (3), Zuzana Macháčková(3), Holly R. Torsey (3), Heather J. Lynch (4), Tom Hart (1)

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Abstract: In the Southern Ocean, two key threats to penguins (Family: Spheniscidae) are an expanding krill fishery and sea ice change, which have the potential to act synergistically – e.g. as the ice-free season lengthens, the time available for krill harvest is also increased. Understanding the impact of complex threats is important for the development of fishing policy and effective conservation strategies, yet this is challenging without rigorous, high-resolution monitoring. We use the Penguin Watch network of remote, time-lapse cameras to examine Gentoo penguin (*Pygoscelis papua*) chick survival in 15 colonies across the Western Antarctic Peninsula and South Georgia, across multiple years (representing the 2012/2013 – 2017/2018 seasons). Individual chicks were identified, hand-annotated, and assigned to nests in over 10,200 time-lapse images. This generated a database of chick number per nest, at each site, at regular intervals (generally bihourly during daylight hours) from chick hatch to crèche. The counts were employed in a model similar to a traditional capture-recapture model, with identification in an image analogous to a 'capture'. Since absence in an image is not necessarily an indicator of true absence, a Bayesian state-space framework was implemented to model both the 'true' and 'observed' states of chicks (i.e. present/absent) at each timestamp, to calculate survival rates. Chick survival was modelled as a function of a year-effect, a site-effect, the effect of average sea ice concentration, the effect of the annual total krill fishing effort, and a global intercept term, in order to investigate the relative contributions of these variables.

HART, Tom

Using citizen science and computer vision to understand behavioural changes in relation to climate and fishing

Presenter: Tom Hart

Authors: Tom Hart (1), Fiona Jones (1), Carlos Arteta (2), Ignacio Martinez (1), Chris Lintott (3)

Author Affiliation:
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(2) Department of Engineering, University of Oxford
(3) Department of Physics, University of Oxford

Abstract: Remote cameras, particularly motion-triggered devices, have long been used in ecological studies. Time-lapse cameras can create datasets of tens of thousands of images per site per year and can facilitate monitoring of infrequently visited colonies. However, the image data produced require further processing to be useful to analyses. Citizen science and machine learning provide solutions to scaling up data extraction (such as locating all animals in an image). However, there are still issues with parameter estimation (such as working out the timing of nest failure). Using data from the Penguin Watch (www.penguinwatch.org) network time-lapse cameras and citizen science project we discuss the use of human and computer - derived parameter estimation to investigate biological questions. We demonstrate how processed citizen science annotations and counts derived from automated computer vision can be processed to show the timing of breeding and reproductive success plus more fine-scale data such as foraging trip duration disturbance. By analysing over 40 sites monitoring all three pygoscelid species, we present data on penguin behavioural changes and interaction with the krill fishery on the Antarctic Peninsula that reinforce calls for increased protection in the region. Now these tools have come of age, we invite researchers to join a network of camera –monitored sites that can augment existing monitoring or add new sites to a global penguin network.

BARHAM, Peter

Awesome birds and rubbish birds

Presenter: Peter Barham

Authors: Peter Barham, Barbara Barham

Author Affiliation:
University of Bristol, UK

Abstract: We have followed the breeding successes and failures of a group of ca. 100 penguins on Robben Island over a five year period and found some remarkable differences in the success of individual birds.

One group of birds has been very successful; the top 17% of the penguins in our sample successfully fledged at least two chicks per year and raised one third of all the chicks fledged by birds in the sample. A second group of birds has had particularly poor breeding success; the bottom 10% of the penguins raised less than 0.5% of all the chicks fledged from the sample. These top and bottom birds perform consistently year on year and the same birds are found in each group every year.

These large differences in success can be largely explained by how often and how well these birds breed. The top 10% of breeding penguins average more than 1.75 breeding attempts per year and have above average success in fledging chicks. On the other hand, the bottom 20% average only 0.55 breeding attempts per year and have below average success in fledging chicks from their eggs.

Or put simply, the best penguins try to breed twice each season and have reasonable success in raising their chicks, while the poorest birds only attempt to breed every other year and are not very good at rearing any chicks they manage to hatch.

ORAL PRESENTATION ABSTRACTS - Monday

ESPINAZE, Marcela

Relationship between nest characteristics and ectoparasite infestations in African penguin nests

Presenter: Marcela P. A. Espinaze *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Marcela P. A. Espinaze (1, 2), Cang Hui (2, 3), Lauren Waller (4, 5), Sonja Matthee (1)

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Abstract: Bird nests can provide a suitable microclimate for the development of nest-dwelling ectoparasites. However, little is known with regard to the relationship between microclimatic conditions and parasite infestations in nests of the endangered African penguin. Artificial nests are commonly used at colonies to provide protected breeding habitats for African penguins. This study aimed to assess the nest characteristics, parasite infestations and basic health of penguins associated with three nest types (artificial, natural open and natural shaded) in the Stony Point colony, South Africa. Penguins (n=50 adults and 192 chicks) and their nests (n=308) were sampled seasonally during 2016 and once in 2017. Ectoparasites were recorded from penguins and their nests. Penguin morphometry was recorded and blood was collected for haematological analyses and haemoparasites incidence. Soil temperature and moisture in nests were assessed with iButtons and soil samples. Several nest characteristics were recorded. Soil temperature was higher and moisture lower in artificial nests. Tick and flea infestations were higher in warmer and drier nest conditions and in artificial nests, compared to the two natural nests. Flea abundance was positively related to nest occupancy. Penguin body mass was lower in natural open compared to artificial nests. Penguin body mass and chick body condition was lower in warmer nests. Nest-dwelling ectoparasites benefit from microclimatic conditions associated with artificial and natural covered nests. Penguin nest design should consider the local-scale factors on parasite populations, in order to minimize the potential risk that ectoparasites present for the conservation of African penguins.

ROBERTS, David

Responding to H5N8 Avian Influenza in African Penguins

Presenter: David Roberts

Authors: David Gordon Roberts (1), Laura Christl Roberts (2), Jessica Kemper (3)

Author Affiliation:
(1) Clinical Veterinarian, SANCCOB – the Southern African Foundation for the Conservation of Coastal Birds
(2) State Vet Epidemiologist, Western Cape Government - South Africa
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Abstract: The recent outbreak of H5N8 avian influenza first affected the domestic poultry in South Africa in mid-2017. Although it is most likely to have been spread through most of its range by wild birds, it was only detected in African penguins in South Africa in January 2018 and in Namibia in early 2019. During the outbreak in South Africa, approximately 100 African penguins (*Speniscus demersus*) deaths were officially attributed to H5N8 in South Africa, a possible 1 500 cases in Cape gannets (*Morus capensis*) and 5 000 cases in swift terns (*Thalasseus bergii*). The true numbers may be far higher. The ongoing outbreak in Namibia has already been responsible for approximately 500 African penguin mortalities since January.

It is a challenge to respond to a novel disease outbreak in endangered wild birds in their natural habitat and in a functioning rehabilitation centre which is constantly admitting and releasing birds. In both instances, the normal disease control and quarantine recommendations designed for farms and zoos are not necessarily appropriate. The outbreak response involved was complex and included disease diagnosis, the collection of epidemiological data, biosecurity measures, decisions on how to reduce disease spread and different treatment options for affected individuals. This was only possible through close collaboration between many stakeholders including conservation authorities, the state veterinary services and rehabilitation centers.

HAMLIN, Taylor

Modelling on the move: A review of advancements in movement ecology modelling, with application for penguins

Presenter: Taylor Hamlin *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Taylor Hamlin (1,2), Dr Matthew Schofield (1), Prof Phil Seddon (2), Dr Dean Anderson (3)

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(1) Department of Mathematics & Statistics, University of Otago, Dunedin, NZ.
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(3) Manaaki Whenua Landcare Research, Lincoln, NZ

Abstract: In recent years, the field of movement ecology has exploded, in large part due to recent rapid advancements in biotelemetry technology. This has allowed less disruptive tracking of species such as penguins, over longer intervals for smaller and smaller individuals. Because of this, collectively, researchers are beginning to accrue a wealth of information on the location and movement of their study species. However, this raises questions on how appropriate is the data we can collect and how effectively are researchers utilising it? This review will discuss how the study of movement ecology has progressed through time and the challenges and advancements that have shaped the field. I will discuss several issues relating to the modelling of movement data, including a lack of population-level inference, few links to ecological outcomes, and difficulty in implementing state-of-the-art statistical tools. I will use penguins as a model species, as they have garnered significant attention from movement ecologists. The marine lifestyle and often remote breeding and foraging locations of penguins have made where they spend their lives an interesting mystery. Because of this, penguins stand as one of the stalwart species of movement ecology, with a sizeable proportion of the movement literature being devoted to them. I will consider the future of the study of penguin movement ecology, including the potential for new advancements and possible issues that might arise.

MORANDINI, Virginia

*Impact of chicks mortality events in pygoscelis penguins populations: Adélie penguin (***Pysgoscelis adeliae***) at the Ross Sea, Antarctica, as a model***

Presenter: Virginia Morandini *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Virginia Morandini, Katie M. Dugger

Author Affiliation:
Department of Fisheries and Wildlife, Oregon State University, 104 Nash Hall, Corvallis, OR 97331, USA

Abstract: Antarctica and the surrounding Southern Ocean play a critical role in global climate changes and climatic fluctuations have been shown to affect population dynamics of top predators, such as seabirds. Rapid breeding failure of Adélie penguins has been observed in modern ecological studies as consequence of extreme weather events where most adults do not breed or a massive chick mortality entails productivity values close to zero. According to climate change predictions those extreme or rare environmental conditions are expected to increase in the future, increasing in consequence, the frequency of massive chick mortality in Adélie penguins' populations.

According that, we modelled the potential impact of chick mortality events on Adelie penguins' populations, simulating different scenarios with changes in populations' sizes, chick mortality rates and events frequency and duration, to understand the effects of massive nestlings' mortality events caused by environmental extremes on affected penguins' populations. We modelled populations responses with an individual base model for population viability analyses (Vortex simulation software). Our results show that longer mortality events even with lower intensity have higher impact on population dynamics than shorter events. And, that small colonies show delayed recovery time and higher probabilities of extinction with a lower number of catastrophic events. Our results suggest that colonies distributions, subcolonies abandonments and colonization processes will be affected in a climate change scenario.

LUDYNIA, Katta

Insights into the "lost years" of young African penguins: using transponders in SANCCOB's hand-reared penguins to understand movements and their role in bolstering the wild population

Presenter: Katta Ludynia

Authors: Katta Ludynia (1,2), Jennifer Grigg (3), Barbara Barham (4), Alistair Mcinnes (5), Nola J Parsons (1), Stephen van der Spuy (1), Rick Urban (6), Richard B Sherley (3)

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(5) Nelson Mandela University, Port Elizabeth, South Africa
(6) Mississippi Aquarium & AZA SAFE, USA

Abstract: Low juvenile survival has recently been identified as a key factor in the decline of the endangered African penguin. Studies have shown that fledglings face an "ecological trap" in their first months at sea but little is known about their movements as pre-breeders and their recruitment into the breeding population.

Since 2006, efforts have been made to increase the number of birds recruiting into the breeding population by rescuing prematurely abandoned chicks from the wild and sending them to SANCCOB's Chick Rearing Unit to be hand-reared. Initial studies confirmed that these hand-reared chicks survive, recruit in the wild and breed at similar rates to their wild-reared counterparts.

Since 2013, we have marked several thousand SANCCOB hand-reared and wild reared chicks with passive integrated transponders (PIT). PIT-tag receivers used in the main breeding colonies have allowed us to detect these birds as they visit and recruit into the breeding population.

Information obtained through the detection of transpondered birds highlight the continuous threat to young African penguins as birds continue to fall into the "ecological trap" when moving west and northwards. However, large numbers (>10% for hand-reared and >30% for wild chicks) have been detected at breeding colonies and data on when and where these birds return will be used to understand what governs recruitment. Ultimately, using transponders on hand-reared chicks will enable us to assess how best to maximize the value of the bolstering strategy at the population level.

HAGEN, Christina

Initial phases of re-establishing an African Penguin colony in South Africa

Presenter: Christina Hagen

Authors: Christina Hagen (1), Ross Wanless (1,2), Kevin Shaw (3), Lauren Waller (4,5)

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(4) Southern African Foundation for the Conservation of Coastal Birds (SANCCOB), Table View 7441, Cape Town, South Africa
(5) The Department of Biodiversity and Conservation Biology, University of the Western Cape, Bellville 7535, South Africa

Abstract: African Penguin *Spheniscus demersus* populations in South Africa are continuing to decrease despite the multiple interventions in place. A major recent driver is poor food availability due to shifting forage fish distributions and fishery competition; both may prove difficult to address directly. Establishing breeding colonies in areas of high fish availability and low fishing pressure on the southern coast could be one solution. Penguins have not been able to colonise this region because there are no islands there and breeding on the mainland puts birds at risk from native mammalian predators. Establishing colonies in novel areas or areas from which they have been extirpated has been a successful strategy for a variety of seabirds globally, although in the penguin group, only in Little penguins. A government-led Biodiversity Management Plan for the African Penguin identified the feasibility of establishing new colonies as a key action to be investigated.

Work has begun to re-establish a breeding colony at the De Hoop Nature Reserve, east of Cape Agulhas. In 2003, African Penguins attempted to breed at a small rocky headland, the colony growing to over 18 pairs with about 100 birds loafing. Predation ultimately caused the colony to be abandoned in 2006. We present progress made towards re-establishing this colony by excluding predators and using social, passive attraction techniques. The challenges and lessons learned will be discussed, including evaluating risks in the face of uncertainty, the challenges and benefits of stakeholder engagement and working in protected areas, and managing native predator impacts.

WEBSTER, Trudi

Conservation management in an unpredictable environment

Presenter: Trudi Webster

Authors: Trudi Webster (1,2) Bruce McKinlay (3), Amanda Salt (3), Kate McInnes (3)

Author Affiliation:
(1) Yellow-eyed Penguin Trust
(2) University of Otago
(3) Department of Conservation

Abstract: It is a critical time for the endemic hoiho | yellow-eyed penguin (*Megadyptes antipodes*), which is surviving at very low levels on the New Zealand mainland. The cumulative impacts of a range of marine and terrestrial threats, have led to increased mortalities and dramatically reduced the breeding success of this bird. The hoiho is an unfortunate indicator of the state of our coastal environment. The latest breeding season has been a particularly bad one with an estimated 225 breeding pairs on the mainland, down from 255 last year. Numbers have declined continuously since 2008 (from the mid-1990s onwards there were an estimated 400-600 pairs) and the threat of mainland extinction is very real. Breeding success was extremely low this season with very few pairs managing to fledge chicks naturally. The season was characterised by a series of adverse events, including two starvation episodes resulting from a changing marine environment, diphtheritic stomatitis, an avian malaria outbreak, and a small number of unexplained mortalities. These events are over and above the usual impacts from visitor disturbance, terrestrial and marine predators, and fisheries bycatch. Conservation management needs to be dynamic, flexible and adaptable enough to cope with the range and changing nature of threats facing hoiho. Human intervention is at an all-time high for these birds, without which their breeding success and survival is unsustainable and their future uncertain.

RAWLENCE, Nic

Sentinels of change: Ancient DNA shows penguins are key indicators of a dynamic world

Presenter: Nic Rawlence

Authors: Nic Rawlence, Jon Waters

Author Affiliation:
Otago Palaeogenetics Laboratory, Department of Zoology, University of Otago, Dunedin, New Zealand.

Abstract: Aotearoa New Zealand is considered the seabird capital of the world. However, this island ecosystem is a relic of its former self. The New Zealand archipelago is unique in that the often confounding impacts of climate change and humans can be clearly separated, allowing for a more nuanced view of how bird-dominated ecosystems change after human arrival. While the majority of ancient DNA research has focused on more charismatic avian megafauna, a growing number of studies on penguins is highlighting how seabirds can be powerful sentinels of change. In this talk I'll outline our labs research on penguins that has discovered human driven extinctions of previously unrecognised species, consequent biological turnover events linked with the Little Ice Age, population bottlenecks and range contractions. These discoveries show the past is the key to the present, and feed directly into evidence-based conservation management of our seabird taonga.

RICHARDS, Marcus

The Last Gargantuan Penguin – a Late Oligocene Fossil from the South Island, New Zealand

Presenter: Marcus Richards *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Marcus D. Richards, R. Ewan Fordyce

Author Affiliation:
Geology Department, University of Otago

Abstract: Giant penguins - those larger than the Emperor Penguin - lived some 55-25 million years ago (Ma) before inexplicably going extinct. We report a new giant penguin which, from ~25 Ma, is one of the youngest and largest recognised. The fossil was collected by a keen amateur, A.M.A. Engelbrecht, probably from rocks of the Waihao Valley. The specimen comprises paired humeri (upper wing bones), the left complete and the right bioeroded. The left humerus is the largest penguin humerus reported from Oligocene or younger rocks (<34 Ma). The bone is stouter and longer (182 mm) than the gracile ~176 mm humerus of the geologically-older *Kairuku grebneffi* which stood at ~1.28 m. Kairuku was the ultimate truly "giant" penguin genus previously reported, and only a few fossils slightly larger than *Aptenodytes forsteri* have been recorded from younger strata. The new giant was probably a little taller and heavier than Kairuku species.

Characters of penguin humeri reveal relationships. In addition to Kairuku-like features, the enormous specimen has a large humeral head relative to humerus size, a very small tricipital fossa, and a sulcus across the ventral tubercle, all reminiscent of Late Eocene giant penguins such as Palaeeudyptes. These and other features indicate a basal species, remote from the modern penguin radiation. Other Oligocene fossils previously recorded as 'Palaeeudyptes-like' await review and comparison with this new giant.

When and why did giant penguins go extinct? Biological or geological change have been proposed (predation, competition, versus climate, tectonics) - inconclusively

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TENNYSON, Alan

Two recently extinct penguin taxa from the Chatham Islands

Presenter: Alan Tennyson

Authors: A.J.D. Tennyson (1), T.L. Cole (2,3), D.T. Ksepka (4), D.B. Thomas (5),

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Ksepka,
(4) Bruce Museum, Greenwich, Connecticut, 06830, USA.
(5) School of Natural and Computational Sciences,Massey University, Auckland, New Zealand.

Abstract: In 2019 we described two new recently extinct penguin taxa from the Chatham Islands. The Chatham Island crested penguin (*Eudyptes warhami*) was a large crested penguin most closely related to the erect-crested penguin (*Eudyptes sclateri*) but with a shallower mandible and a more bowed premaxilla. Richdale's penguin (*Megadyptes antipodes richdalei*) was the smallest form of *Megadyptes*, being smaller than the yellow-eyed penguin/hoiho (*M. a. antipodes*) and the extinct Waitaha penguin (*Megadyptes a. waitaha*). Bones of both taxa were found in sand dune deposits younger than 7,000 before present and both were once widespread in the Chatham Islands archipelago before the arrival of humans. Today only the little penguin (*Eudyptula minor*) breeds on the Chatham Islands, yet 500 years ago the archipelago held substantial penguin diversity, with the two extinct endemic taxa alongside the little penguin and possibly the erect-crested penguin.

ORAL PRESENTATION ABSTRACTS - Tuesday

SCHNEIDER, Tom

Developing Partnerships with AZA Institutions to Further Penguin Conservation and Public Awareness

Presenter: Tom Schneider

Authors: Tom Schneider (1), Michael Adkesson, DVM (2), Patricia McGill, PhD (3), Anne Tieber (4)

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(2) Vice President, Clinical Medicine Chicago Zoological Society / Brookfield Zoo
(3) Program Leader, African Penguin SAFE
(4) Curator of Birds, St. Louis Zoo

Abstract: Association of Zoos & Aquariums (AZA) accredited institutions have supported conservation efforts for more than 40 years, but have ramped up these programs, spending $220 million in 2017 on direct field conservation. This includes the 2015 initiation of the Saving Animals From Extinction (SAFE) program, AZA's flagship conservation program, which selected African penguins as one of ten inaugural species. In support of the Biodiversity Management Plan for African Penguins, SAFE members coordinate projects in artificial nest box technology, PIT tag deployment, public engagement, and disaster readiness.

While SAFE is a new effort, AZA institutions have worked with NGOs, universities and governmental agencies to support Humboldt penguin conservation for over 30 years. These efforts include protecting the Punta San Juan colony, coordinating annual censuses, and funding Population Habitat Viability Analyses in 1998 and 2019. Recent collaborations for other species include research in the Falkland Islands and Antarctic Peninsula, and long-term financial support for programs in Galapagos Islands and Argentina. The AZA Penguin Taxon Advisory Group also participates in the IUCN Penguin Specialist Group.

In addition, AZA institutions have leveraged their experienced education staff to participate in public engagement at penguin field sites and develop interpretive messages for more than 180 million people that visit AZA institutions annually.

This presentation will discuss current and past AZA penguin conservation programs, unique resources and staffing zoos can provide, and how penguin biologists can develop collaborative relationships with AZA institutions to support field conservation efforts, public engagement and telling their stories to the AZA audience.

BUZZARD, Paul

Collaboration between the Detroit Zoological Society and Falklands Conservation in assessment of penguin populations in the Falkland Islands

Presenter: Tom Schneider

Authors: Paul Buzzard (DZS), Andrew Stanworth (FC), Ann Duncan (DZS), David Spivack (FC), Stephanie Allard (DZS), and Tom Schneider (DZS)

Author Affiliation:
DZS: Detroit Zoological Society; FC: Falklands Conservation

Abstract: The Detroit Zoological Society (DZS) works around the world to support and advance wildlife conservation, and with the development of the Detroit Zoo's Polk Penguin Conservation Center (PPCC), the DZS has strengthened financial support and field collaboration with the ngo, Falklands Conservation (FC) to achieve this. FC works to conserve some of the same penguin species as at PPCC (gentoo, rockhopper and king penguins), and from 2016-2018, the DZS and FC conducted joint expeditions to census penguins and assess habitat at remote and rarely visited islands owned by FC. In 2018, collaboration expanded to include health and welfare research with gentoo and rockhopper populations at two colonies, one in the more remote west and one near the capital, Stanley. Data gathered will serve as a baseline for future research, to assess potential human impacts and inform conservation efforts. Comprehensive health assessments were performed on 95 penguins, and included routine bloodwork to assess overall health and screening for infectious diseases, including PCR and serological screening for a variety of viruses and bacteria. Samples were collected for several physiological parameters of stress, including oxidative status, corticosterone levels, and telomere length, and for future testing to screen for heavy metals, persistent organic pollutants and chlorinated pesticides. Additionally, each penguin's behavior during handling was rated as one way to evaluate if participation in the project has any acute impacts on welfare. Continued monitoring and health and welfare assessments are planned to further understand and monitor human pressures and penguin conservation in the Falkland Islands.

SEAMAN, Laura

Aged Care for King Penguins

Presenter: Laura Seaman

Authors: Laura Seaman, Kristen Buckley, Nicola Walker, Amy Wardrop

Author Affiliation:
Sea Life Kelly Tarlton's Auckland, New Zealand

Abstract: Sea Life Kelly Tarlton's Auckland's penguin exhibit was built in 1995 with our initial King penguin colony from the USA hatched in 1988 & 1993. Currently, a third of our King colony are 26 years or older. This is a significant number of birds exceeding believed life expectancy and has necessitated a change in the way we manage our colony, ensuring all ages of life are accommodated for. We have attempted to establish what makes life 'good' for a King, and then created a way to assess how our older birds are measuring up to this, taking into consideration how age affects a penguins life. We've implemented daily observations of each bird's colony inclusion, activity, appetite and mobility to assess their wellbeing on a daily basis. This also allows us to see how their behaviours may change over time. The main issue we've found with older penguins is mobility - particularly arthritis. We have actively rearranged areas of the enclosure to accommodate for this; along with more variety of substrate and enrichment to allow the birds to find what suits their comfort and nature best. Quality of Life Assessments are also helping us to take emotion out of the equation, be subjective and quantitatively assess an individual's health and quality of life. With advances in captive penguin care, colonies are outliving previous life expectancies, but with limited worldwide knowledge for aged care for penguins, assessment tools and recording successful care strategies are a good starting point to guide future care.

VIBLANC, Vincent

A bridge between generations: positive effects of parental telomere length on offspring phenotype and survival in king penguins

Presenter: Vincent A Viblanc

Authors: Vincent A. Viblanc (1), Quentin Schull (1,2), Antoine Stier (3), Laureline Durand (1), Emilie Lefol (1), Jean-Patrice Robin (1), Sandrine Zahn (1), Pierre Bize (4), François Criscuolo (1)

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Abstract: What makes a high quality penguin? Can we measure individual quality in breeding colonies? Because telomere length and shortening rates are related to individual growth, reproductive investment and ageing, telomeres (genomic repeats that protect DNA) have emerged as possible markers of individual quality. Yet, how parental telomere length (TL) influences offspring early-life fitness, and the contribution of genetic and environmental factors in shaping offspring TL in early life remain unclear. To disentangle how genetic (biological parental TL) and environmental (foster parental TL) effects modulated offspring growth trajectories, survival patterns and TL dynamics, we swapped the single eggs of breeding king penguins (*Aptenodytes patagonicus*) shortly after laying. We found that (1) foster and genetic mother TL had positive additive effects on hatching success and chick survival to 105 days; (2) The body mass of 10 days-old chicks was related to the telomere length of genetic fathers, but the TL of chicks was foremost related to the TL of foster mothers, and to a lesser extent to that of genetic parents; (3) At 105 days, chick TL (but not body mass) was foremost explained by the TL of their genetic father and foster mother; (4) Breeding pairs were positively assorted by TL. Thus, choosing a partner with long telomeres appeared important in determining hatching success, early chick mass and telomere dynamics over growth in king penguin. Remarkably, chick's phenotype seem to be foremost influenced through genetic effects associated with their genetic father TL and environmental effects associated with their foster mother TL.

FERNANDES, Flávia

Evolutionary and biogeographic history of extant penguins (Aves: Spheniscidae) using genomic data

Presenter: Flávia Akemi Nitta Fernandes *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Flávia A. N. Fernandes (1), Juliana A. Vianna (2), Rauri Bowie (3), Ke Bi (4), Daly Noll (2), Celine Le Bohec (5), Christopher Burridge (6) , Claudia Godoy (7), Patricia Parker (8), Gisele Dantas (9), Barbara Wienecke (10), Andrea Polanowski (10), Antje Steinfurth (11), Francesco Bonadonna (12), Pierre Pistorius (13), Cynthia Y. Wang-Claypool (3), Elie Poulin (14), Mariana F. Nery (1).

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Abstract: The evolutionary and biogeographic history of marine species is highly dependent on their biology and the oceans they inhabit, which is the case of extant penguins (Aves: *Spheniscidae*). Although previous studies have focused on unraveling the evolutionary relationships of penguin species and the connection with their distributional range, the hypotheses in literature remain controversial. We used ultraconserved elements as genomic markers in order to unravel the main questions about the evolutionary history of extant penguins: (i) what are the evolutionary relationships among penguin taxa, (ii) when radiation events occur, (iii) what is the most likely geographic range of the ancestor of crown penguins, and (iv) how the diversification events correlated with the Southern oceans' dynamics and geology. To answer these questions, we inferred a robust phylogenetic tree and estimated the divergence times and ancestral range of penguins using molecular data in genomic scale. We demonstrate how genomic-scale data can support the resolution of incongruences in the evolution of penguins. Our results can aid further interspecific and intraspecific comparisons on the importance of ocean and climate conditions in the radiation of different penguin species, which can be useful to model these birds' putative responses to the ongoing climate change conditions.

VIANNA, Juliana

Comparative population genetics and phylogeography of penguins in the Southern Ocean and South America

Presenter: Juliana A. Vianna

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Abstract: Penguins have a wide latitudinal distribution across different environments in the southern hemisphere. In the Southern Ocean, the polar front (PF) and the subtropical front (STF) are associated to strong north/south variations in temperature and salinity, delimiting the Antarctic and Subantartic biogeographic Provinces. Such oceanographic fronts may act as a barrier to dispersal of marine biota, generating genetic structure and promoting lineage diversification. Moreover, alternance of glacial and interglacial periods during Pleistocene should have also affect the geographic distribution and population size of these species. During the last years, we have been evaluated mtDNA, microsatellites and genome-wide markers for several penguin's species along their distribution within Antarctica, across the fronts, up to north. We found contrasting phylogeographical and Population Structure patterns within species for Spheniscus, Pygoscelis, Eudyptes, however the PF and STF always act as a barrier of gene flow in different degrees, depending of the taxa. Low degree of introgression has been detected overall among species, which level increase among closely related species. Lack of divergence and incomplete lineage sorting has also been detected between closely related species. Our results are part of long term international collaboration which has been significantly contributing to the penguins knowledge and conservation worldwide.

WALKER, Brian

Potential of epigenetic effects on the glucocorticoid stress response in Magellanic penguins exposed to tourist visitation

Presenter: Brian Walker

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Abstract: Penguins are charismatic birds that people want to see in the wild. How such tourist visitation affects birds at breeding colonies has been the focus of extensive study. In Magellanic penguins (*Spheniscus magellanicus*) we have shown that birds appear relatively robust to tourist visitation. There are, however, some interesting physiological impacts on penguins that experience tourist visits, particularly in colonies with higher visitation intensity and a longer history of visitation. We compared two colonies with different levels and history of tourism, and show that in eggs laid in the tourist area of the most visited Magellanic penguin colony in Argentina - Punta Tombo - recently hatched chicks show an unexpectedly high glucocorticoid stress response, regardless of where the eggs were incubated/hatched (as determined via egg exchange studies). In contrast, both in eggs laid in areas at Punta Tombo without tourist visits, and in eggs in both tourist-visited and un-visited areas at a less extensively visited Argentine colony - San Lorenzo - eggs produce chicks with the expected low "hyporesponsive" glucocorticoid stress response regardless of where they are hatched. We discuss the potential of this phenomenon as an epigentic effect passed to chicks from parents. Future research will be directed to determine the potential causes and effects of this response.

DEWAR, Meagan

Penguin Metagenome

Presenter: Meagan Dewar

Authors: Meagan Dewar (1,2), Stuart Smith (3), John Arnould (4), Peter Dann (5), Phil Trathan (6), Theo Allnutt (7)

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Abstract: Within all higher organisms, lives a thriving ecosystem of microorganisms including, bacteria, viruses and fungi. These microorganisms are crucial for an animal's health, nutrition and physiology, playing an important role in digestion, protection against harmful pathogens, secretion and synthesis of essential vitamins, minerals and amino acids. So what microbes colonise the penguin gut and what functional pathways are involved?

Previous studies using amplicon sequencing have assisted in the profiling of the microbial community within different penguin species. However, amplicon sequencing is restricted to a specific target region (bacteria, virus, and parasite) and due to the short read length is often unable to identify organisms to the species and genus level. This study used shotgun metagenomics to sequence the microbial community (including viruses) and the associated functional pathways of king, gentoo, macaroni and little penguins. Similar to previous studies species specific differences were observed between the four species. In addition a number of known pathogenic organisms were identified along with known avian and murine DNA viruses that have previously not been observed in penguins and 1 unknown virus. Over 2,600 functional pathways were identified in the study with significant differences between species overserved in approximately 2,000 pathways, with many of these pathways being present in little and macaroni penguins and absent in king and gentoo penguins.

LOIS, Nicolás

Intraspecific genetic structure and foraging plasticity in the Southern Rockhopper Penguin

Presenter: Nicolás A. Lois *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Nicolás A. Lois (1,2,3), Leonardo Campagna (4,5), Ulises Balza (2,3), Mike Polito (6), Klemens Pütz (7), Juliana A. Vianna (8), Annick Morgenthaler (9), Esteban Frere (9), Ricardo Sáenz-Samaniego (3), Andrea Raya Rey (3,10,11), Bettina Mahler (1,2)

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Abstract: Population connectivity is mainly driven by individual dispersal potential and modulated by natal philopatry. In seabird species, high levels of philopatry have been classically reported but also new colony foundation is widespread and increasingly recorded. Under the current climate change scenario, this apparent paradox could turn into a key factor for the evolution of marine bird species. In this study, we assess the level of past and current connectivity among Southern rockhopper penguin colonies using a combination of genomic (ddRAD-seq) and stable isotope analyses. We sampled 140 adult individuals from 7 colonies in the south western Atlantic Ocean: Isla de los Estados (83) and Isla Pingüino (14) in southern Argentina, Isla Terhalten in southern Chile (20), and Islas Malvinas/Falkland Islands (23). We found two distinct genetic clusters and detected low levels of gene flow from the northern (Isla Pingüino, Falklands) to the southern (Estados, Terhalten) population. Stable isotope values differed both between and within genetic clusters, supporting previously reported intraspecific plasticity in foraging habitats and behavior for these populations which are generally associated with local oceanographic conditions. We propose that foraging niche diversification will drive metapopulation demographic patterns, including colony foundation and connectivity in seabird species.

DODINO, Samanta

A tale of three "cities": variations by site and ages in isotopic composition and mercury concentrations of Magellanic penguin during the pre-molt stage

Presenter: Samanta Dodino *ELIGIBLE FOR STUDENT ORAL AWARD*

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Abstract: Penguins are good indicators of environmental changes and respond to oceanographic conditions within their foraging grounds. We studied adult and juvenile Magellanic penguin (*Spheniscus magellanicus*) trophic niches using stable carbon (δ13C) and nitrogen (δ15N) isotopes and determined their feather mercury (Hg) concentrations. We sampled feathers during the pre-molt stage from three colonies of Tierra del Fuego with different oceanographic conditions and population sizes: Staten (1,000 pairs), Martillo (5,000 pairs) and Observatorio Islands (70,000 pairs). Adults had higher δ15N and δ13C values compared with juveniles for the three colonies ($p < 0.05$), and occupied a higher trophic position (TP) that was reflected in their higher Hg concentration. Adults did not differ in δ15N values, while δ13C values differed significantly only between Franklin Bay on Staten Island and Martillo Island. We found significantly higher adult Hg concentration and a wider isotopic niche in Observatorio Island compared with Franklin Island and Martillo Island, despite their similar TP. Meanwhile, juveniles from Martillo Island had significantly higher δ13C and δ15N values relative to the other colonies. Juveniles had similar TP but differed in Hg concentration, with the lowest Hg concentrations at Martillo Island and the highest at Observatorio Island. These results suggest that foraging area differences among colonies may explain the observed patterns in Hg concentration and isotopic niche more so than TP. This demonstrates the plasticity of these penguins according to the oceanographic variability in their preferred foraging grounds and demography with positive implications in terms of conservation under a climate change scenario.

COTTON, Ali

Could eDNA help map the dynamics between African penguins and their prey?

Presenter: Ali Cotton

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Abstract: Human actions are profoundly altering the oceans, threatening the existence of many large marine animals. The Endangered African penguin (*Spheniscus demersus*) is one such species, with both climate change and fishing practices negatively impacting the survival of this charismatic predator. It is critical that we understand how African penguins are using their environment and particularly how they are interacting with their prey as abundance and distribution of these species continues to change. Current methods of tracking penguins to understand their general distribution, whilst providing powerful individual data, are expensive, often invasive and subsequently result in small sample sizes. Understanding prey (fish stock) movements are done separately, often utilising large-scale fish sonars, primarily close to shore. As both penguins and fish move through the water, they shed DNA and this environmental DNA (eDNA) can be extracted to detect species' presence and abundance. In this talk, I will discuss the potential to utilise eDNA as a non-invasive tool to detect the presence of both penguins and fish simultaneously, and understand where they are matched or mismatched in both space and time across key areas of their range. I will discuss the genetic work that has been undertaken and the challenges and opportunities that this technology might provide for African penguin conservation.

HAMMER, Tracey

Social signaling of individual quality in king penguins: an experimental test of auricular feather patch as a « badge-of-status »

Presenter: Tracey L Hammer *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Tracey L Hammer (1), Vincent A Viblanc (1), Antoine Stier (2), Denis Michaux (1), Emmanuelle Voisin (1), Jean-Patrice Robin (1), Pierre Bize (3), Quentin Schull (1,4)

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Abstract: Understanding the evolution of exaggerated morphological signals in animals is a central question in evolutionary biology, as those signals often appear costly to produce and maintain. King penguins are a monomorphic species where both males and females share conspicuous yellow-orange auricular feather patches known to relate to individual aggressiveness/territoriality and position in the breeding colony. Individuals with larger auricular patches are more aggressive and secure more central spots in the colony, thought to be of higher breeding quality. However, whether auricular patches of king penguins are used as "badges-of-status", hence allowing individuals with larger patches to signal to conspecifics both their aggressiveness and their ability to bear the costs of frequent aggressive contests, remains unknown. Here, we will present results from a study where we experimentally reduced the auricular patch size of experimental birds by colouring in black the yellow auricular feathers, and compared them to control birds where we only coloured in the black feathers surrounding the auricular patch (i.e. no reduction in auricular patch size). We investigated the effects of our treatments on individual behaviour and physiology including the time spent in aggressive contests, stress levels (assessed both through heart rate and glucocorticoid stress hormones), and finally on resting and daily energy expenditure assessed through heart rate. Our results suggest a mild increase in resting energy expenditure and heightened stress responses to acute disturbances (captures) in treated vs. control birds, consistent with the idea that auricular patch size may signal social dominance in this species.

SEDDON, Philip

Penguin Portraits: The rise and impact of wildlife selfies

Presenter: Philip Seddon

Authors: Philip Seddon

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Abstract: Urbanisation and the general public's associated alienation from the natural world, an increase in animal encounter opportunities within commercial captive collections, together with hugely enhanced image-sharing capacity through social media, have given rise to a proliferation of "wildlife selfies", self portraits taken with an animal in shot, or even in hand. The more exotic the animal and the location, the greater the social cache accorded to a selfie. Close human proximity for many wild species is known to reduce fitness by causing deleterious stress responses, disrupting normal behaviours, compromising immune systems, and increasing exposure to zoonoses. There is evidence too that even in captive collections with habituated individuals, wildlife selfies can undermine conservation messaging and set public expectations that wild animals can be approached. The local organising committee of the 10IPC found itself in a debate over whether to accept conference sponsorship from institutions promoting penguin encounters. This spilled out into wider issues around the freedom of penguin researchers to take their own "wildlife selfies" during the course of their sometimes intrusive, studies of wild penguin populations. This talk aims to set out a framework for considering the spectrum of activities that are associated with wildlife selfies in general, and explores the pros and cons of "close-encounters of the penguin kind" in terms of individual animal welfare, wildlife population management, public perceptions of wildlife, and conservation messaging.

ORAL PRESENTATION ABSTRACTS - Wednesday

CAPPELLO, Caroline

Consequences of delayed and less synchronous breeding in Magellanic penguins (Spheniscus magellanicus)

Presenter: Caroline D. Cappello *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Caroline D. Cappello, P. Dee Boersma

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Abstract: Global change is causing widespread shifts in the timing of key biological events (i.e. phenology). As such events drive population dynamics, species distributions, and ecological interactions, understanding the implications of phenological shifts may aid in conservation planning. Breeding has become later and less synchronous in the Magellanic penguin (*Spheniscus magellanicus*) colony at Punta Tombo, Argentina, but the extent to which these changes influence demographic rates is unknown. Once the largest breeding colony of this species, the population at Punta Tombo has declined over 40% since the 1980s. We used our 34-year dataset to examine the consequences of later and less synchronous breeding at Punta Tombo. Chicks hatched 0.23 days later each year, amounting to 8 days over the course of the study. Reproductive success varied considerably among years, but overall, chicks that hatched earlier and later than the mean hatch date of the given year were significantly less likely to fledge than those that hatched closer to the mean. Survival was highest in chicks that hatched 0.8 days before the mean hatch date. Though hatch dates at the colony were progressively later, fledge dates remained the same over the 34-year period. Similarly, later-hatched chicks that did fledge did so at a significantly younger age than earlier-hatched chicks. Our results suggest that delayed breeding has significantly decreased reproductive success and shortened nestling periods at Punta Tombo. These changes may ultimately influence juvenile survival, adult recruitment, and population viability.

WALLER, Lauren

Moult phenology of adult and juvenile African penguins (Spheniscus demersus), are we seeing adjustments in timing of moult in the Benguela Upwelling System?

Presenter: Lauren Waller

Authors: Lauren Waller (1, 2), Peter Barham (3), Barbara Barham (4), Richard Sherley (5), Robert Crawford (6), Katrin Ludynia (2,7), Azwianewi Makhado (6,8), Leshia Visagie (6), Bruce Dyer (6), Les Underhill (7), Alison Kock (9), Johan Visagie (10), Deon Geldenhuys (10, Cuan McGeorge (10)

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Abstract: Counts of active nests provide estimates of a breeding population, yet moult counts in African penguins (*Spheniscus demersus*) can provide an estimate of the total population. Comparing the ratio of moulting to breeding birds can give an estimate of numbers of adult-plumaged birds electing not to breed, an important aspect to consider in an endangered species. Moult of African penguin in adult and juvenile plumaged birds from five colonies in the Western Cape, South Africa was analysed for seasonality, synchronicity and colony population estimates. Moult seasonality for both adults and juveniles was bimodal, with the major peak in summer (November/December). Some colonies were more synchronous than others, and shifts in the timing of peak moult were observed. Drivers for this change are considered. Formerly, adult penguins usually moulted at their breeding colony but this is no longer the case for all penguins. Given that there is now movement of adults from their breeding colonies to other moulting locations, moult counts need to be considered on a regional, as opposed to colony, scale when interpreting population estimates based on these counts. The number of adult-plumaged moulters has declined considerably in the Western Cape. While Stony Point is an important breeding and moulting colony for adult and juvenile African penguins in the Western Cape, these counts still represent a decline and not a redistribution of birds. Information derived from moult counts can provide an indication of areas that are considered more abundant in terms of food availability and assist in improved protection.

EMMERSON, Louise

Insights into the behaviour of non-breeder penguins: patterns of seasonal mass change

Presenter: Louise Emmerson

Authors: Louise Emmerson (1), Sarina Walsh (2), Colin Southwell (1)

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Abstract: Because of the difficulty in studying non-breeding penguins very little is known about them or their resource requirements which is unfortunate because they are a significant component of a population. Here we bring together data sources on the non-breeders to understand what they are doing during the breeding season, particularly related to their seasonal mass changes. In terms of body mass changes, our expectation is that non-breeders will 1) be in poorer condition than the breeders which potentially explains why they do not breed, or 2) remain at a stable higher mass as they are unconstrained by physiological costs associated with rearing chicks. Here we interrogate body mass data of breeding and non-breeding birds of two penguin species to assess whether differences in mass exist and when. The first data set is from a wild Adélie penguin population, where bird mass was recorded automatically and breeding status determined from a resighting program. A second population of captive gentoo penguins were weighed regularly each breeding season. We demonstrate that although there were times in each year when breeders were heavier than their non-breeding counterparts for both populations, the mass changes showed similar patterns throughout the breeding season irrespective of breeding status. It appears that breeding status per se and the constraints that breeding places on birds is not the only driver of changes in mass throughout the breeding season and, although not explicitly studied here, the role of hormones in driving changes in appetite could be key to explaining these results.

SCHULL, Quentin

Linking ornamentation to mitochondrial function in breeding king penguins

Presenter: Quentin Schull *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Quentin Schull (1,2), Antoine Stier (1,3), Jean-Patrice Robin (1), Damien Roussel (4), Vincent A. Viblanc (1), Pierre Bize (5)

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Abstract: A central aspect of sexual and social selection theories is that ornaments provide reliable (i.e. honest) information on the current condition of their bearer. However, the mechanisms that may enforce the honesty of ornaments remain debated. The 'condition-dependent signalling hypothesis' proposes that honesty is enforced by physical, developmental or physiological constraints that cannot be cheate and a universal mechanism was recently proposed who highlighted that mitochondrial function may underlie the associations between ornamentation, condition and performance for a broad range of traits across taxa. Mitochondria are cellular organelles responsible for the transduction of energy from food into the cell and whole organism therefore defined as "the powerhouse of the cell". Mitochondria are also the primary producer of reactive oxygen species (ROS) that have important roles in cell signalling and immunity but that can also, when produced in excess, damage cellular components. Therefore, if ornament production relies on mitochondrial function and ATP/Energy production efficiency and allocation, we expect that ornament quality should mirror mitochondrial function. Adult king penguins display conspicuous yellow to orange feathers on both side of the head (auricular patches) and on the breast, and yellow-orange beak spots that also reflect UV. Using breeding king penguins, we report here on one the first investigation of the links between mitochondrial function and ornamentation. We show in breeding king penguins that the UV brightness of the beak spot is negatively linked to mitochondrial endogenous respiration measured in red blood cells and therefore honestly reflect individual metabolism.

MCINNES, Alastair

Group foraging in African penguins - improved foraging efficiency and benefits to volant seabirds

Presenter: Alistair McInnes

Authors: Alistair McInnes (1), Lorien Pichegru (1), Cuan McGeorge (2), & Pierre Pistorius (1)

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Abstract: Group foraging is known to improve the foraging efficiency in aquatic predators, such as dolphins who have the ability to herd prey into situations that are more profitable to conspecifics and other species who take advantage of these aggregations. Many penguin species are known to associate in groups at sea and are also thought to facilitate prey capture by volant seabirds. We documented the foraging behaviour of African penguins using animal-borne video recorders to assess the benefits of group foraging on their principle prey, small pelagic fish. Individuals pursued both solitary as well as schooling pelagic fish, and demonstrated independent as well as group foraging behaviour. Catch-per-unit-effort was significantly improved when targeting fish schools as opposed to single fish, especially when foraging in groups. The most profitable foraging strategies involved group corralling of schooling fish from depths > 30 m to the near surface. In addition to improving foraging efficiency among conspecifics this hunting strategy facilitated prey access to volant seabird species. Our results show that volant seabird species are actively cuing on penguins at the surface to look for signs of prey availability. The implications of these findings are discussed in terms of allee effects and the significance of African penguins to inshore seabird communities.

VAN HEEZIK, Yolanda

*Evidence for declining diet quality of mainland yellow-eyed penguins (*Megadyptes antipodes*): is this their final dive?*

Presenter: Yolanda van Heezik

Authors: Melanie J. Young, Fiona Robertson, Ludovic Dutoit, Thomas Mattern, Philip J. Seddon, Bruce C. Robertson, Yolanda van Heezik

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Abstract: Diet variability is a significant driver of seabird productivity, but long-term monitoring is necessary to identify whether changes in diet might be responsible for ongoing population declines. Traditionally, stomach flushing has been used to quantitatively determine penguin diet, and provides species-level resolution, however less-invasive biochemical methods are also being developed, although they do not always offer the same level of diagnostic accuracy. We used DNA meta-barcoding to determine the current diet of yellow-eyed penguins on mainland New Zealand, following a 25-year knowledge gap and calorimetry to investigate potential changes in diet quality. Our results suggest shifts in species taken and a decline in overall diet quality of mainland yellow-eyed penguins, which supports our observations of poor adult survival and low reproductive success in the mainland population, factors that will lead to localised extinctions.

THIEBOT, Jean-Baptiste

Jelly Bellies: re-thinking why penguins consume gelatinous prey

Presenter: Jean-Baptiste Thiebot

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Abstract: There is growing evidence that gelatinous zooplankton ("jellies") are a regular prey for a wide array of marine endotherms including penguins. This interaction has been documented across the southern oceans and using varied techniques. Consumption of jellies is intriguing in terms of energy reward, given endotherms have relatively high energy demands and jellies would provide little energy as prey. Here we show that many of the intuitive hypotheses commonly raised to explain predation on jellies have already been tested and most of them are unsupported. We emphasize that jellies are generally a non-anomalous prey (i.e., not reflecting a collapse in the trophic webs), and propose that they might be beneficial to penguins for non-energetic reasons, such as enhancing physiological processes. Changing the "junk-food" hypothesis for a "green tea" framework may thus allow to better understand the widespread predation on jellies, although further biochemical analyses are needed to clarify this point.

WHITE, Jeff

Investigating Fiordland penguin (tawaki) dietary plasticity using stable isotope analysis

Presenter: Jeffrey White *ELIGIBLE FOR STUDENT ORAL AWARD*

Authors: Jeffrey White (1), Thomas Mattern (2,3), Ursula Ellenberg (3,4) Pablo Garcia-Borboroglu (3,5), David M. Houston (6), Philip Seddon (2), John Hopkins III (7), Brooke Crowley (8), Herman Mays (1)

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Abstract: Fiordland penguins or tawaki (*Eudyptes pachyrhynchus*) depend on the abundant resources of the Tasman Sea and Southern Ocean to ensure reproductive success and build fat reserves to sustain them during the molting fast. Climate change impacts prey distribution and abundance, which will require penguins to change their foraging behavior. Tawaki exploit a broad range of marine ecosystems suggesting they have higher diet plasticity than most other penguins. To assess differences in foraging strategies between sexes and among marine habitats, we analyzed stable isotope ratios of carbon (13C/12C expressed as δ13C values) and nitrogen (15N/14N expressed as δ15N values) in penguins from three sites associated with either pelagic, continental shelf, or fjord marine habitats. This allowed a comparison of dietary preferences across the breeding range during incubation and among sites during the pre-molt dispersal. We examined whole blood (which integrates prey intake within 2 weeks prior to sampling) and feathers (which represent dietary preferences during the pre-molt dispersal and feather formation) and assessed isotope values using SIBER. Although we found that stable isotope values did not differ significantly between sexes, they did vary among locations, suggesting that penguins used different foraging strategies in each habitat. As climate change continues to affect marine ecosystems, detailed investigation of tawaki foraging ecology will be critical for understanding how penguins will respond. We will construct isotope mixing models (IsotopeR) to better understand foraging behavior and use these results to estimate dietary requirements that will impact reproductive success and survival of tawaki under different climate scenarios.

STEINFURTH, Antje

The effect of latitude on the foraging behaviour of the most northerly Eudyptes penguin

Presenter: Antje Steinfurth

Authors: Antje Steinfurth (1,2), Richard J Cuthbert (3,4), Trevor Glass (5), Mara Nydegger (4), Chris Bell (4), Ben J Dilley (2,6), Delia Davies (2,6), Azwianewi Makhado (6), Robert J M Crawford (6), Peter G Ryan (2), Ross Wanless (2,7), Alex Bond (4,8), Norman Ratcliffe (9)

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Abstract: Tristan da Cunha and Gough Island are home to ~90% of the global northern rockhopper population. Despite the close proximity between the islands, Gough constitutes the only breeding site for this species south of the sub-tropical front placing the islands in two different biogeographical realms. The study aimed to (1) identify key foraging areas by combining year-round tracking data and (2) assess the effects of intrinsic (sex, stage) and extrinsic (island, year) factors on the rockhopper foraging behaviour. Penguins were tracked on either side of the front: Nightingale (north) and Gough (south) in 2012/13 and 2013/14 and again on Nightingale in 2016/2017. Penguins displayed discrete foraging behaviours, distributions, and habitat use during both the breeding and non-breeding seasons. While Nightingale penguins showed high variability in foraging locations during incubation and dispersed widely across the South Atlantic during winter migration, penguins on Gough displayed strong directionality with high continuity, travelling south/southeast towards the sub-antarctic front. During chick-rearing, penguins stayed close to home with an average foraging distance of 34 and 25 km for Nightingale and Gough birds, respectively, and showed high fidelity to foraging areas between years. Trip metrics across stages therefore were affected by island but not by year, with foraging effort being significantly higher on Nightingale Island.
Our results show that northern rockhoppers demonstrate foraging plasticity as a response to distinct marine environments. This ability is likely to be particularly important under increasing extrinsic constraints such as long-term environmental change.

PÜTZ, Klemens

The effect of oceanographic conditions on wintering strategies of Rockhopper penguins Eudyptes chrysocome from two distinct locations: Falkland/Malvinas and Staten Islands

Presenter: Klemens Pütz

Authors: Sabrina Harris (1), Klemens Pütz (2), Benno Lüthi (2), Andrea Raya Rey (1)

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Abstract: Premoult foraging is essential for penguins to restore body condition after breeding and to gain enough energy reserves to sustain them during moult. In February/May 2016, a large die–off was observed in moulting Southern Rockhopper penguins *Eudyptes chrysocome* from the Falkland/Malvinas Islands. In March 2016, twelve adult Rockhopper penguins from East Falkland and sixteen penguins from Staten Island, Argentina, were equipped with satellite transmitters and their dispersal subsequently monitored. Results obtained were compared with tracking data from previous studies in the Falklands/Malvinas (1998,1999 and 2000) and Staten Island (2002 and 2003). In earlier years, penguins from the Falklands/Malvinas usually relied heavily on shelf areas and the shelf break. In 2016, they also travelled to the south and east into the open ocean, when sea surface temperatures (SST) were lower than historic average at both locations. In contrast, penguins from Staten Island migrated south beyond the Polar Front into deeper waters, either remaining to the east of the continent (2003) or moving westwards into the Pacific (2002 and 2016). Thus, Southern Rockhopper Penguins from the Falklands/ Malvinas seem to be more reliant on the productive continental shelf for their winter food supply and are thus more affected by changes in productivity in this region. Staten Island birds appear to behave more dynamically, actively searching for productive areas in the open ocean. Our results confirm that this species is very sensible to changes in SST, particularly in their northern distributional range, which makes them susceptible to global climate change.

MARKER, Perviz

North, South, East or West – which is best?

Presenter: Perviz Marker

Authors: P.F. Marker (1), M.A. Hindell (2), A.M.M Richardson (1)

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Abstract: Proximity to food resources determines the distance from foraging area to terrestrial habitat in seabirds. Open areas, underground or under vegetation are typical of seabird nesting sites. So what characteristics of the nest site are important, and can a model be used to describe them? This study developed a model of nest-site habitat for little penguins (*Eudyptula minor*), a burrowing seabird, using the terrain variables derived and extracted from a digital elevation model (DEM). Accurate positions of 1600 burrows were mapped in six sample colonies using differential GPS. Random points were generated from the DEM to represent locations where no burrows were found and the two data sets were combined and tested. The model explained 62% of the variation for predicting the presence of burrows but only 42% for predicting their absence. Thus, unused habitat might have the capacity to support more nesting sites given the right environmental conditions. This study is an example of how terrain variables obtained from a high resolution DEM can support model development by providing data that are not easily accessed in the field. Such a model can assist conservation and planning.

REBSTOCK, Ginger

Foraging-site fidelity in chick-rearing Magellanic penguins

Presenter: Ginger A. Rebstock

Authors: Ginger A. Rebstock (1), P. Dee Boersma (1,2,3), Pablo Garcia-Borboroglu (1,2)

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Abstract: When foraging on spatially predictable resources, animals should return to the same site to forage. When foraging on unpredictable resources, they should explore a variety of sites. To determine how foraging-site fidelity affects breeding success, we compared foraging-site fidelity within breeding seasons among Magellanic penguins rearing chicks at Punta Tombo, Argentina. Our index combined distance to the farthest point of each foraging trip and bearing to that point. The index comparing two trips ranges from -0.99 (foraging locations far apart) to 1 (same distance and direction). The mean of all pairwise comparisons for a penguin's trips is the index for that penguin. Fidelity indices averaged 0.54 (range -0.10-0.90, n = 192). Penguins were more consistent in their directions (0.83, 0.2-0.98) than in their distances (0.26, -0.89-0.90). Penguins that were least faithful to foraging sites were likely to raise two chicks because they made short foraging trips (< 1 day) as well as longer, multiday trips. Penguins that were most faithful to foraging sites had a high probability of raising one chick. The probability of raising zero chicks did not change with foraging-site fidelity. The fidelity indices of penguins that made short trips were similar to those of penguins that made only long trips when we excluded short trips. Penguins that made short trips were not in better body condition than penguins that only made long trips. We found that penguins at Punta Tombo should have high site fidelity during multiday trips and make some short trips to raise two chicks.
